
# Participative Water Demand Management as an Adaptive Response within Complex Socio-Institutional Systems: A Case Study of Cape Town, South Africa

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# DECLARATION

I, Nina Susara Viljoen, know the meaning of plagiarism and declare that all the work in this document, save for that which is properly acknowledged, is my own.

Signed: Signed by candidate Date: June 2019

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## ABSTRACT

Worldwide adaptive strategies are being developed to address water insecurity. The current path of water resource management is not sustainable in the long-term, which requires the investigation of improved and adapted strategies. However, adaptation theory is proving difficult to implement. A range of serious practical issues are emerging as adaptation moves from theory to implementation. One of these is that the implementation of water demand management strategies are not aligned with the needs of the water users. Improvement can effectively enhance the success of water demand management, especially in cases where a water institution's focus differs from the priorities identified by the water users. The aim of this thesis is to examine and analyse the role of participative water demand management in complex socio-institutional systems theory, and its potential to ameliorate adaptive capacity within the system in response to increasing water stresses. The research methodology consists of a literature review as well as a case study. The literature review include a discussion on the key concepts of adaptation theory, participative water demand management, and complex socio-institutional systems theory, amongst others. The case study contributed towards a practical understanding of the main aim of this thesis. The case study was undertaken in the City of Cape Town (CCT), which is a large metropolitan municipality in South Africa, a developing country. The theory suggested that individual behaviours can impact on water demands, especially during periods of drought, and that communication, participation and feedback among the social and institutional components must therefore form part of the adaptive strategies within water demand management. The literature alluded to a complex systems approach to water demand management, which can assist the different socio-institutional actors to increase their understanding of complex interactions and their capacity to adapt to these. A main empirical finding of the thesis is that adaptive measures, such as participation, is of paramount importance to the long-term sustainability of water demand management within the CCT, but are mostly lacking within its current management system. The results indicated that participative water demand management, as part of a suit of adaptive strategies, is able to increase flexibility within the CCT to address droughts more efficiently. Although water demand management in itself is an adaptive strategy to manage constraints on water resources, there is still a gap in finding better and more effective implementation methods to improve its acceptance by society and its success rates at reducing water demand. This thesis contributed towards new theoretical knowledge about adaptive theory, complex systems theory and participative water demand management as an adaptive response. It generated new thinking that contributes to improved and sustainable implementation of water demand management strategies within a developmental agenda that knows no bounds.

# ACRONYMS

| | |
|---|---|
| **AADD** | Annual Average Daily Demand |
| **AM** | Adaptive Management |
| **CBO** | Community-Based Organisation |
| **CCT** | City of Cape Town |
| **CMA** | Catchment Management Agency |
| **DWA** | Department of Water Affairs |
| **DWAF** | Department of Water Affairs and Forestry |
| **IDP** | Integrated Development Plan |
| **IQMS** | Integrated Quality Management System |
| **IUWRM** | Integrated Urban Water Resource Management |
| **IWA** | International Water Association |
| **IWRM** | Integrated Water Resource Management |
| **KPI** | Key Performance Indicator |
| **kℓ** | Kilolitres |
| **LOS** | Level of Service |
| **MAP** | Mean Annual Precipitation |
| **MDG** | Millennium Development Goal |
| **MIS** | Management Information System |
| **NEMA** | National Environmental Management Act |
| **NRW** | Non-Revenue Water |
| **NWA** | National Water Act of South Africa |
| **O&M** | Operations and Maintenance |
| **PI** | Performance Indicator |
| **RDP** | Reconstruction and Development Programme |
| **RSA** | Republic of South Africa |
| **SAEON** | South African Environmental Observation Network |
| **SALGA** | South African Local Government Association |
| **SAP** | System Applications Products |
| **SD** | Sustainable Development |
| **SDI** | Sustainable Development Indicator |
| **SFWS** | Strategic Framework for Water Services |
| **SI** | Sustainability Indicator |
| **SoER** | State of the Environment Report |

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| **SUWM** | Sustainable Urban Water Management |
| **SWIFT** | Sewsan and Wadiso Interface to Treasury |
| **UAW** | Unaccounted for Water |
| **UN** | United Nations |
| **UNDP** | United Nations Development Programme |
| **UNEP** | United Nations Environment Programme |
| **UN-HABITAT** | United Nations Human Settlements Programme |
| **UWM** | Urban Water Management |
| **WB** | World Bank |
| **WC** | Water Conservation |
| **WC/WDM** | Water Conservation and Water Demand Management |
| **WDM** | Water Demand Management |
| **WHO** | World Health Organisation |
| **WQM** | Water Quality Management |
| **WRC** | Water Research Commission |
| **WRM** | Water Resources Management |
| **WSA** | Water Services Authority |
| **WSP** | Water Services Provider |
| **WSDP** | Water Services Development Plan |
| **WSSD** | World Summit on Sustainable Development |
| **WSUD** | Water Sensitive Urban Design |

# Glossary

| Term | Definition |
|---|---|
| Adaptation | The conscious design and implementation of interventions in order to reduce existing as well as emerging vulnerability to impacts of change (Stuart-Hill, 2015). |
| Adaptive Capacity | Systems that are resilient to sudden and disordering change by absorbing the disturbance without losing major functioning capacity (Fazey *et al.*, 2007; Folke *et al.*, 2002; Walker *et al.*, 2002)**.** |
| Adaptive Management | The process of predicting the impact of alternative strategies and policies, thereby creating a systematic commitment to adjust to changing conditions, learn from outcomes, and constantly redesign management policies and practices (Holling, 1978; Limerick and Hanson, 2012; Walters, 1986). |
| Boundary Spanning | The process of reaching across borders, margins, or sections to build inter-connections, relationships, and inter-dependencies in order to manage complex challenges (Williams, 2002). |
| Capacity | The "*knowledge, attitudes, skills and values as we find them in individuals, and as they are aggregated in organizations, communities and in all other forms of arrangements that define individual and collective behaviour*" (Alaerts, 1996:59). |
| Catchment | An area from which any rainfall will drain and which contributes surface flow and groundwater runoff from source to the point of discharge into a watercourse/s, or part of a watercourse, to a common point or points. |

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| | (DWS, 1998). |
| Climate Change | Climate change refers to the statistically significant deviation in the average state of the climate or its variability that persists for an extended period (IPCC, 2001). |
| Climate Variability | Climate variability refers to the deviation in the average state of the climate on all temporal and spatial scales, beyond that of separate weather events (IPCC, 2001). |
| Collaboration | Collaboration can be understood as the social and institutional connections across levels and scales resulting in collective action towards a common goal (UN, 2013). |
| Co-Management | Co-management can be defined as the sharing of responsibilities between an authority and resource users to manage a specified resource (ICLARM, 1998). |
| Household | A household consists of one or more person/s who live in the same residential unit and may consist of a single family or multiple families (Haviland, 2003). |
| Institution | Institutions can be defined as bodies or groups with ‘regularised practices’ ‘regulatory systems’ or ‘prescribed patterns’, with the primary goal of standardising human activity in order to achieve its objective/s (Giddens, 1984; Kayambazinthu *et al.*, 2003). |

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| Potable Water | Water that has been treated by a municipality and that is safe to drink and to use for food preparation (Grandjean, 2004). |
| Resilience | The ability of a system to absorb disruption and change, by reorganising capabilities, so as to still retain the same essential functions, structures and feedback (Walker *et al*., 2002). |
| Riparian Zone | Any area of land that borders a body of water, or which is directly influencing, or influenced by, that water body (Lovett and Price, 1999). |
| Robustness | The ability of a social system to prevent ecological systems from moving into a regime that cannot support the human population, or causes long-term suffering to human well-being (Anderies *et al.,* 2004). |
| Social Capital | The benefits that can be gained from social networks, which includes an increase in bonding, cooperation and bridging links (Arora and Henny, 2009; Plummer and Fitzgibbon, 2007). |
| Socio-Institutional | A system that consists of complex behavioural and relationship patterns of interrelated relationships, transactions, knowledge, and flows between an institutional entity and the social system (Herzog, 2014), and functions to satisfy basic social needs by linking the individual to the larger institution (McCarthy, 2006). |
| Social Learning | The capacity of society to benefit from information obtained by others to reduce threats inherent to trial-and-error learning (Van Leeuwen *et al.*, 2018). |

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| Stakeholders | A person, group or organisation that has an interest or concern in an organisation, and that are impacted on by the organisation's decisions, actions, or policies (Business Dictionary, 2018). |
| Systems Theory | Complex systems thinking can be defined as a reasoning approach where the interrelatedness of concepts and components are considered to act as a whole system. The systems approach is concerned with systems and the interrelationships among their components to reveal new aspects which are only evident at the systems level (Bohensky and Lynam, 2005; Duru, 2013). |
| Water Availability | The long-term average renewable water resource that is readily available for human consumption and environmental requirements (Du Plessis, 2017). |
| Water Demand Management | Tyler (2007:02) defines water demand management (WDM) as *"any measure that aims to improve the efficiency of water use by adjusting strategies and implementation processes in order for less water to be used".* |
| Water Policy | A document which contains the policy-making processes that affect the collection, treatment, use, disposal, and sustainability of water to support adequate human water needs and to protect the environmental hydrological requirements to ensure healthy ecosystem functioning (Hollo, 2017). |
| Water Security | The availability of water of acceptable quality and in acceptable quantity in order to sustain human and environmental health, livelihoods, ecosystems and |

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| | food security, coupled with an acceptable level of water-related risks (Grey and Sadoff, 2007). |
| Water Services Authority (WSA) | In terms of the Municipal Structures Act (Act 118 of 1998), it is a municipality that has the managerial authority to provide water services to the public within its jurisdiction (RSA, 1998b). |
| Water User Group | A group of water resource users with shared traits such as homogeneity in interests, preferences, priorities, beliefs, circumstances and geographic location (Kokemuller, 2018). |

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# 1 Introduction

The World Economic Forum (2018) report ranked water crises and water-related risks as the most pressing global concerns of the next decade. Rapid urbanisation, climate change, economic development and increasing population growth are cited as the primary factors causing water scarcity across the world (Arfanuzzaman and Rahman, 2017; Wang *et al*., 2014; Wegelin, 2015). A United Nations Water report (2014) indicated that more than 40% of the world's population lived in water-scarce areas. In addition, in 2015, both the United Nations Children's Fund (UNICEF) and World Health Organisation (WHO) reported that an estimated 1.8 billion people had limited access to reliable water that was safe for human consumption (UNICEF/WHO, 2015). Regarding global water stress, the 5th Intergovernmental Panel on Climate Change Assessment (IPCC) reported that with each degree increase in global temperatures, approximately 7% of the world's population would be subjected to a 20% decrease in renewable water resources (IPCC, 2014; Sadoff *et al*., 2017).

Water scarcity, the impacts of climate change, and food scarcity, are three of the top five global water-related risks identified by the World Economic Forum and are all directly related to water management (World Economic Forum, 2018; Sadoff *et al*., 2017). In 2015, estimates indicated that water insecurity would affect the global economy by as much as US$ 500 billion annually, which may increase by 1% if the environmental impacts are also considered (Sadoff *et al*., 2015). Climate induced water scarcity could lead to a 6 to 14% decline in economic growth in some regions of the world (World Bank, 2016).

## 1.1 Water Security

It is estimated that approximately 80% of the world's population is experiencing high water security risks and challenges (Bakker, 2012; Vörösmarty *et al.*, 2010). Definitions of water security generally include concerns over water-related risk management

together with water availability. Water security has been defined by Grey and Sadoff (2007:08) as "*the availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to people, environments and economies*". The United Nations Water Analytical Brief (2013) defined water security as "*the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development* (UN-Water, 2013:01; UNESCO-IHP, 2012).

In the past decade there has been an increase in research and policy development that investigates innovative strategies to deal with increased water-related vulnerability and uncertainty (Bakker, 2012; WWAP, 2012; Zeitoun *et al*., 2013). Given its limited predictability, the water security research agendas include an increasing theoretical emphasis on innovative adaptive management strategies to address water vulnerability, risks and resilience (Bakker, 2012). This includes a shift from infrastructural focused management to key strategies such as governance and social learning (Palmer, 2010). Water security goes beyond single-issue indicators by including aspects relating to social adaptive capacity (Sadoff *et al*., 2017). Water security is dynamic as it changes with the growth of social economic well-being and values of societies, as well as social exposure and tolerance to water risk changes (Sadoff *et al*., 2015). Water insecurity is often the result of a combination of climatological, environmental and socio-institutional factors, the latter including the lack of adaptability, ineffective service delivery, insufficient information, the lack of sufficient institutional capacity, an institutional silo approach, as well as a lack of socio-institutional cooperative and collaborative governance (Sadoff *et al*., 2017).

According to Mukheibir *et al*. (2013:10) "*a cooperative and collaborative approach is needed where joint recognition of the scale of the issues and its inherent cross-scale complexities are realised*". Many of the barriers or constraints to water security and adaptation planning are interlinked, requiring a whole government approach (Mukheibir *et al*., 2013). Water management decision makers must take a wide range of socio-

economic factors into account, with special focus on an integrated approach (Arfanuzzaman and Rahman, 2017). Water security is also essential for achieving human security, such as health and well-being, food safety and security, a healthy environment, secure livelihoods, and the protection of fundamental rights and liberties (UN-Water, 2013). According to Cardin *et al*. (2016), new approaches to water management are needed if serious socio-economic threats are to be avoided.

Over the past 50 years the world has experienced unprecedented population growth that has put pressure on available water supplies (Mukheibir *et al*., 2015). According to the United Nations Population Division (UNPD) (2008) the world's population increased from 2.5 billion people in 1950, to 6.5 billion people in 2005, almost 3 times more than in 2005. According to the UNPD (2016) as of July 2015 there were 7.3 billion people in the world. Population statisticians have predicted that by the year 2050 this number could increase to more than 9 billion people (UNDP, 2016). Population growth in metropolitan areas is likely to create water distribution problems due to increased total demand, which is viewed to have an even greater impact on water system performance than climate change (Gleick and Adams, 2000). The societal costs of water supply and demand challenges are likely to rise with increasing competition and changing conditions (Gleick and Adams, 2000). Water demand management is critical for balancing future demands with supplies, especially with increasing complexity and uncertainty (Frederick and Major, 1997). Global climate change is specifically threatening the short- and long-term sustainability of available water resources (Bakker and Morinville, 2013; Pahl-Wostl, 2009).

Climate change is impacting on water security as it reduces the availability and quality of water resources, therefore hindering a water institution's efforts to deliver effective and sustainable water services (Barnett and Adger, 2007; Sadoff, *et al*., 2017). As defined by the United Nations Framework Convention on Climate Change (UNFCCC, 2006:16), climate change refers to anthropogenic induced changes in the average weather over time and space, that *"will continue to change atmospheric composition throughout the twenty-first century*". Climate change is influencing drought related

disasters by increasing the frequency of climate extremes such as the El Niño Southern Oscillation, causing dramatic shifts in environmental conditions and resulting in water scarcity (Cai *et al*., 2015; Sadoff, *et al*., 2017; Stocker *et al*., 2013; Power *et al*., 2013). According to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change IPCC (2014), there is a 90% probability that the extent of drought-affected areas will increase.

Climate change has the greatest impact on the most vulnerable of society, particularly where resilience is weak and government involvement is insufficient (Sadoff *et al*., 2017). The most challenging situations are likely to occur in areas under fragile contexts that are chronically water insecure, where water-related shocks or disruptions of water supplies can overwhelm a water institution's resilience capacity (Sadoff *et al.,* 2017). This lack of resilience capacity is a problem within most developing countries, and contributes to the serious water scarcity problems experienced within these countries.

Being a limited resource, water has to be shared or allocated between competing uses. The variable water demand stresses that society puts upon these different uses will affect the mode of resource allocation (Henriques, 2007). In order to keep up with the supply of water to these growing population densities, water demand management would need to become more innovative by incorporating adaptive measures that can consider the different complex scenarios that forms part of providing increasingly limited water supplies to a constantly increasing demand for water (Mukheibir *et al*., 2015).

South Africa is also experiencing similar water threats to its water security. The country has experienced rapid population growth rates over the years, and in 2015 it had the 24th largest population in the world with 54.4 million people. It is predicted that by the year 2050, this figure will have increased to approximately 65.5 million people (Stats SA, 2015). With water demand in the region expected to increase at extremely rapid rates, meeting water provision needs will require a major investment in resource development and adaptive management (Bergkamp *et al*., 2003).

South African water management scenarios must therefore factor in the projected future impacts of change (Ziervogel *et al*., 2014). Drought disasters pose a direct threat to human life, health, livelihoods and dignity (Ziervogel *et al*., 2014). Due to current increases in drought episodes within South Africa, together with more frequent and severe drought episodes as projected into the future by climate change models, water demand management is becoming increasingly important as a water management strategy within the country (Ziervogel *et al*., 2014). Arfanuzzaman and Rahman (2017) suggested that an understanding of adaptive management could be critical for sustainable water resource management.

## 1.2 Adaptive Theory

The concept of adaptive theory was originally introduced by the ecologist C.S. Holling in 1978, at the International Institute for Applied Systems Analysis in Vienna, to facilitate and support the management of natural resources under uncertainty (Hoffman and Zellmer, 2013). According to Pahl-Wostl *et al.* (2008), adaptive management theory can be defined as a methodical process for improving management policies and practices by learning from the results of implemented management strategies and policies. Adaptability is the ability of a system to survive in spite of uncertainty and change (Hoffman and Zellmer, 2013). It is a scientific approach to management that addresses flexibility and information management (Ahjum and Stewart, 2014). There are two dimensions of adaptation which are applicable to this thesis:

- Adaptive capacity, where individuals, communities, society or institutions have the relevant knowledge and information, as well as the necessary conditions (financial status, willpower, understanding, regulatory, institutional, political and managerial) to respond to that information, which is needed to change their behaviour and operations to keep up with change (Adger *et al.*, 2005; Henriques, 2007), and,
- Adaptive management; which is an iterative, structured process of robust decision making in the face of uncertainty, with an aim of system monitoring over time (Giacomoni, 2012; Henriques, 2007; Holling, 1978). It is where institutions

wilfully change their strategies and operations to manage water resources with current and future changes in mind.

At the heart of adaptive theory is the continuing engagement between empirical data (Medema *et al*., 2008). Adaptation involves cascading decisions across individuals, institutions and society, government at local, regional and national scales, as well as international agencies (Adger *et al.*, 2005).The overall objective of adaptation is to secure the continued improvement within a system (Giacomoni, 2012). Adaptive theory could therefore assist water provision institutions to act on imperfect information in their quest for solutions to increasingly complex challenges (Medema *et al*., 2008).

### 1.3 Participation Theory as an Adaptive Response

There are numerous definitions of participation theory, but most represent a lack of participative theory conceptualisation (Claridge, 2004). It is however commonly agreed that it is about shared decision making (Tikare *et al*., 2001). Ndekha *et al.* (2003:326) defined participation as a "*social process whereby specific groups with shared needs living in a defined geographic area actively pursue identification of their needs, take decisions and establish mechanisms to meet these needs*"*.* Participation is not a new concept, and its evolution appears to be built on trial and error (Buchy *et al*., 2000).

Participation theory represents a shift in focus away from top-down strategies that dominated early development initiatives, to a bottom-up, more socially sensitive approach (Claridge, 2004). Buchy *et al.* (2000) suggested that literature on participative theory originated broadly from the political sciences and development theory. The advancement of participatory approaches highlighted the weaknesses inherent in traditional, top-down approaches that focused on reductionist paradigms and single disciplines (Johnson and Walker, 2000). According to Reed *et al*. (2018), participation grew out of the recognition that everyone needs to be involved in development decisions, its implementation and benefits. Some researchers however argued that

participation can lead to negative outcomes and conflict if not implemented correctly (Reed *et al*., 2018).

Participative theory comprises four factors that can explain the variation in outcomes. According to Reed *et al*. (2018) different outcomes can result from varying types of engagement, such as: (1) the number of institutional, social, economic, and cultural contextual factors, (2) the process design factors across a wide range of socio-cultural, economic, political, and biophysical contexts, (3) the power dynamics, the values of participants, and their epistemologies, and (4) engagement processes operated over different spatial and temporal scales. According to Reed *et al*. (2018), participative processes that systematically represent relevant social interests, and which reflect transparency, are more likely to deliver beneficial outcomes across a wide range of contexts. By effectively collaborating and engaging with communities who can affect, or who are likely to be affected by, decisions, the implementation of initiatives are more likely to reflect the views of those who are impacted on by it (Reed and Stringer, 2016; Reed *et al*. 2009). This research will investigate the theoretical framework of participative water demand management as an improved adaptation strategy compared to traditional water demand management processes.

### 1.4 Participative Water Demand Management

The concept of water demand management (WDM) is defined by Wang *et al.* (2014:04) as "*any technical, economic, administrative, financial or social approaches to reducing the quantity or quality of water required to accomplish a specific task*". Tyler 2007:02 defines water demand management as "*any measure that aims to improve the efficiency of water use by adjusting strategies and implementation processes in order for less water to be used*". The main benefit of water demand management initiatives are to reduce water consumption and water losses (Folke *et al*., 2002). Water demand management involves the efficient use of water by end users in order to get more productive use out of the existing volumes of available water (Giacomoni, 2012). In 2008, the South African Department of Water and Sanitation (DWS), previously known

as the Department of Water Affairs and Forestry (DWAF), stated that water institutions will have to develop a greater ability to manage uncertain conditions and risk, and to adapt more readily to different and new challenges and conditions (DWAF, 2008). Once thought to be the solution to our water needs, large-scale initiatives and infrastructure are being challenged by more frequently occurring weather extremes and other complex water resource problems (Folke *et al*., 2002).

There is a need to investigate improvement strategies relating to adaptation practices (Conway and Mustelin, 2014). Continued adaptive management within the water demand management sector is essential as the threats of increasing climatic changes and population density levels, and their accompanying impacts, are not static (Conway and Mustelin, 2014). Current water demand management strategies and technologies may not be suitable to changed future conditions. The severity of water scarcity will constantly change, requiring water demand management strategies that are increasingly sensitive and adapted to the accompanying stresses and conflicts resulting from these changes (Folke *et al*., 2002). Adaptive water demand management should incorporate the use of scenarios to envision alternative, sustainable outcomes within a changing future (Folke *et al*., 2002).

In the Dublin Statement on Water and Sustainable Development, also known as the “Dublin Principles”, it was agreed that water resources management should be based on a participatory approach at all levels (International Conference on Water and the Environment (ICWE), (1992). Water resources management should facilitate a participative, social context with flexible and open socio-institutional collaborative governance systems that will allow for knowledge generation and learning (Reed *at al.,* 2018).

Corathers and Brechenmacher (2014) however argued that participative theory is highly varied and complex due to different theoretical positions. According to Emery *et al*. (2015), when social participation fails to deliver the expected outcomes, it can result in socio-institutional conflict, which may escalate into distrust and alienation. Redpath *et*

*al*. (2013) argued that the assertion of an institution's interests to the detriment of a community is the cause of many socio-institutional conflicts. These negative views have contributed to an on-going debate criticising participatory processes, the most notable that of Cook and Kothari (2001), in their publication named "Participation: The New Tyranny", which led to a reduction of faith in the participation process. Bulkeley and Mol (2003); Newig (2007) argued that well-designed engagement processes are more likely to be effective if they engage with those that are affected by, and responsible for, the implementation of decisions from the onset.

There is increasing recognition that water demand management challenges cannot be addressed in isolation from each other due to the complex interactions that occur between society and institutions. The decisions and commitments made by a community can significantly impact the water supply and demand balance (Giacomoli and Berglund, 2015). Complex water demand management challenges can be relieved by participatory approaches, which have the capability to reduce socio-institutional conflict, to build trust and to facilitate learning (Reed *et al*., 2018). Water management institutions therefore need to adapt to incorporate social engagement approaches in their decision making processes (Mukheibir, *et al*., 2015b). It is against this background that this study will seek to investigate participative water demand management strategies within complex socio-institutional systems.

## 1.5 Research Aim and Objectives

The aim of this thesis is to examine and analyse the role of participative water demand management in complex socio-institutional systems theory, and its potential to ameliorate adaptive capacity within the system in response to increasing water stresses.

The main objectives of this thesis are:

1) To conduct a theoretical investigation into adaptation theory and its potential contribution towards an improved understanding of participative water demand management as an adaptive response.
2) To understand the implications of a complex systems approach to socio-institutional adaptive capacity, and its potential to increase and improve adaptive capacity.
3) To assess the influence of an adaptive approach on the improvement and efficacy of water demand management outcomes through a case study approach.
4) To understand the complex interactions and challenges between a public water management institution and society within a large metropolitan city.

## 1.6 Contribution to Knowledge

The percentage increase in water use on a global scale has exceeded twice that of population growth within recent decades (Cosgrove and Loucks (2015). Climatic changes and increasing population growth are placing severe stress on available global water resources. South Africa has also been affected by the impacts of climate change. The Western Cape Province of South Africa is classified as a water-stressed region, and under the current planning scenarios projected by the South African National Department of Water and Sanitation, the Province's water demand is projected to surpass its supply by the year 2019 unless effective measures are taken to manage water supply and demand (DWS, 2015). An analysis across the Western Cape, conducted by Midgley *et al*. (2005), from 1967 to 2000, showed that the maximum temperatures of the hottest days within the year have increased, as well as an increased frequency of very hot days during the last decade. The mean annual minimum and maximum temperatures also showed significant warming trends at most monitoring stations (Midgley *et al.*, 2005). The projected temperature of the coastal areas of Southern Africa is expected to increase by ~1.5ºC by the year 2050 (Mukheibir

and Ziervogel, 2006). Except for flooding and seasonal rainfall shifts, the major threat of climate change is related to long-term future water availability and security (Ziervogel *et al*., 2014). New knowledge around improved adaptive strategies is therefore worth investigating within the face of these challenges.

A shift from traditional water demand management approaches towards a path where new social research and thinking will lead to adapted and improved water demand management approaches, and an increase in social acceptance, is required (Cosgrove and Loucks, 2015). The question can be asked of how adaptive capacity contributes to different forms of system change (Wilson *et al*., 2013). This thesis will provide the theoretical and practical analytical scope to understand participation as an adaptive strategy and its potential to increase socio-institutional adaptive capacities. It will investigate a practical qualitative case study, focusing on a large metropolitan municipality within a developing country such as South Africa, which will contribute towards an improved understanding of the different capacities that contribute to the different adaptation responses, as well as the operational processes, social factors and enabling mechanisms that can influence these capacities.

According to King (2013), adaptive capacity is needed in order to generate and implement sustainable water demand management options. According to Giacomoni (2012), adaptive water demand management is able to increase a systems flexibility to address increasing stresses, such as droughts, more efficiently. There is however significant research gaps in adaptation capacity theory (Bettini *et al*., 2015). According to Huntjens *et al*. (2012:80), "*further research is needed to assess the capacity of institutions and society to adapt to change, and how it can be improved*".

The aim of this research is therefore to examine and analyse the role of participative water demand management as an adaptive response within a complex socio-institutional setting. It seeks to explore a deeper understanding of the socio-institutional adaptive capacities to adapt to change within a complex socio-institutional systems theory framework. In order to assess the research need and knowledge contribution of

this proposed research effectively, a Google Scholar citation string search was conducted (Table 1):

**Table 1:** A Google Scholar citation string search.

| Search string | Number of Articles Worldwide | Number of Articles for "South Africa" | Number of Articles for "Cape Town" | SA Articles as a % of Total Worldwide |
|---|---|---|---|---|
| "Water Demand Management" | 7 990 | 6 | 0 | 0.08% |
| "Demand Side management" | 1 190 000 | 148 000 | 22 200 | 12.44% |
| "Social Adaptive Capacity" | 748 | 274 | 106 | 14.17% |
| "Institutional Adaptive Capacity" | 357 | 165 | 37 | 46.22% |
| "Socio-Institutional System" | 109 | 25 | 1 | 22.94% |
| "Socio-Institutional System Water Resources" | 0 | 0 | 0 | 0% |
| "Systems Approach" | 818 000 | 21 900 | 5 560 | 2.68% |
| "Systems Approach Water Resources" | 24 | 0 | 0 | 0% |
| "Systems Approach Water Demand Management" | 0 | 0 | 0 | 0% |
| "Adaptive Management" | 87 800 | 10 600 | 2 380 | 12.07% |
| "Adaptive Water Resources Management" | 324 | 51 | 6 | 15.74% |
| "Adaptive Water Demand Management" | 3 | 0 | 0 | 0% |
| "Adaptive Water Management Systems Approach" | 0 | 0 | 0 | 0% |

Based on the results in Table 1 the following conclusions can be drawn:
The terms "Demand Side Management", "Systems Approach", and "Adaptive Management" are the most numerous in terms of English-language articles worldwide, indicating a wide interest on these topics. The number of articles for "Demand Side Management" is 1 190 000, and for "Water Demand Management" is 7 990, which indicates a high interest level in this topic worldwide. The results also indicate that there is a high interest in demand side management in South Africa and Cape Town. There is however very little information worldwide on "Adaptive Water Demand Management" and a "Systems Approach within Water Resources". If these terms are combined as a

chosen research topic, there seems to be a serious lack of information available in the literature worldwide, South Africa as well as in Cape Town. The conclusion can be drawn that there is a need for this research topic which will create new knowledge worldwide and within South Africa.

The literature review will also point out the potential benefits of the implementation of the theoretical concepts mentioned within this thesis, as well as its application within water resources management. While most research studies on adaptive water demand management systems are focused primarily on institutional policy, technical approaches, norms, and the nature of the water resource, this thesis will examine the relationship between water institutions, individual residents and their water demand management and consumption behaviours and adaptations.

This research project will therefore contribute towards new theoretical knowledge around adaptive theory as well as participative water demand management within the realm of socio-institutional complex systems. It aims to understand the impact of existing water demand management initiatives on society, and to explore new, adaptive management theory that examines and integrates socio-institutional issues. It will provide a better understanding of the current perceptions of water demand management, will generate new thinking on socio-institutional systems and explain the need to adapt to change for improved and sustainable water demand management. It will also provide new knowledge on the key theoretical concepts through a practical case study approach which will provide valuable insights and learning to other large metropolitan municipalities within developing countries.

## 1.7 Scope of Study and Limitations

The scope of this thesis included a comprehensive literature review in order to fully understand the various concepts as discussed during this study. As part of the research methodology, a qualitative case study was also investigated in order to understand the complex interactions, in practice, between a water services institution and the receiving

society of its services, as well as the capacity of both to adapt to water demand management policy and implementation.

During the present study some limitations were experienced. This included the challenges to retrieve certain types of data from the City of Cape Town (CCT). There was a strong political influence within the CCT and some of its data were considered as being too sensitive and politically compromising to release. Only permissible information could be used which hindered the study as the unavailable data could have provided a fuller picture of the study results.

## 1.8 Thesis Layout

The main components of this thesis are a literature review and a qualitative case study approach to investigate participative water demand management as an adaptive approach within a complex socio-institutional system. The City of Cape Town metropolitan municipality (CCT), in the Western Cape Province of the developing country South Africa, will be investigated as the case study. The thesis consists of six main chapters, as well as a seventh references chapter and annexes. The following is a general description of the structuring of the chapters in this thesis:

**Chapter 1** – this chapter is the introductory chapter which sets the scene for the study. It provides the reader with an introduction to the main theoretical terms, provides the research aims and objectives, and indicates the research and novel contribution of this thesis.

**Chapter 2** – comprises a review of the literature on the various aspects pertaining to adaptive theory as well as the concept of participative water demand management as an adaptive response within complex socio-institutional systems. This chapter introduces the key concepts and adds a theoretical background to the study. The review investigates insights gained from other research and examines the potential resolving of complex challenges from a theoretical perspective. It will also look at how society and institutions interact, as well as whether participation as an adaptation response, as

described in the literature, can provide improved water demand management responses and outcomes.

**Chapter 3** – describes the main research methodology and provides some background to the case study area.

**Chapter 4** – provides a summarised view of the case study policy and document analysis results, as well as the case study survey results.

**Chapter 5** – consists of a discussion of the case study results as presented in chapter 4. The discussion is focused on providing practical case study evidence to strengthen the thesis theory. It is strongly linked to the fourth objective of this thesis which reads: "*to understand the complex interactions and challenges between a public water management institution and society within a large metropolitan city*".

**Chapter 6** – provides a discussion on the main research conclusions.

**Chapter 7** – provides the research recommendations as presented in the research conclusions chapter. It also provides some insights on further recommended research requirements.

**Chapter 8** – consists of a comprehensive list of all literature referenced throughout this thesis.

# 2 Literature Review

The literature review is structured around the main aim of this thesis which is to examine and analyse the main theoretical aspects of adaptation theory, participative water demand management, and complex socio-institutional systems theory. It will also examine the interlinkages and dependencies between these aspects.

## 2.1 Introduction

Due to the scarcity of water experienced in many parts of the world there is growing concern that water supply will not be able to match increasing water demands (Giacomoli and Berglund, 2015). Within urban areas, climate change, population growth, and land-use change are threatening the dynamic balance between water supply and demands (Cosgrove and Loucks, 2015). Long-term water supply planning is commonly based on projections of water demands and population growth, as well as the capacity of the existing or augmented water supply system assuming an unchanging climate (Giacomoli and Berglund, 2015). Thus it is based on the assumption that future distributions of precipitation and temperature will match the historical record. With increasing impacts of climate change, it is becoming more difficult to assume an unchanging climate and historical data are no longer adequate to plan for climatic extremes (Cosgrove and Loucks, 2015). According to Lemos *et al.* (2013), there is a need for an improved understanding of the key factors that can impact on adaptation. According to Giacomoni and Berglund (2015), new innovative water demand management strategies are needed to address future uncertainty and increasing water demand.

A paradigm shift occurred with the publication of the 3rd World Water Development Report (2009), which stated that water management decisions are not made by water managers alone, but begins with a combined approach between water institutions, society and businesses, which should all participate in developing objectives and to

formulate water conservation policy and operational decisions (UN WWAP, 2009). The evolution of water management therefore shifted from a largely infrastructural, supply focused management, towards an integrated water resource, demand focused management, which has an increased social collaborative perspective, driven by a growing understanding of the issues of environmental sustainability (Ashton and Haasbroek, 2001).

According to Murtinho *et al*. (2013) regarding water scarcity in the Andes, no single strategy was found to be sufficient to solve water scarcity problems. It was found that a reduction in water scarcity challenges within the Andes were more likely to occur through the implementation of various, community focused strategies (Murtinho *et al*., 2013). Certain groups in society have an ability for autonomous, or self-directed, adaptation to change (Cosgrove and Loucks, 2015). An example of this is farmers which can adjust their planting dates and crop mix over time to allow for changes in precipitation variability. Other societal groups such as high income urban water users might however require a greater investment in adaptation awareness as they might not be adequately deterred by water demand management strategies such as increasing water prices. Adapting to change will therefore involve the implementation of different and improved management strategies which considers the variations in adaptive capacity across different water user groups (Cosgrove and Loucks, 2015).

For adaptation policies and programmes to be effective, we need to understand the socio-institutional dynamics. Through the identification and understanding of current social responses to water scarcity changes, an institution can learn from these factors and re-direct its strategies to facilitate adaptation. According to a study on water management in the Taos Valley Acequias by Cox (2014), certain characteristics such as socio-economic and organisational factors can facilitate collective action to manage local water resource systems and to ensure greater water security.

### 2.1.1 Water Security as an Emerging Paradigm

The concept of water security is an emerging paradigm due to its adoption by an increasing number of academics and policy makers, as well as its growing use by international organisations to frame water-related issues (Cook and Bakker, 2012). Water security is primarily measured against human water supply efficiency (Bakker and Morinville, 2013; Rijsberman, 2006). There is however a growing focus in academic literature on water-related risks and vulnerability. The United Nations Educational, Scientific and Cultural Organization (UNESCO) advocates a systems approach to water security which involves the protection of vulnerable water systems against water related risks such as floods and droughts, sustainable development and access to safe water services (UNESCO, 2009). Research on water security is challenging because of the limited predictability of water security, and the complexity of analysing the interrelationships between resilience, vulnerability, and risk across sectors, scales, and disciplines. The inherent barriers between governing institutions and society also creates additional challenges for researchers (Bakker and Morinville, 2013). According to the authors Cook and Bakker (2012), water security is partly threatened by water institutions' inability to govern water resources effectively and efficiently.

The United Nations Economic and Social Commission for Asia (UNESCAP) (2011), described good governance as including eight major characteristics, 1) participatory implementation and/or management, 2) accountability, 3) transparency, 4) consensus, 5) responsiveness, 6) effectiveness, 7) efficiency, 8) as well as the inclusive and equitable rule of law. This ensures the minimisation of corruption, the consideration of minority views, and that "*the voices of the most vulnerable in society are heard in decision-making*" (Cook and Bakker, 2012:98). One of the four themes of the Global Water Partnership (2008) is the process which promotes the coordinated development and management of water resources. Good governance of water management addresses water security issues such as water availability, sustainability, human vulnerability, and human needs, through a coordinated and increasingly adaptive governance style (Bakker, 2003; Cook and Bakker, 2012). In order to ensure water

security, adaptive governance is a promising strategy for water resource management (Cook and Bakker, 2012). Increasing socio-institutional collaboration can broaden the adaptive capacity of governance systems which will bring about greater resilience (Pahl-Wostl, 2006). By involving social participation in water management, new and innovative management and governance ideas that challenge bureaucratic management styles can be created (Cook and Bakker, 2012; Ison and Watson, 2007; Mostert *et al.*, 2007; Pahl-Wostl *et al*., 2007).

There is however also those that are sceptic regarding the uptake of the concept of water security. The aspect of social learning connected to water security has been critiqued by some researchers through their questioning whether it is obstructing the importance of power dynamics between the actors involved (Bakker and Morinville, 2013). Could an emphasis on social learning serve to obscure the power imbalances between actors in water governance contexts and what might the implications be for water security (Bakker and Morinville, 2013)? There has been promising efforts by academics to recognise adaptive governance and the role of power, but few however extend their concerns and investigations of power disparities beyond the inclusion of informal and marginalized actors (Armitage, 2008; Pahl-Wostl, 2009; Pahl-Wostl *et al*., 2011).

Cook and Bakker (2012) examined the links between an increased uptake of the term water security and recent reforms in water governance, most notably that of decentralisation, social learning, and greater participation of communities in water governance. These changes in water governance have occurred due to shifting views over the role of governments and an increased desire for public participation and an increased emphasis on integrated water resource management (Cook and Bakker, 2012); Reed and Bruyneel, 2010). The authors concluded that a broad, integrative framing favours water security as it brings good governance issues to the fore, which is also a central aspect of integrated water resource management.

### 2.1.2 Integrated Water Resource Management and its Evolution to Water Demand Management

Humans generally have difficulty in dealing with future water challenges, which is evident by the slow evolution of the positions adopted by international organisations (Cosgrove and Loucks, 2015). During the final declaration of the United Nations (UN) Conference on Environment and Development held in Rio de Janeiro in 1992, water issues were absent from the discussions (UN, 1992). It was only in 1998 when the UN Commission on Sustainable Development adopted the text '*Strategic Approaches to Freshwater Management'*, that water started to be considered as a crucial part of sustainable development (UN, 1998:02).

Integrated water resource management (IWRM) is considered to be an improvement on water resource management (Cosgrove and Loucks, 2015). The Global Water Partnership (GWP), (2000) defines IWRM "*as a coordinated process that supports water resource management, and which maximizes economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.*" The IPCC (2014) advocates an integrated institutional approach aligned with the principles of IWRM that includes appropriate policy and legislative development in order to deal with climate change impacts as well as managing water challenges to meet increasing demands. Pahl-Wostl (2007) compared conventional water resources management with an integrated, adaptive management approach (Table 2).

**Table 2:** A comparison between conventional water resources management, and integrated, adaptive water resources management approaches (Pahl-Wostl, 2007).

| | **Prediction and Control Management Approach** | **Integrated, Adaptive Management Approach** |
|---|---|---|
| **Management Paradigm** | **Mechanistic Systems Approach** | **Complex Systems Approach** |
| Governance | Centralised, hierarchical with narrow stakeholder participation. | Polycentric, horizontal with broad stakeholder participation. |
| Sectoral Integration | Sectors are separately analysed resulting in policy conflicts. | Cross sector analysis and integrates policy implementation. |
| Information Management | Fragmented and lack of integration of information sources. | Open, shared information sources that facilitates integration. |
| Finances and Risk | Financial resources concentrated in structural protection. | Financial resources diversified using a broad set of private and public financial instruments. |
| Scale of Analyses and Operation | Large infrastructural scale of analysis and management. | Trans-boundary issues addressed by multiple scales of analyses and management. |
| Infrastructure | Massive, centralised infrastructure, single sources of design, power delivery. | Appropriate scale, decentralised, diverse sources of design, power delivery. |
| Environmental Factors | Quantifiable variables such as biological oxygen demand or nitrate concentrations that can be easily measured. | Qualitative and quantitative indicators of whole ecosystems and ecosystem services. |

One of the essential characteristics of IWRM is its strong institutional orientation (Imperial, 2009). The concept of IWRM can be successfully incorporated within three levels of an institution: 1) operational, such as the biophysical, environmental, hydrological, ecological and socio-institutional aspects of the water resource system, 2) organisational, such as administrative aspects, and 3) policy and legislative aspects (Hashemi, 2012). A report by the fourth World Water Forum (WWF, 2006) made some key recommendations for future work on integrated water resource management. These recommendations are focused around five themes which are: 1) an institutional and legal framework, 2) socio-economic impacts, 3) stakeholder participation, 4) capacity-building, and 5) environmental sustainability. The fifth World Water Forum, which was held in Istanbul in 2009, confirmed the importance of the institutional and cultural dimensions of water resource management (WWDR, 2009).

Changing dimensions and insights relating to water resource management over time led to the use of changing terminologies. Scholars mostly used the term ‘integrated water resources’ in the 1980s, when concerns that water resource challenges could not be properly addressed unless considered in a holistic way were dominant (Hoekstra *et al*., 2018). The publication of the Brundtland report by the World Commission on Environment and Development (WCED) (1987), initiated the use of the term ‘sustainable water resource management’ which became more prevalent in the 1990s, inspired by the idea of sustainable development. The term ‘adaptive water management’ however became increasingly popular within the last decade, inspired by the need to adapt to climate change (Hoekstra *et al*., 2018). The authors Xiao *et al*. (2017) depicted the emergence of new water management concepts over time, which eventually led to an adaptive water management approach which included a large focus on demand side management (Figure 1).

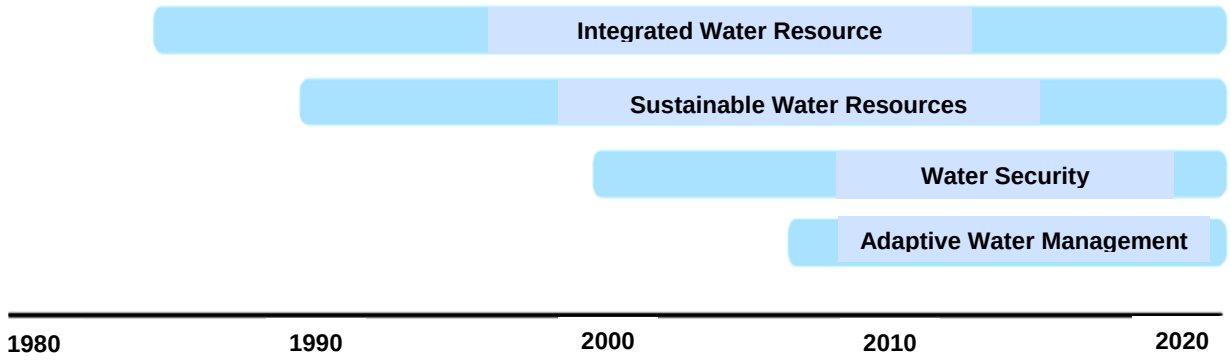


**Figure 1:** The emerging new water management concepts over time (Xiao *et al*., 2017).

With recent challenges relating to serious supply-deficit issues due to climatic variability and increasing population densities, water demand management has entered the water management sector as a way to address water scarcity (Kanta and Zechman, 2014). Water demand management is intended to manage the growing demand for water. Savenije and Van der Zaag (2002) defined water demand management as the development and implementation of policies, strategies, or other initiatives aimed at influencing demand, in order to ensure efficient and sustainable water resources.

Brooks (2006) proposed an operational definition of water demand management which consists of the following five facets: 1) the reduction of the quantity of water required to achieve a specific task, 2) reduction of the loss in quantity or quality of water available for use, 3) adaption towards the nature of water use so that it can be accomplished with less water or with lower water quality, 4) water usage timing shifts from peak to off-peak periods, and 5) improving the ability of a water system towards water supply sustainability during periods of water scarcity. Water demand management is about the "*governance and tools that motivate people and their activities to regulate the amount and manner in which they access, use and dispose of water*" (Baroudy, 2005:01).

Water demand management strategies typically includes aspects such as water use restrictions during periods of drought, education and awareness campaigns, the installation of water-efficient appliances, promoting the use of rainwater harvesting systems, water price increases, and planning land-use changes. Water shortage strategies which are usually implemented as short-term initiatives includes the prioritisation of water end uses, increased water pricing, the restriction of non-essential water uses such as the filling of swimming pools, garden irrigation, and washing of vehicles. The longer, more permanent strategies includes water-efficient appliance installations and supply augmentation technologies, such as rainwater or greywater harvesting systems (Kanta and Zechman, 2014). The effective implementation of water demand management strategies are however challenged by behavioural, social, economic, institutional, and political challenges (Fielding *et al*., 2013).

New and improved methods for water demand management are needed to address increasing water demands and uncertainty. Water demand management forms part of a complex system which are not static, and continuous adaptation is necessary to keep up with change (Giacomoni and Berglund, 2015). A study conducted by Giacomoni and Berglund (2015) evaluated a combination of multiple strategies for the most effective managing of water under the threat of increasing stresses, and the results indicated that

adaptive demand management strategies result in long-term per capita reduction in water demand.

Many of the existing water demand management methods are likely to under-perform if changing future conditions, increased water scarcity, the development of increasingly water-efficient technologies, sterner water restriction strategies and cultural shifts towards sustainability are not taken into consideration (Giacomoni and Berglund, 2015). By recognising that water demand management forms part of a complex adaptive system, alternative adaptive management policies are stimulated which demonstrates that the interactions among available water resources, household water use decisions, and management strategies are creating unexpected dynamics that drives the emergence of water use sustainability (Giacomoni and Berglund, 2015). Improved water use efficiency and system flexibility can be achieved through adaptive water demand management strategies (Giacomoni and Berglund, 2015). In studies conducted by Georgakakos *et al*. (2011) and Westphal *et al*. (2003), adaptive management outperformed traditional management approaches. Many water demand management models typically consider urban demands as static parameters that are exogenous to the water resources system (House-Peters and Chang, 2011). Urban water demand is however ultimately driven by the decisions of water users, which are influenced by information and knowledge, water prices, demographic factors, perceptions, behaviours and attitudes, as well as local water restrictions and legislation (Blokker *et al*., 2010; Kanta and Zechman, 2014; Polebitski and Palmer, 2010).

The concept of water demand management was originally developed from the energy management field during an energy crisis in the 1970s, where more focus was placed on the users' side and how they can reduce their energy usage (Xiao *et al*., 2017). The idea of water demand management thereafter originated from emerging debates among social scientists and analysts (Gellings and Chamberlin, 1987; Lovins, 1977). Driven by increased water scarcity, the evolution of water resources management in urban areas has passed through several phases (Figure 2) (Ashton and Haasbroek, 2001; Xenos *et al*., 2002). The first phase was called the water abundance phase, which consisted of

low population densities and stable climatic conditions which were dominated by low water demands relative to the quantity of water available (Ashton and Haasbroek, 2001). The second phase was the water scarcity phase, where water demands started to exceed the water availability due to increased population densities as well as climatic features which started to change (Turton and Ohlsson, 1999). The third phase was known as the water deficit phase, where the demand for water exceeded the additional water which could be obtained by conventional engineering solutions. It is at this point that water demand management became a priority, which initiated efforts to manage water demand through various strategies aimed at improving the efficiency of water use (Ashton and Haasbroek, 2001; Xenos *et al*., 2002).

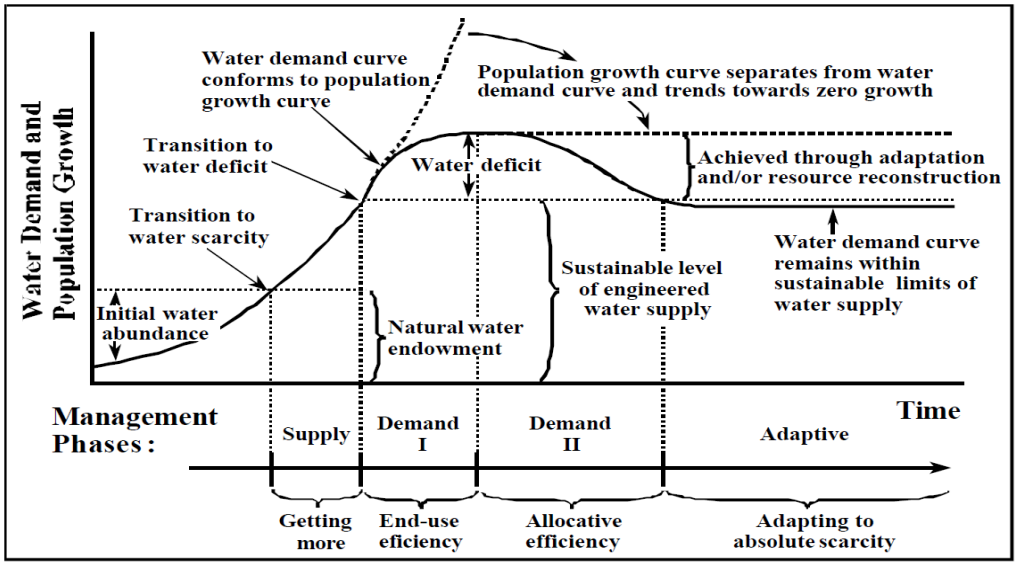


**Figure 2:** The evolution of water resources management to an adaptive, demand side approach (Ashton and Haasbroek, 2001).

Recently, it has widely been recognised that water demand management strategies are becoming less viable in an increasingly complex water resource system (Xiao, 2017). Water is shared among competing users, creating severe challenges such as water conflicts due to the imbalance between available water and demand (Gleick and Heberger, 2014). The Organisation for Economic Co-operation and Development

(OECD) (2011) recognised that integrated water resource cannot be properly implemented without considering a broader governance framework. This should include measures governing scientific, educational, and technological issues as well as communication and participation (Carr *et al*., 2012; Delli Priscoli, 2004).

This revelation has led to the more recent and improved water management concept known as the ‘One Water’ approach, which considers themes centred on the idea of cities that are adaptable, liveable, sustainable, productive and resilient (Mukheibir *et al*., 2015a). According to Maheepala *et al*. (2010) and Mitchell (2006), this concept is similar to the term ‘Integrated Urban Water Management Planning’, which states that water supply, wastewater and stormwater should be managed in an integrated way that considers:

- all the elements of the water cycle as an integrated system;
- the impact of water cycle management on planning and management;
- the anthropogenic and ecological demands for water;
- all the different water supplies over time;
- demand reduction practices which can provide water which is fit for purpose in both water quantity and quality;
- the stakeholder views and local context;
- sustainability of water service provision;
- the functional, scale and engineering aspects of the water system, and;
- the strategies by which transition from current water practices to improved water practices can be achieved.

Both the terms, ‘One Water’ and ‘Integrated Urban Water Management Planning’, fosters water security through diversity rather than single-sectoral, short-term planning, with cooperation and participation between different actors at the heart of it.

The One Water approach strives to move away from conventional approaches to one with greater coordination among stakeholders, decision-makers and diverse interests, and recognises multi-faceted collaborations (Maheepala *et al*., 2010). The transitioning

to the One Water approach (Figure 3) consisted of different phases associated with different objectives and technical solutions, such as the water supply phase of the early 1800s and the sewered city phase of the late 1800s. The drained city phase of the mid 1990s and the waterways city phase of the late 1990s. The water cycle phase of the 2000s, and finally the water sensitive city of the future, which considers a combination of adaptive, collaborative, multi-functional infrastructure and design, as well as a water sensitive behavioural focus (Maheepala *et al.*, 2010).

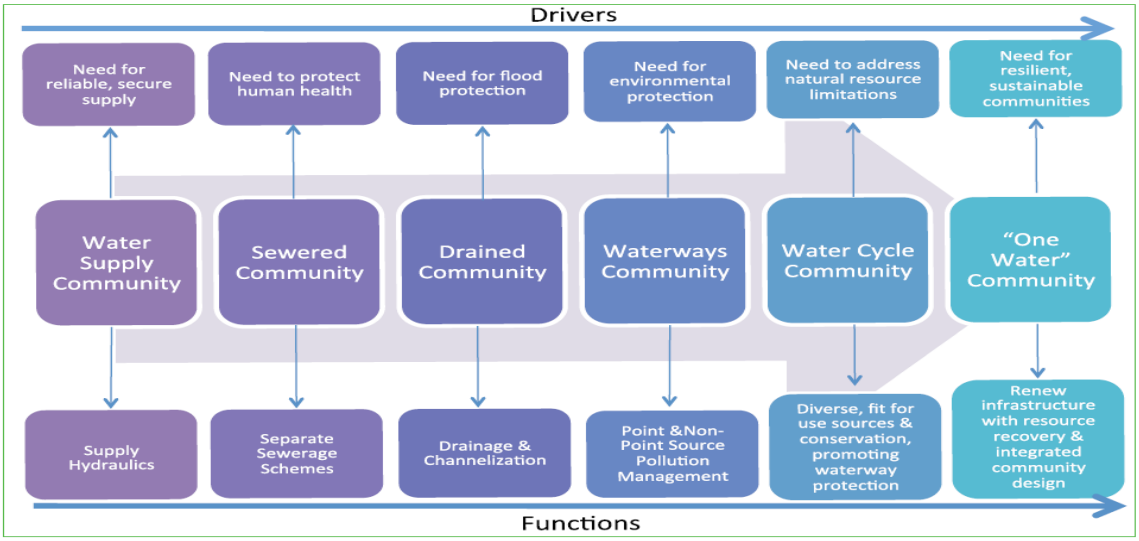


**Figure 3:** The transitioning of integrated water management (Brown *et al*., 2008; Maheepala *et al*., 2010).

The transitioning from one phase to another is seen as the natural evolution of water resource management (Maheepala *et al*., 2010). New emerging solutions to urban water challenges includes legislation that is goal-oriented and collaborative, that enables new financing mechanisms, that encourages a complex systems approach, that shares data, that incorporates new innovation, that considers changing cultural norms, capacity and knowledge, and that implements a large focus on improved water demand management strategies such as engagement and participation (Mukheibir *et al*., 2015a).

### 2.1.3 The Drivers of Water Demand Management

Climate change, and its resultant impact on local weather fluctuations, is a major driver of water demand. Within every water demand management model, temperature and precipitation are considered as crucial water demand variables (Arbués *et al*., 2003). Other important drivers of residential water demand include household characteristics and composition, type of outdoor irrigation, frequency of billing, as well as water pricing and income levels, which are all considered important drivers of residential water demand (Arbuès *et al*., 2003; Grafton *et al*., 2010; Ramachandran and Johnston, 2011; Shandas and Parandvash, 2010; Shearer, 2009; Worthington and Hoffman, 2008).

Household characteristics are a very relevant element of water demand modeling (Breyer *et al*., 2012; House-Peters *et al.,* 2010; Maggioni, 2015; Ramachandran and Johnston, 2011; Shandas and Pavarandash, 2010; Shearer, 2009). Studies conducted by Guhathakurta and Gober, (2010); House-Peters and Chang, (2011) and Kenney *et al*. (2008) have all tested the positive correlation between the size of residential properties and household water demand. Fox *et al*. (2009); Polebitski *et al*. (2011) found a negative correlation between household occupancy density and water demand patterns.

The elasticity of water demand to price can also drive water demand. Worthington and Hoffman (2008) found that studies conducted on price elasticity estimate that urban water demand is inelastic and negative. This finding is however highly variable with some studies indicating widely contrasting results (Worthington and Hoffman, 2008). There are varying factors that can influence water demand elasticity to pricing, but the general consensus of researchers is that higher water rates usually result in a reduced water demand (Maggioni, 2015).

In the last decade there has been an increase in studies that focused on water users' consumption behaviours, attitudes and perceptions. These studies brought the idea to the foreground that social aspects and societal capacity to adapt can also be viewed as

potential drivers of water demand (Adams *et al*., 2013; Beal *et al*., 2010; Cook *et al*., 2012). The research conducted on the social aspects analysed the relationship between the social variables and water usage. The effect of water users' education or behaviours are however not well understood yet and more research is needed on the societal aspects as drivers of water demand (Beal *et al*., 2010; Maggioni, 2015; March *et al*., 2010).

Another driver of water demand management implementation is institutional water resource policies, which are crucial for effective water resource management (Maggioni, 2015). With increasing episodes of drought, the implementation of some of these strategies are however not always effective in managing water demand (Maggioni, 2015). This ineffectiveness has driven an increased focus on demand management strategies to ensure more effective and sustainable water resource management (Maggioni, 2015).

Kanta and Zechman (2014) identified some of the driving forces of water demand management within the Western Cape province of South Africa as 1) climate change, 2) population growth, 3) growing urbanization, 4) economic development, 5) increasing impermeable surfaces due to inappropriate development, 6) alien invasive species encroachment, 7) increasing water pollution and quality challenges, and 8) development encroachment and overutilization of riparian zones, amongst others. The alteration of our path to a more desirable future requires new adaptive thinking that can lead towards new or improved water demand management approaches, as well as their improved social and political acceptance (Cosgrove and Loucks, 2015).

### 2.1.4 The Impact of Water Demand Management on Society

According to Pahl-Wostl *et al*. (2013), good governance is participatory, accountable, responsive, transparent, effective and efficient, equitable and inclusive. Although water is essential for sustainable livelihoods, many water services institutions fail to address different water needs and typically do not include the impacts of water demand

management on societal livelihoods. The discrepancy between the needs of people and the design and management of water services can jeopardise the sustainability of water services (Smits, 2005).

Smits (2005) referred to the concept of livelihoods as peoples' capabilities and their means of living, such as food, income and assets, and housing, amongst others. Moriarty and Butterworth (2003) found that water demand management practices which consider livelihoods can enhance communities through:

- Better health –improved water quality contributes to reducing disease.
- Community capacity – is a pre-requisite and outcome of practices that considers livelihoods.
- Empowerment – water projects may help to empower the vulnerable and poor to participate in community decision-making.
- Productivity and income – improved water supplies can make other productive use of water possible and generate employment and income.
- Time savings – the time and effort taken in collecting water from distant water points can be reduced. This time can be put into other activities.
- Expenditure savings – reduced expenditure can be the consequence of improved water supplies.
- Food security/ nutrition – improved water supplies can enable small scale livestock farming and backyard irrigation for food production.

A mismatch between communities' water needs and supply can however have a negative impact on societal livelihoods and can cause the efficiency and equity of the water services to become threatened (Smits, 2005). Some water institutions are limiting the supply of water to certain communities, and the residents are not given the option to step up the ladder (Smits, 2005). If water supply is restricted to certain communities, the residents may use excessive water through unauthorised connections which can leave other residents without water. This can lead to community protests and socio-institutional conflict situations.

According to Pahl-Wostl *et al.* (2013) water allocation is a social decision and scientific knowledge is merely the starting point for the socio-political process of allocation decisions. Depending on the legal framework, institutions may make water allocation decisions with or without input from the water users and stakeholders affected by these decisions (Komakech and Van Koppen, 2012). In the cases where water users and stakeholders were consulted, added limitations such as inflexible institutional policies, regulation, red tape, closed-minded operational management and inertia or political decisions may hinder implementation which points to the complexity of issues around water governance and implementation (Pahl-Wostl *et al*., 2013).

In general, water demand management initiatives typically consider demand as static parameters that are exogenous to the water resources system. Initiatives are implemented in isolation with limited stakeholder and water user engagement. Interventions therefore neglect the important interactions and dynamics that have an impact on society (House-Peters and Chang, 2011). Water demand management can impact water users through increasing prices (Espey *et al*., 1997; Howe, 1982; Young, 1973), attitudes, habits and beliefs (Corral-Verdugo *et al*., 2008; Kallis Ray *et al.*, 2010; Russell and Fielding, 2009), demographic factors (Blokker *et al*., 2010; Hurd, 2006; Polebitski and Palmer, 2010; Rosenberg, 2007; Rosenberg, 2010), seasonal variation of global climatic conditions, as well as local regulations and restrictions (Hardberger, 2008; Morris *et al*., 1997). According to Kanta and Zechman (2014) water use is ultimately driven by the decentralised decisions of water users. The sustainability of the urban water supply may be significantly influenced by the adaptations and decisions of water users and policymakers as well as the feedback loops that this create within a water resources system (Kanta and Zechman, 2014).

If an institution is regulating in a fair, equitable and reasonable manner, collaborating with its water users and stakeholders, then water demand management initiatives should be fairly well received and accepted by society. By including water users, stakeholders and special interest groups within policy development and planning processes, the institution may gain legitimacy and experience success in the

implementation of its water demand management programme. By recognising the impact of water demand management on society and their livelihoods, a change in water demand management decision-making can be triggered (Doremus and Tarlock, 2013). Increasing attention on water demand management as a socio-institutional system shifts the focus on the resilience of such systems and the necessity for adaptive management. According to Pahl-Wostl *et al*. (2013), polycentric governance that balances multi-level and inter-sectoral pathways of influence seem to be particularly beneficial. The emphasis of good governance should be on combining shared decision-making, and of more flexible polycentric water governance structures (Susskind, 2013).

## 2.2 Adaptive Water Resource Management

Adaptive management includes the constant empirical analysis of the prevailing conditions, the incremental adjustments of outcomes and the synchronisation with more slowly evolving changes over time (Brunch, 2009). Water resource management policies are mostly focused on a management style which is largely isolated and fragmented from water user needs and behaviour. It requires a shift in attention towards a system-wide approach to address complex uncertainties and to alter unsustainable trajectories of current water resource management approaches.

According to Giacomoni (2012), adaptive water resource management is able to increase a systems flexibility to address increasing stresses, such as droughts, more efficiently. A new adaptation paradigm for water demand management can address increasing stresses and uncertainties by incorporating flexibility in management strategies (Giacomoni and Berglund, 2015). Within urban water systems, different socio-economic, environmental and governance-related drivers cause transformations and adaptations, making urban water demand management complex and dynamic (Daniell *et al*., 2015; Hoekstra, 2018). Because of the complexity of water resources systems, its interacting parts and functioning are not well understood by institutions and society and should therefore be managed in a flexible manner in order to adjust to change (Bergkamp *et al*., 2003). More research is needed on how to measure the

complex processes involved in effective socio-institutional adaptation (Baird *et al*., 2014). Complex water resources management challenges, especially those associated with water availability and demand, cannot be resolved by simple solutions, and may require an approach that considers the aspects of adaptive theory to reach more congenial, sustainable solutions (Giacomoni (2012). Because individual behaviours can impact on water demands, especially during periods of drought, feedback and interactions among the social and institutional components must form part of adaptive strategies within water resource management (Liu *et al*., 2007).

The adaptations and dynamics of the interactions among water users, policymakers, and natural and engineered water resource systems, affect the long-term system-wide sustainability of water resources, and may expedite or delay the need for new supplies (Kanta and Zechman, 2014). Institutions that embrace flexibility, as well as the ability to cope with change, will be essential in managing water resource challenges (Pahl-Wostl, 2007). Because urban water systems are dynamic and complex, innovation and development in almost all technical, institutional and organisational dimensions is required (Larsen *et al*., 2016). The process of innovation and development however need to be driven by new knowledge and learning.

Numerous information gaps exist on the diversity of water resource issues (Hoffman and Zellmer, 2013). As population growth, urbanisation, and climate change alter the expected volumes and timing of available water, the future of water resource availability is becoming increasingly uncertain (Kanta and Zechman, 2014). Rapid population growth, drought and economic expansion have already created disaster conditions in some urban areas globally, where demand has risen beyond the limits of local water supplies (Hardberger, 2008; Kanta and Zechman, 2014). This lack of information can limit a water institutions ability to control extreme events using technical initiatives, dealing with conflicting values, uncertainty, and changing environmental conditions. Water resource managers need to change and adapt their management practices based on new experience and continued learning in order to continually improve implementation strategies (Bergkamp *et al*., 2003).

Adaptation is likely to progress only if changes are viewed as a stimulus for innovation. An adaptive style of management is needed if water management is to adapt to change and become more sustainable (Kanta and Zechman, 2014). Adaptation could assist in promoting innovative solutions that are more effective than those that have traditionally been used. Change can bring new innovation to water management (Bergkamp *et al*., 2003). Innovation can potentially play an important role in adapting to changing conditions in the water sector and can lead to improved outcomes and increased coping mechanisms under challenging conditions (Bergkamp *et al*., 2003). Improvement is often initiated by the open exchange of ideas between people and institutions. Organisational fluidity can be facilitated through effective communication between an institution and societal structures (Bergkamp *et al*., 2003). Such communication should be linked to an overall learning process that adopts water user feedback and information dissemination. A ‘results-first’ approach that expedites innovative and improvement appears to be the most desirable (Bergkamp *et al*., 2003).

Over the last twenty years, progress has been made worldwide to adapt and improve institutional water policies, plans and legislation. An example of this is the case of the Australian Millennium Drought which lasted for over a decade, from the late 1990s through to the summer of 2010-11. This drought led to widespread social, environmental, and financial impacts. The most severe impacts on water availability in the River Murray System were between the years 2006 to 2007 and 2009 to 2010, when recorded inflows were half of previous recorded minimum volumes, which created severe water security uncertainty (Murray–Darling Basin Authority, 2016). The Millennium Drought triggered a major reform in Australia’s water management policy and legislation, which included changes to their National Plan for Water Security, Water Act (2007), significant investments in water related infrastructure and the replacement of the Murray–Darling Basin Commission with the Murray–Darling Basin Authority (Table 3) (Murray–Darling Basin Authority, 2016). In July 2008 the signing of the Intergovernmental Agreement on Murray–Darling Basin Water Reform led to additional

reforms which included the arrangements for critical human water needs (Murray–Darling Basin Authority, 2016).

**Table 3:** Australia's new governance framework adopting adaptation strategies after the Millennium Drought (Murray–Darling Basin Authority, 2016).

| **Policy and Legislation Framework** | **Adaptation Changes** |
|---|---|
| Water Act 2007 (Cwlth) | Part 2A establishes the concepts of:<br>• Critical human water needs<br>• Tiers for water sharing<br>• Conveyance water (to deliver)<br>• Conveyance reserve |
| Basin Plan 2012 | Chapter 11 sets out:<br>• Volumes of critical human water needs<br>• Conveyance water and the<br>• conveyance reserve<br>• Salinity and water quality triggers at which water becomes unsuitable for meeting critical human water needs<br>• Processes to assess and manage risks associated with inflow prediction<br>• Triggers for changing water sharing tiers |
| Murray-Darling Basin Agreement | Changes to the Murray-Darling Basin Agreement include:<br>• Addition of Schedule G – SA Storage Right<br>• Addition of Schedule H – water sharing during Tiers 2 and 3<br>• Supporting amendments |
| Objectives and Outcomes Document for Operation of the River Murray System | Basin Officials Committee has set Specific Objectives and Outcomes that provide further direction on river operations during periods of Tier 2 and Tier 3 water sharing arrangements. |

Water managers should pay attention to the goals of adaptive theory and should place more emphasis on leading, facilitating and communicating the concept of adaptation (Conway and Mustelin, 2014). One of the hindrances to affective institutional adaptative management is the lack of water user inclusion within new water planning initiatives (Allen and Gunderson, 2011). According to Turton (2016), technical ingenuity is mostly linked with government and is therefore distanced from the level of society and the individual. By only concentrating on infrastructural projects to manage the demand for water, there can be a lack of natural institutional legitimacy because of the degree of remoteness from the water users that are served.

### 2.2.1 Adaptive Theory applied to Water Demand Management

Population growth and climate change require that decision makers adjust the way that they plan for water resources in the future. Meeting an increasing water demand involves the revision of attitudes and tactics. Through the adaptation of water demand management strategies, increasing water demand can be met through an improved flexibility and efficiency of the water system operations (Giacomoni and Berglund, 2015). The systematic commitment to adjust to changing conditions, learn from outcomes, and constantly redesign and improve water demand management policies and practices is needed (Mayberry, 2015).

Adaptive water demand management approaches describe and predict systems that exhibit complex behaviour at the macroscopic level, emerging from the collective actions of many interacting components which constantly adapt to their environment (Mitchell, 2009). Adaptive water demand management can help systems to operate more efficiently (Giacomoni and Berglund, 2015). Adapting to the dynamic impacts between human decision-making, environmental processes, and infrastructure performance may increase water sustainability. According to the results of an analysis conducted by Giacomoni, (2012), adaptive demand management strategies can help water systems cope with increasing water stresses caused by population growth, droughts and climate change. In studies conducted by Georgakakos *et al*. (2011) and Westphal *et al*. (2003), adaptive management outperformed traditional pre-determined management strategies. The results of a study by Giacomoni and Berglund (2015) indicated that adaptive demand management strategies can help water systems cope with increasing stresses of population growth, droughts, and potential decreases in water availability due to climate change.

Based on worldwide policy evidence, adaptive and integrated water resources management strategies, incorporated in many countries' policy and legislation, are having a significant impact on improved water demand management (Table 4).

**Table 4:** Examples of countries where adaptive and integrated water resources strategies were included in policies and legislation (Hassing *et al*., 2009:11-12).

| **Country** | **Policy and Legislative Evidence** |
|---|---|
| Algeria | National Plan for Water – Ministry of Water Resources (2003)<br>National Water Law – Government of Algeria (2005)<br>Action Plan for the implementation of an IWRM Framework – Ministry of Water Resources (draft 2006-2007) |
| Angola | IWRM and Water Efficiency Roadmap – Ministry of Water and Energy ( draft 2007) |
| Argentina | IWRM Roadmap – Sub-secretariat of Water Resources (2007) |
| Armenia | Water Code – Government of Armenia (2002)<br>National Water Policy – Government of Armenia (2005)<br>National Water Programme – Government of Armenia (draft 2007) |
| Botswana | IWRM Strategy and Action Plan – Ministry of Minerals, Energy and Water Resources (2006) |
| Brazil | National Water Resources Plan – Ministry of Environment (SRH/MMA), National Water Council (CNRH) and National Water Agency (ANA) (2007) |
| Burkina Faso | Decree No. 2003-2020: Action Plan for IWRM in Burkina Faso (PAGIRE) – Ministry of Agriculture, Hydraulics and Fishing Resources (2003)<br>Water Law No. 002-2001 – Government of Burkina Faso (2001) |
| Cambodia | Integrated Water Resources Management (IWRM 2005) and Roadmaps in Cambodia - Department of Water Resources Management and Conservation (2006)<br>Water Law – Royal Government of Cambodia (Sept. 2006) |
| China | China Water Law – Government of China (2002) |
| Colombia | National Development Plan 2006-2010 – National Planning Department (2006) |
| Costa Rica | National Strategy for Integrated Water Resources Management – Government of Costa Rica (2006)<br>National IWRM Action Plan – Government of Costa Rica (2006)<br>National Water Law (No. 14585) – Government of Costa Rica (draft 2006) |
| Ivory Coast | IWRM Roadmap 2007-2015 – Ministry of Environment, Water and Forestry (2007) |
| Egypt | National Water Resources Plan – Ministry of Water Resources and Irrigation (2004) |
| Eritrea | Integrated Water Resources Management and Water Efficiency Plan (IWRM/WE) – Ministry of Land, Water and Environment (draft 2007) |
| Ghana | IWRM Component Support Programme (2004-2008) – Water Resources Commission (2004)<br>Water Resources Policy – Water Resources Commission (draft 2007) |
| Grenada | Simultaneous preparation of IWRM Roadmap and National Water Policy – Water Policy Steering Committee (April 2007) |
| Honduras | IWRM Action Plan – Honduran Water Platform (2006) |
| Indonesia | National Water Law No. 7/2004 – Government of Indonesia (2004)<br>IWRM Roadmap – Directorate General Water Resources of Ministry of Public Works (2006) |
| India | National Water Policy – Government of India (2002) |
| Kazakhstan | IWRM National Roadmap including proposed project outlines – speed-up of the IWRM 2005 objectives implementation in Central Asia – Government of Kazakhstan (2006) |
| Kenya | Water Act 2002 – Government of Kenya (2002)<br>National Water Policy on Water Resources Management and Development (Sessional Paper No. 1 of 1999) – Ministry of Water and Irrigation<br>Integrated Water Resources Management and Water Efficiency Plan for Kenya – Ministry of Water and Irrigation (draft 2007) |

| | |
|---|---|
| Kyrgyzstan | IWRM National Roadmap including proposed project outlines – speed-up of the IWRM 2005 objectives implementation in Central Asia – Government of Kyrgyzstan (2006) |
| Lao PDR | IWRM National Roadmap – Water Resources Co-ordination Committee Secretariat (2006) |

Too many water management institutions however still tend to stick to conventional thinking and prevailing practices when it comes to water demand management, with past investments and strategies that tend to perpetuate a certain way of thinking, causing the formulation and execution of policies even if they are inferior to known alternatives (Giacomoni, 2012).

Merrey *et al*. (2005) examined the weaknesses in the current understanding of integrated water resource management (IWRM) and it not recognising the perspective of different livelihoods. The basic objectives of IWRM should be to reduce poverty, empowering the most vulnerable and to improve livelihoods (Merrey *et al*., 2005). The current system is however largely focused on second-generation issues such as cost recovery and the reallocation of water to ‘‘higher value’’ uses (Merrey *et al*., 2005). The author suggested that IWRM should be a combination of current approaches as well as the livelihoods approach.

IWRM is largely based on a positivist view, which describes the measurable and observable phenomena that are experienced from the water resource strategies used (Merrey *et al*., 2005; Roccard, 2014). This approach is however criticised by those researchers that advocate for a post-positivist perception (Roccard, 2014). Major questions exist over whose interests should be reflected in the integrating process. The post-positivist point of view advocates the inclusion of livelihoods within the integration process (Roccard, 2014). Rather than approaching communities with pre-conceived notions, they should be assisted to evaluate their water requirements and challenges as well as their various options for making use of the water resources for their own benefit (Merrey *et al*., 2005; Roccard, 2014). According to Funke *et al*. (2007) the integration of both current water management approaches as well as the human systems should

occur which will allow for a balance to be attained between resource use and resource protection.

An integrated planning process that promotes a suite of locally adapted water demand strategies should be the central focus of an “adaptation portfolio” (Cohen *et al*., 2004). This can allow for no or minimum regrets in the long term, it is reversible, robust, flexible, incorporate safety strategies and takes cognisance of societal and climatic issues (England, 2012). An understanding of adaptive strategies and its impacts on society is necessary for new and improved water demand management (Cosgrove and Cosgrove, 2013).

### 2.2.2 Conclusions

The above section provided a literature assessment of the adaptation theory, as per the first part of Objective 1 in Chapter 1.7 of this thesis, which reads:

- **Objective 1:** ***“To conduct a theoretical investigation into adaptation theory*** *and its potential contribution towards an improved understanding of participative water demand management as an adaptive response*”.

The literature is proposing adaptive management as a tool to ensure sustainable water resource management within a changing and uncertain future. It is suggested that ‘business as usual’ will be unsustainable when considering current change relating to population increases and climatic changes, amongst others, and new, innovative solutions, that are adapted to these changing conditions, will be necessary in order to mitigate future water related disasters and conflicts.

The literature indicates that, when applied to water demand management, adaptive management can build on effectiveness and efficiency with increased benefits, such as increased water provision and demand sustainability, as well as an improved social acceptability and service delivery. The literature indicates that growing water demand

and threats derived from variability and change will make it increasingly important for water institutions to develop the required skills to manage conflicts over decreasing water resources. They need to adapt their strategies to consider society and institutions as whole systems with different interacting components. By disseminating the information obtained from the literature, it is clear that a change is needed towards adaptive water demand management initiatives that considers whole systems thinking, variability, societal impacts and sustainability.

## 2.3 Socio-Institutional Adaptation

According to Devisscher *et al*. (2016), the key actors within water resource management are the water users (society) and the water service providers (water management institutions). It is important that both these actors are considered within water resource management adaptation practices, as these are non-linear and complex process which are influenced by an integrated and interdependent system consisting of different disciplines, group perspectives, as well as different knowledge and belief systems (Young *et al*., 2014). The capacity of both these actors is therefore influenced and dependant on each other.

### 2.3.1 Institutional Adaptive Capacity

Institutions can be defined as ‘regularised practices’ (Giddens, 1984), ‘regulatory systems’ (Kayambazinthu *et al.*, 2003), or “*a structure or mechanism of enforcing behaviour to conform to shared community practice”* (Herzog, 2014:xiv). The primary goal of institutions is to standardise human activity in order to achieve its objective/s. Institutions are that normative factor that develops in society to standardise and regulate the society’s conduct (Nleya, 2006). Policies, strategies, norms, by-laws, and rules are typical regulatory documents that form part of an institution. Water resources in South Africa are mostly managed through local government institutions in the form of municipalities, which consist of the political, economic, social, and administrative

systems to develop and manage water resources and to deliver water services at different levels of society (Rogers and Hall, 2003).

The adaptive capacity of a water management institution refers to an institution that continually improves its management policies through learning and through the ability to change practices based on new experience and insights (Richter, *et. al*., 2003). Institutional adaptive capacity development is a corner stone of water resources management (Hashemi, 2012). Alaerts and Kaspersma (2009) defines institutional capacity as the capability of an institution to identify and understand its development and future issues, to address them effectively, learn from experience, and to accumulate knowledge. The adaptive capacity of an institution reflects learning, flexibility to experiment and adopt novel solutions, and the development of generalised responses to new and uncertain challenges (Walker *et. al*., 2002).

A comparison of the different dimensions of the term “capacity” is shown in Table 5. The terms “local capacity”, “community capacity”, “social capacity” and “institutional capacity” are closely connected because the water management literature uses these terms interchangeably and within the same contexts (Patch, 2010).

**Table 5:** A comparison of literature on the different dimensions of the term “capacity” (Patch, 2010).

| **Reference** | **Term Used** | **The Dimensions of the term “capacity” as defined by: de Loë, Di Giantomasso and Kreutzwiser (2002).** | | | | |
|---|---|---|---|---|---|---|
| | | **Technical Capacity** | **Financial Capacity** | **Institutional Capacity** | **Political Capacity** | **Social Capacity** |
| Gleick (2003) | Institutional Capacity | * | * | * | | * |
| Turton (1999; 2002a) | Adaptive Capacity | * | | * | * | * |
| Biswas (1996) | Capacity Building | * | | * | * | * |
| Healey (1998) | Institutional Capacity | * | | * | * | * |
| de Loë *et al*. (2002) | Local Capacity | * | * | * | * | * |
| Pahl-Wostl (2007) | Adaptive Capacity | * | | * | | * |

| | | | | | | |
|---|---|---|---|---|---|---|
| Grindle and Hildebrand (1995) | Capacity Building | * | * | * | * | |
| Ivey *et al*. (2004) | Community Capacity | * | * | * | * | * |
| Ivey *et al*. (2006) | Local Capacity | * | | * | * | * |
| Patch (2010) | Institutional Capacity | * | * | * | * | * |
| Pres (2008) | Capacity Building | * | | | * | * |
| Franks (1999) | Capacity Building | * | | * | * | * |
| Timmer *et al*. (2007) | Community Capacity | * | * | * | * | * |

According to Tol (2018:10), "*institutions within developing countries tend to have a limited adaptive capacity*", depending on a range of determinants such as the availability of technology, the availability and distribution of resources, as well as the ability of the institution to learn and to incorporate new knowledge. Institutional capacity can be described as consisting of mainly two broad aspects which are: 1) the expertise of individuals and 2) the organisational experience and resources. This can be sub-categorised into five further aspects: 1) governance, 2) internal operations, 3) financial resources, 4) core services, and 5) organisational development (Patch, 2010). For an institution to function under changing conditions it needs to incorporate aspects of social wellbeing and capacity development, knowledge capacity development, organisational capacity development, as well as good governance and conflict resolution mechanisms within its policies and legislation (Hashemi, 2012). Theory around institutional adaptation indicates the need for a design to involve people affected by policies during institutional policy formulation and understanding (Eppel, 2009). The inclusion of water users and affected stakeholders in the design and implementation of policies and strategies tend to contribute to a higher awareness of the policy implications and outcomes, better policy understanding and improved and informed policy analysis (Eppel, 2009).

There is a need for strong municipal leadership as well as horizontal and vertical collaborations with other water management organizations for more effective water demand management outcomes (Patch, 2010). Strong leadership increases the capacity of a water provision institution by establishing the vision and direction of its goals and by establishing an organisational culture of flexibility (Patch, 2010; Timmer *et al*., 2007). The presence of champions, or agents of change, within an institution is crucial, and flexible managerial staff with the skills to assess a situation, that can learn from experience, and can create new and innovative strategies, is essential to drive institutional reform. Through constant adjustment, experimentation, learning, and stakeholder engagement, institutional adaptation may follow (Eppel, 2009).

New information and knowledge creation enables improved decision making, thereby facilitating the amendment of management initiatives for more adaptive and efficient water operations (Stuart-Hill, 2015). New and updated information on existing and emerging vulnerabilities is strongly determined by social entitlements, and detailed information on individuals, communities and their livelihoods is therefore essential (Stuart-Hill, 2015). The uptake of new information must occur internally as well as externally, and has to flow unobstructed between society, science and management, especially in times of severe change (Stuart-Hill, 2015). New partnerships and collaborations will be needed in order to gain insights across various disciplinary perspectives to be able to inform policies in a productive way (Pahl-Wostl *et al*., 2011). Individual narratives revealed multiple perspectives and different understanding of both institutional barriers and solutions (Eppel, 2009), but the general consensus is that barriers can greatly impact on an institution’s level of adaptive capacity.

Policy implementation barriers and challenges associated with social outcomes are complex and multi-dimensional. Eisenack (2014), Ekstrom and Moser (2014) defined barriers as hurdles that can cause adaptation efforts to be ineffective and unproductive. According to Eisenack (2014), barriers can be the cause of low adaptive capacity. Four major categories of institutional barriers were identified by Ekstrom and Moser (2014, namely: 1) institutional governance, 2) attitudinal and approach, 3) political, and 4)

financial barriers. According to Mukheibir *et al*. (2013), adaptation literature has identified common barriers to adaptation within the Australian local government, such as a lack of leadership, competing priorities, inefficient planning processes, as well as institutional and information constraints. Biesbroek *et al*. (2011) identified seven barriers: 1) contradictory schedules, 2) strategic and functional uncertainty, 3) closeness and void, 4) institutional fragmentation, 5) the absence of communication, 6) motivation to act, 7) a lack of resources, and 8) ethical and value barriers. Water users' perceptions, attitudes, and ethics are not easily changeable as they are commonly rooted in longstanding beliefs and world views, and therefore tend to affect water management institutions inconsistently over time (Ekstrom and Moser, 2014).

Ethical principles include the values, beliefs and perceptions of society and are frequently ignored by water management institutions (Sohail and Cavil, 2006). The meaning of the concept of values can be drawn from the theoretical work of Feather (1975), Maslow (1954), and Rokeach (1973), who conducted research studies on values in order to assess human adaptation to various roles through value fulfilment. Some common human values identified by these authors includes self-respect, warm relationships, security, a sense of self-fulfilment and accomplishment, belonging, excitement, as well as life enjoyment. These values can directly affect the relationship between a water management institution and its water users, as well as the users' water consumption behaviour (Ekstrom and Moser, 2014). For instance, if a water user feels that water provision is unfairly and unequally distributed, therefore impacting on the user's self-respect, conflict situations can occur which can be considered a barrier to the provision of water services. Another example is that of a water user who does not possess the enjoyment of the value of life or security due to financial poverty, and as a consequence does not care about water conservation as they have more direct needs and focusses, i.e. survival. In this example, the consequence of poverty will be a barrier to the water institution's water demand management efforts. Within the current situation of change and uncertainty, it is crucial for adaptation strategies to overcome barriers of effective socio-institutional communication, partnerships and collaborations (Biesbroek *et al*., 2011).

Socio-institutional barriers to adaptation often occur through the larger governance setting in which the system is rooted (Adger *et al*., 2005). A complex systems, multi-level governance approach to adaptation planning, that supports socio-institutional communication and collaboration arrangements, can enhance system flexibility (Mukheibir *et al*., 2013). Adaptive decision-making is dependent on an institution's flexibility and resilience attributes (Eisenack, 2014; Lehmann *et al*., 2015). According to Eisenack (2014), it is the nature of institutions to stabilise societal procedures and thus making themselves prone to rigidity, which can cause a barrier that hinders change and adaptation. Burch (2010) concluded that effective institutional adaptation in Canadian councils occurred due to a greater re-working of complex, interconnected structures and processes, rather than through the acquirement of additional resources. The creation of adaptive and flexible organisations can be facilitated through the reinforcement of institutional capacity by integrating social collaborative partnerships, creating an institutional learning oriented approach, aligning and integrating policies to consider changing conditions, and through multi-sector integration and collaboration (England, 2012; WWDR, 2012).

#### 2.4.1.1 Institutional Adaptation under Uncertainty

According to Bergkamp *et al*. (2003) water professionals are increasingly facing new and ever more complex uncertainties. Uncertainty relates to challenges and questions of how to deal with unprecedented events. More informed and confident decision making can be achieved by reducing the level of uncertainty and adapting strategies to that uncertainty. (Bergkamp *et al*., 2003). Clear trends can assist with the identification and defining of ranges of future uncertainty. Maintaining and improving monitoring networks and forecast systems are essential if these aspects of uncertainty are to be adequately addressed (Bergkamp *et al*., 2003). With increasing uncertainty, stakeholder involvement will be essential to build a wide acceptance of sharing the potential burden and benefits of the impacts of change on water resources. Managing risks and dealing with uncertainty from increasing variability and change can reduce the vulnerability of societies and institutions (Bergkamp *et al*., 2003).

Adaptive management is an attempt to deal with uncertainties which will enable decision makers to act despite incomplete information (McLain and Lee, 1996). It requires open and flexible institutions thereby increasing the ability of institutions to deal with socio-economic change (Folke *et al*., 2002). In terms of adaptive responses, the term "flexibility" is used when changes in the assumptions are accommodated by the modification or adjustment of the responses or plans, whereas "robustness" refers to the ability to withstand changes in assumptions or conditions without changing the nature of the system. According to a definition by Lempert and Collins (2007) an adaptation strategy is robust when it performs well across a wide range of uncertainty and future projections, thereby reducing water system vulnerability to changing conditions. Robust strategies can be more financially costly than flexible strategies because a certain factor of satiety needs to be incorporated. Adaptive strategies are more likely to be flexible to changing conditions as opposed to static strategies, such as large-scale infrastructural projects where design and construction modifications can be very costly once change has occurred (Hallegate, 2009). According to the US National Research Council (2004) adaptive water strategies promotes flexible decision making in the face of uncertainties.

Knowledge uncertainty relates to available data, information, inadequate assumptions or gaps in strategies, and is dominant in water resources management. According to Silberstein (2006), data management technology and modelling will not improve knowledge uncertainty unless the data collection and measurement methods are improved. Sutcliffe (2004) calls for an improvement of data measurement techniques within institutions and a shift from purely technological to a combined technological and data collection approach. Knowledge uncertainties can reduce the authority of scientific conclusions within the decision-making process, but should not affect the importance of scientific knowledge in decision-making, as uncertainty is a by-product of analysing complex issues (Armitage, 2004).

### 2.3.2 Social Adaptive Capacity

Alaerts (1996:59) defines the term "*capacity" as "the knowledge, attitudes, skills and values as we find them in individuals, and as they are aggregated in organisations, communities and in all other forms of arrangements that define individual and collective behaviour*". Alaerts and Kaspersma (2009) defines social capacity as a society's capability to identify and comprehend its water resource issues and to actively address these, to learn from past experiences, and to accumulate knowledge for the future. Adapting to natural resource scarcities entails the mobilisation of an increased level of social resources, also called the "adaptive capacity" of a given society (Turton, 1999). According to studies conducted by Ohlsson (1998; 1999); and Ohlsson and Turton (1999), social resources are needed to adapt to increasing levels of water scarcity. Ohlsson's concept of "social resource scarcity" focused for the first time on the social mechanisms that allows for social adaptation towards increased water scarcity. Social adaptive capacity should include the skills and resources needed to adapt, along with the capability to harness and combine these attributes into adaptative processes (Bettini *et al*., 2015). Without more knowledge on these elements, critical insights on how this can be achieved, in different social contexts, will be missed (Bettini *et al*., 2015). The access, availability, and interpretation of information in order to provide feedback within a governance system are essential components of the adaptive processes (Bettini *et al*., 2015; Engle, 2012; Hill and Engle, 2013). Results from a study by Bettini *et al*. (2015) on the Australian cities Adelaide and Perth, indicated that participants recognised the gaps in information relating to the water management systems' performance in light of new environmental conditions. In Adelaide, new information on drought impacts initiated community discussion on the water scarcity situation and challenged the general assumptions and strategies of the water institution. There was however limited information around the impacts of drought in Perth, causing static perceptions and behaviours and a limited capacity to adapt to change (Bettini *et al.*, 2015). New information and learning has therefore altered the frames of reference for urban water users and managers in Adelaide, with new ideas creating an increase in adaptive capacity and displaying greater cohesion. These insights correlate with ideas

of participation and collaboration, highlighted by a variety of scholarly perspectives on social-ecological systems theories, social innovation, and sustainability transitions (Bettini *et al*., 2015). By increasing the community's capacity to adapt through education, collaboration and participation, the basis for developing shared visions or objectives and gaining shared commitment to changed agendas can be created (Gupta *et al*., 2010).

## 2.4 Adaptive Socio-Institutional Participation

The management of natural resources took a fundamental turn after the research conducted by Ostrom (1990), who identified an alternative based on the ability of communities' to participate and to self-organise. Participation can be understood as the social and institutional connections across levels and scales resulting in collective action towards a common goal (UN, 2013).

According to Ostrom (1990), participatory solutions have a greater probability of being respected and enforced, which supports an environment within which institutions can thrive. Participation is an effective way to extend networks of trust, which is crucial to the flow of information and resources (Campbell and Sacchetti, 2017). Participatory strategies are based on effective community engagement as well as capacity building. "*Embedding a culture of participation opens up previously unidentified opportunities for collective action and cooperation*" (Campbell and Sacchetti, 2017:04). Socio-institutional participation can therefore substantially contribute to the aims of sustainable water resources management and create a platform for the creation of innovative ideas.

According to Huybers and Bennet (2003) independent decision making in interdependent situations is a social problem. This causes the "tragedy of the commons" where the failure to cooperate on resource use results in over-exploitation of common property resources. As a result of communication channel breakdown, individuals may fail to cooperate, even if they would be better off doing so. This is the central tenet of 'Game Theory' as proposed by John Nash in his PhD thesis in 1947 and for which he

was later awarded the Nobel Prize. Many institutions pursue self-interest rather than a collective which leads to socio-institutional conflict. Conflict results from incompatible ideas and goals (Panteli and Sockalingam, 2005; Slabbert, 2004). As a result of conflict, social trust and relations weaken (Panteli and Sockalingam, 2005). Through socio-institutional collaborative efforts, stronger relationships and trust are developed (Panteli and Sockalingam, 2005).

In order for an institution to achieve its own as well as social goals, it should include stakeholder participation and partnerships within its policies. According to Armistead and Pettigrew (2004), research on partnership capacity suggests that partnerships that afford members the opportunity to collaborate and share their experiences are often more effective. Water demand management, as a complex socio-institutional system, calls for a collaborative approach (Shandas *et al*., 2008).

Adaptive management should include collaborative theories where most stakeholders can participate in finding solutions for sustainable resource management (Herzog, 2014). All stakeholders should bring valuable information, while producing cooperation and knowledge integration, thus, accruing deeper, broader shared wisdom. An emphasis should be placed on understanding social behaviour and the reasons for failure of certain initiatives. This should be done in the form of social learning which involves the building of shared communication and understanding through experimental initiatives (Stuart-Hill, 2015).

Improved respect for human behaviour within certain economic and physical conditions, cultural and language knowledge, and diversity of opinions should be incorporated. In order to achieve this, more research into water user satisfaction is needed in order to understand conflicts. Greater communication should follow in the form of public outreach meetings, shared vision, shared resources and water user participation (Plummer and FitzGibbon, 2007). By strengthening shared understanding and facilitating cooperation, adaptive management fosters an improved knowledge base, water user trust and understanding.

Cooperation, coordination and trust within the water sector, as well as beyond, is crucial when prioritising options for adaptation (Stuart-Hill, 2015). Trust is a key variable within collaborative partnerships and consists of sharing, mutual understanding, reliability, equity, honesty and ethics. Trust is considered an essential element within socio-institutional partnerships, without which water initiatives and technology will be poorly accepted, resulting in initiative failure (Herzog, 2014). The process of building trust can lead to greater tolerance for a wider diversity of opinion and solution options with a more directed problem-solving focus (Herzog, 2014).

Collaboration and partnership involves the management of difference (Brown, 2011). The development of inter-personal relationships is part of a process of exploration, discovery and understanding of different water user groups and the institution that is delivering the service. The process of collaborative partnerships should include effective social communication principles such as messages developed with the targeted water user groups in mind (Brown, 2011). Sensitivity should be incorporated into language preference, literacy level and circumstances in order not to misinform, give offence or be unclear (Brown, 2011).

Because partnerships require the integration of diverse interests, perspectives, resources, identities, the capacity to build and maintain partnerships implies social learning (Brown, 2011). In the context of water resource management, partnership capacity is often discussed in conjunction with social learning (Fernandez-Gimenez *et al*., 2008; Pahl-Wostl, 2007). Adaptive management approaches focusing on improved communication and feedback from water user groups are better able to devise workable initiatives for managing water resources based on the specific physical, social, and economic conditions. Managers can gain knowledge from specific water user groups' interests and needs, thereby implementing targeted and focused initiatives.

Solutions to water demand problems require the application of scientific principles and an understanding of the social, political and economic conditions in which these problems exist. By assessing and monitoring the decision making process and initiative

impacts of initiatives on socio-institutional systems, information can feed the adaptive management processes (Plummer and FitzGibbon, 2007). An approach of “sense and respond” rather than “command and control” is needed within water demand management (Gleick, 2003). Large scale projects, policies and decisions should be reduced into smaller initiatives that consider a socio-institutional systems approach. This can assist in the successful navigation of a changing and only partly predictable system (Roux and Biggs, 2010).

### 2.4.1 Participation and Socio-Institutional Politics

Water resource management is a relatively concrete part of society as the public is directly affected by decisions that are made and implemented at the local level. Water resource managers therefore increasingly recognise the importance of public participation in decision-making, since water resource management is a technical as well as a social process and should therefore reflect the objectives of social participation. The benefits of involving the public in making these decisions could include better understanding of public values with respect to the water resources, and a greater support for implementation (Korfmacher, 2001). There are many different justifications for including socio-institutional participation within water resource management. Three types of reasons are commonly cited, namely 1) democratic, 2) substantive, and 3) pragmatic rationales (Fiorino, 1991, Korfmacher, 2001). The democratic rationale recognises the intrinsic value of public participation and offers several rationales for why the public should participate in decision-making (Korfmacher, 2001). Recognising that in some cases residents might have unique contributions to decision-making due to their in-depth knowledge of conditions within their specific communities, the substantive rationale claims that social values and technical knowledge should help inform the final decision making process (Korfmacher, 2001). The pragmatic justification for public participation recognises that water resource projects or policy are more likely to be socially acceptable if the public has participated in the decision-making process (Fiorino, 1991; Korfmacher, 2001). However, there has also been widespread critique that social participation is driven by political agendas

(Korfmacher, 2001; Kweit and Kweit, 1981). Amongst the several arguments, biased governance, the misrepresentation of consensus, insufficient influence, and a lack of political will is recognised (Korfmacher, 2001).

Little attention has been paid to the politics of the social participation process (Korfmacher, 2001). The term ‘politics’ refers to the activities associated with the governance of a country, especially the debate between parties over power (Fallon, 2018). Ndudula (2013) defines politics as being the maintenance of power over the public of a particular jurisdiction by certain political affiliated persons or groups of people. Inherent in the definition is the allocation of values authoritatively in such a manner that it seeks to regulate or accommodate conflicts within the local communities in question (Reddy, 2016). The author Ker Rault (2008) argue that social participation in water resources management is more a socio-political issue rather than a technical one. According to Allan (2000:184), the political environment constrains the water resource management environment so “*that there is a distinct difference between what should be done to manage resources sustainably, and what can be done to manage those resources sustainably*”. Political buy-in is therefore extremely important before water resource management policies can become viable.

According to the authors (Motion, 2005; Petts, 2008), social participation has been attributed to the benefit of improving good governance, but it has also caused scepticism and disappointment. Aspects such as trust, fairness, accountability, and different categories of stakeholders, amongst others, can be considered as conflict determinants, but are however poorly defined and scattered in the literature (English *et al*., 1993; Fisher, 1993; Ker Rault, 2008; Rowe and Frewer, 2005; Webler, 1999). Disillusion in democratic governance and participative approaches can generate conflicts due to socio-institutional manipulation, misunderstanding, and the disregard of alternative opinions (Ker Rault, 2008; Motion, 2005).

Advocates of participatory democracy argue that social participation should be as local and direct as possible (Korfmacher, 2001; Reddy, 2016). Many water management decision makers however still implement a bureaucratic management style, which

acknowledges that water resource management decisions require technical expertise and should be handled by water resource management experts (Korfmacher, 2001). It has however been shown that even in technically complex decision-making cases, meaningful social involvement is possible (Korfmacher, 2001; Ozawa, 1991). Academics involved with the science of sociology argue that, because the generation of scientific information is a social process, it is appropriate for the affected society to be included in decision making (Tesh, 1999).

Within the politics of shared decision making, there are generally two styles of socio-institutional participation, namely 1) the administrator is an analyst who bases public policy decisions on a maximisation of net-benefits, or 2) the administrator acts as an inter-group mediator who bases public policy decision on arbitration between interest-groups (Dietz, 1995; Ker Rault, 2008). The degree to which the water management institution promotes inclusive and discursive participation processes seems to be associated with its capacity to adapt its governance style to the context and issues at stake within different communities' unique circumstance (Ker Rault, 2008; Ridder *et al*., 2005).

Arnstein's ladder to social participation is an example of a participative model. The authors Pröpper and Steenbeek (1998, 1999) proposed a modification of this model consisting of an interactive level of participative governance recognised by six parallel steps or degrees of socio-institutional participative governance styles, according to an increasing level of interaction between the socio-institution actors (Table 6).

**Table 6:** Pröpper and Steenbeek's (1998, 1999) modification of Arnsteins ladder, indicating the different degrees of socio-institutional participation (Ker Rault, 2008).

| Step/Degree of Participation | Style of Governance | Role of Participants | Level of Participative Interaction |
|---|---|---|---|
| 6 | Facilitative | Initiator | Interactive Participation |
| 5 | Cooperative | Cooperating Partner | |
| 4 | Delegating | Co-decision Maker | |
| 3 | Participating | Advisor | |
| 2 | Consultative | Consultant | Non-interactive Participation |
| 1 | Open Authoratative | Information Provision Only | |
| 0 | Closed Authoritative | None | |

At the bottom of the ladder there is no socio-institutional participation in the decision-making process. The first degree of participation is characterised as 'open authoritative' governance, where the public are merely being supplied with information by the institution (Ker Rault, 2008; Pröpper and Steenbeek, 1998, 1999). The second level is characterised by a socio-institutional participative style which is 'consultative', where the public are merely consulted on possible actions to be taken by the institution (Ker Rault, 2008; Pröpper and Steenbeek, 1998, 1999). The third degree of participation is called 'participative' governance, where the public takes on an advisory role in the decision making process (Ker Rault, 2008; Pröpper and Steenbeek, 1998, 1999). The fourth step on the ladder is where the institution delegates tasks and the public become 'co-decision makers' (Ker Rault, 2008; Pröpper and Steenbeek, 1998, 1999). The fifth degree is recognised as a 'co-operative' participative governance style, where the public are partners in the decision making process (Ker Rault, 2008; Pröpper and Steenbeek, 1998, 1999). At the top of the ladder the socio-institutional participative relationship is recognised as a 'facilitative' role, where participation is initiated by the social actors, which is the most desirable form of participation (Ker Rault, 2008; Pröpper and Steenbeek, 1998, 1999; Van Ast and Boot, 2003).

South Africa as a young democratic state has only been in existence for just over two decades (Ndudula, 2013). Its newly elected post-1994 democratic governance opted for

a strong local government system which has been constitutionalised in terms of Chapter 7 of the Constitution of the Republic of South Africa Act 108 of 1996 (RSA, 1996). Section 1 (a) of the Constitution of South Africa embeds the founding values of human dignity, the advancement of human rights and freedoms, as well as the realisation of equality. Section 27 affords the rights to equal benefit of the law (RSA, 1996).

The new ruling political party sought to ensure a democratic governance, and that the executive leadership of municipalities share the same political ideology to enable shared and equitable local development opportunities for all (Reddy, 2016). In South Africa, the local government is driven by politicians, which consists of councillors and the executive management component of the council within the local sphere of government, known as municipalities (Thornhill and Cloete 2014; Van der Walt, 2014). The local sphere of government is particularly important as it forms the root of local democracy, is the closest to the people, and more importantly, it is at the first interface with the public when it comes to basic service delivery (Reddy, 2016).

The politicisation of local government has however been critiqued by some, who question where the politicisation of local governance commences and where it ends, and what is the ideal local political boundary for efficient and effective water service delivery and good governance (Reddy, 2016)? South Africa's local governing system is characterized by political infighting and related clashes between the political and management components in municipalities, which is having an adverse effect on water resource management within municipalities (Booysen, 2012; Cameron, 2010; De Visser, 2010).

Thornhill (2014) pointed out that the local political process may appear to be simplistic, but that it is quite complex. He argues that local politics involves the "*attachment of values to factual information, thereby determining the relative importance of requests by society*" (Thornhill (2014:58). The political component of local government has the power of "*initiating and overseeing the executive actions of officials appointed to act on its behalf in terms of discharging its governmental responsibilities*" (Thornhill (2014:58), which according to De Visser (2010), undermines the institutional integrity of

government. Water governance in South Africa is therefore very complex in nature. The country has a dynamic and democratically comprehensive set of water legislation, but it is also characterised by a failing governance system at local level which is functioning with its own political agendas and will, and a general lack of implementing the country's water legislation.

### 2.4.2 Participation towards Socio-Institutional Learning

According to Mezirow (1994: 222-223) learning is the "*process of construing and appropriating a new or revised interpretation of the meaning of one's experience as a guide to action*". The concept of social learning is based on the work of social-psychologist Kurt Lewin and revolves around the process being socially interactive (McCarthy, 2006). Argyris (1993) viewed social learning as a process within social structures such as organisations or institutions, whereas Wynne (1992) viewed it as coordinated cognitive and normative adjustments that results in social change. Webler *et al*. (1995:445) defined social learning as more than individuals learning in a social situation, but a "*community of people with diverse personal interests, but also common interests, who must come together to reach agreement on collective action to solve a mutual problem".* Pahl-Wostl, (2007) advocates the incorporation of adaptive management principles within a socio-institutional learning process. According to Pahl-Wostl (2007) socio-institutional social learning is the combination of subjective perceptions such as values, belief systems and ideology with factual knowledge in a participatory group process in order to increase adaptive capacity (Pahl-Wostl, 2007).

According to Plummer and FitzGibbon (2007), social-institutional adaptive capacity requires the inclusion of social water user groups in institutional decision making, and the incorporation of diverse perspectives, knowledge integration, social networking, partnerships and collaboration, and social systems in institutional strategies. Although various authors have described socio-institutional adaptive capacity, the description by Turton (2002c) encompasses the theory well, in which he defines:

- Institutional adaptive capacity as the ability of institutions to respond appropriately to a change in the social, physical, political or economic environment in which they are embedded.; and,

- Social adaptive capacity which is the ability of people to respond appropriately to a change in the social, physical, political or economic environment in which they are embedded.

This study however argues that the aspect of participation theory should be part of the above definitions of Turton, which includes the capacity of institutions to adapt to the social factors such as behaviours, perceptions and understanding, and not just change, that drives water demand within communities. The same can be said for social adaptive capacity, which not only consist of the ability to have adaptive responses to change, but also their capacity to adapt their behaviour towards the facilitation of institutional strategies, therefore an increased understanding of the institutional reasons, objectives and challenges when it comes to water demand management, and the ability to respond to that in a positive way.

According to Senge (2014) we need to think strategically in order to have some idea of how we can create the conditions for social learning, and to have a deeper understanding of the link between these conditions and social learning. In his research paper, Checkland (1981:117) referred to the idea of soft systems thinking, which considers human beings as "*individuals with their own goals which may or may not harmonise with organisational priorities*". Soft systems methodologies are used in the process of collaboration between society and an organization, through a process of learning, in order to achieve a required outcome. Soft systems thinking illustrates that people will try to take purposeful action to resolve challenges and problem situations, in spite of conflicts, uncertainty and disagreement in all problem situations (Checkland, 1981). It is this action, trial and error which causes "human beings to learn from their experience", and to make improved decisions in challenging situations (Checkland and Scholes, 1999:2).

As we learn we are adapting and evolving and our behaviour and performance will change and improve over time (Checkland and Scholes, 1999). This implementation of change and new ideas will result in new systems that will affect the bigger system leading to more opportunities. Checkland (1981:74) stresses that the aim of systems thinking is "*to tackle problems of irreducible complexity by thinking in wholes, rather than overthrowing the tradition of science"*. The endurance of a socio-institutional system is "*only possible where a system has processes of communication and control to adapt to changes in the environmen*t" (Checkland and Scholes, 1999:19).

An increased socio-institutional learning capacity can provide benefits to the system, such as an increase in social trust, participation and cooperation reciprocity, knowledge, and stakeholder engagement (Herzog, 2014). A large flood which occurred in Bear Creek, Colorado in the United States can serve as an example to demonstrate the benefits of socio-institutional participation and capacity upliftment. The Bear Creek flood control reservoir was subjected to cultural eutrophication due to complex social causes. By applying participatory management to social issues appearing after the flood occurrence, an increase in socio-institutional learning, knowledge generation, community outreach, and change incorporation for improved future responses were achieved (Herzog, 2014). The Bear Creek Water Association authorities and stakeholders welcomed the collaboration which seemed to have impacted on bringing forth a change in discussion focus and enabling alternative options that brought a shift towards improved socio-institutional relationships (Herzog, 2014).

Experimental research studies conducted by Ostrom (2005) and Imperial (1999) have shown evidence that water users have the ability to manage common pool resources by learning from each other (Brown, 2011). In order to deal with highly complex and uncertain drivers, collaborative learning and self-reflection may create opportunities for institutional innovations (Woodhill, 2010; Huppè *et al.*, 2012; Leach *et al*., 2012). Learning and feedback will be crucial to management and implementation under the challenges of change (Pollard and Du Toit, 2011; Never, 2012).

Learning demands new partnerships, collaboration and cooperation, improved communication, new organisational arrangements and a strong focus on gathering a variety of socio-economic information that has to be included in robust and continuous monitoring processes (Stuart-Hill, 2015). Given that new structures emerge from the creative interactions of humans, any attempt to manage learning and knowledge in a social system should enable individuals to reach their creative potential (McCarthy, 2006; Fuchs, 2004). By providing an opportunity for dialogue with its water users and stakeholders, a water institution may create an environment for innovation, system integration and adaptive water management. According to Senge (2014) we need to think strategically in order to have some idea of how we can create the conditions for social learning, and to have a deeper understanding of the link between these conditions and social learning.

### 2.4.3 Case Examples of Socio-Institutional Participation

An improved understanding of the impacts of water demand management strategies on society is especially needed in order to adapt to change. The impacts of strategies that focus on improving water user behaviour can contribute significantly to the effectiveness of implemented strategies (Schulze, 2000). Water demand management strategies adapted to include community involvement have many indirect benefits, which are difficult to quantify, but are often critical to the overall success of a project (Wegelin, 2015). Studies done in Australia, New Zealand, United States of America and the United Kingdom are showing that the correct behaviour toward water consumption is extremely important in terms of enabling long-term sensitivity to water conservation (Zadeh *et al*., 2014). Wegelin (2015) researched the impact of two South African awareness projects undertaken in isolation in the areas of Johandeo (WRP, 2009) and Boitumelo (Siqalaba *et al.,* 2009). The results indicated a reduction of 8% and 10% respectively in the average daily water demand within the two areas. The author also investigated the impact of before and after initiative knowledge, attitude and perception (KAP) using surveys in the areas of Sebokeng and Evaton, which revealed remarkable behaviour changes. Some of the most noticeable behavioural changes observed

included positive changes to irrigation schedules, an increased rate of leak repairs, a reduction in water usage during laundry washing as well as reduced laundry washing frequencies, and an increased awareness among children of water conservation methods (Wegelin, 2015; Management Consultant, 2014).

Part of this thesis is to investigate the socio-institutional interactions between water institutions and society, as well as their impacts on each other and capacity of each to adapt to each other's objectives, perceptions and needs. By understanding the socio-institutional challenges, a case for an improved adaptive, systems approach to water demand management can be explored.

#### 2.4.3.1 Case Example: Participative Water Demand Management, City of Santiago, Chile

An example of potential adaptive water demand management impacts can be seen in the work by Meza *et al*. (2014) as part of their investigation on adaptive water demand management within a complex system in the City of Santiago, Chile. The research investigation called Maipo: Plan de Adaptación (MAPA), included the development of a hydrological and water resource model in consultation with a number of water use stakeholders in the city. This model was designed to assess socio-institutional collaboration in the form of water option contracts in the City. The development of the model enabled the creation of a tool to assess the effectiveness of adaptation measures designed to mitigate the impacts of future risks.

The model was developed using the Water Evaluation and Planning System (WEAP) platform (Yates *et al*., 2005), and corresponded to a refinement of the model used by Meza *et al*. (2014). The model was based on the production and demand areas for surface water resources within Santiago which belong to three hydrographic systems, known as the Mapocho River, the Maipo River, and the Quebrada Ramon system. Together these systems supply over 150 water demand sectors through a complex water distribution system with different operational procedures (Vicuña *et al*., 2018; (MacAlister and Subramanyam, 2018). This complex potable water provisioning system

is subject to significant threats from climate change and related variability as well as increasing population densities.

The city of Santiago is home to nearly 7 million people who are relying on the Maipo and Mapocho Rivers, known collectively as the Maipo basin, as well as groundwater resources, as their main sources of water for residential, commercial, industrial and agricultural usage (MacAlister and Subramanyam, 2018). The Maipo basin has a semi-arid hydro-scheme subjected to high rainfall variability during the winter months and a high water availability during the spring and summer period due to melting snowpack. The water resource system is a complex system as it has different types of raw water sources, including surface water intakes that supply the treatment plants, and groundwater which is pumped into different areas of the city (MacAlister and Subramanyam, 2018).

According to Meza *et al*. (2014), their research indicated that climate change could reduce the annual water flows in the Maipo River by 10–40%. Impacts are projected related to the increases in temperature, and reduction in rainfall, which are already being observed within the region (Vicuña *et al*., 2018; MacAlister and Subramanyam, 2018). The study by Meza *et al*. (2014) indicated that future changes in climatic conditions "*range between −20% to 0 and −40% to −10% change in precipitation for an early (2010–2040) and late (2070–2100) time period, respectively, and between 0.5–1 °C and 1.5–3.5 °C increase in temperature for the two time periods, considering uncertainty in models and emission scenarios*" (Vicuña *et al*., 2018: 247).

If a scenario is considered where higher emissions (radiative forcing of 6 W/m2) are occurring, but with similar climate model projection possibilities, then failures within the system are foreseen, as there is at least one week when supplies from the Maipo system is unable to meet the needs of production of the treatment plants that serve a large portion of the population (Vicuña *et al*., 2018). Variability in the frequency of extreme weather events could also affect the water quality due to an increased turbidity linked to sediment erosion from the mountainous areas, with a resultant failure of water supply intakes from the river (MacAlister and Subramanyam, 2018). An urgent need

was therefore identified for cost efficient, adaptable solutions in order to provide a sustained water provision service to the city.

One of the solutions that was investigated as part of the model was water savings option contracts as a cost efficient adaptation measure for the mitigation of climate change induced system variability impacts. These contracts were proposed between the water service institution, Aguas Andinas, and its large urban water users such as municipalities and industries. The objective of the proposed contract agreement was to establish a socio-institutional collaborative partnership in order to reduce the urban water demand and to increase the period of water availability, as well as to avoid water restrictions that impose prohibitive measures on the city's water users (MacAlister and Subramanyam, 2018).

The contract system involves the participation of large water users that can contribute sufficient water to the system through water conservation methods within their operations. The study of the contract system's potential effectiveness focused on the municipal department of City Parks as an example to demonstrate how the option contract could be a useful adaptation measure. The implementation of the contract system may be triggered during a period of looming drought. In the study example, the City Parks is being compensated by means of the total costs transferred from urban water users, to cease with their irrigation operations within the city's green areas during an established period, thereby increasing the ability of Aguas Andinas to meet the demands of the residential water users (MacAlister and Subramanyam, 2018). The City Parks normally has a use of 40% to 70% of potable household water for their landscape irrigation operations (Hilaire *et al*., 2008). If there is a sufficient reduction in water consumption due to the water option contract system, then the water provision institution could provide a sustainable supply of potable water to its water users for an extended period in the event of extreme droughts, and thereby avoiding water restrictions such as the those imposed during the summer of 2013 drought event (Vicuña *et al*., 2018; MacAlister and Subramanyam, 2018).

In the event that the City Parks would cease its irrigation operations of green areas within the city, enough potable water could be made available to carry the city for short periods of time. If similar contracts can however be implemented with the other large water users within the city, longer periods of water supply autonomy could be achieved (Vicuña *et al*., 2018; MacAlister and Subramanyam, 2018) (Figure 4).

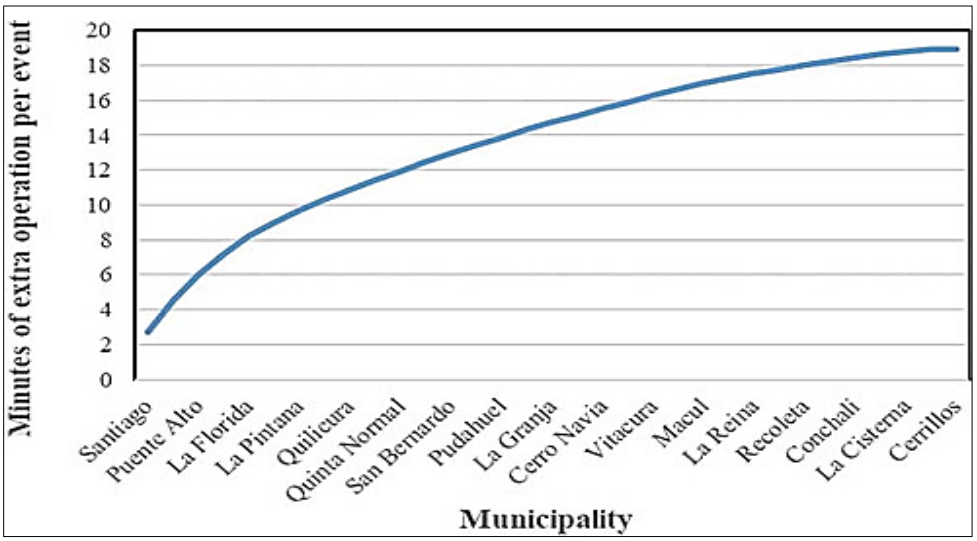


**Figure 4:** The length of time of extended operation within the city of Santiago (Vicuña *et al*., 2018).

This proposed participative approach is an adaptive water demand management alternative based on the complex characteristics of the existing water supply system in the city of Saniago. The proposed socio-institutional agreement contracts will respond to the need to find an acceptable solution that does not require large regulatory changes. The implementation of the proposed initiative will also enable the analysis of management processes that might enable participants to be interested in future contracts that are also cost effective (Vicuña *et al*., 2018; MacAlister and Subramanyam, 2018). The implementation of water demand management alternatives such as option contracts may however require complex socio-institutional arrangements as well as "*a greater understanding of the dynamics of water markets"* (Vicuña *et al*., 2018:241; Wheeler *et al*., 2013).

Regardless of its socio-institutional complexity, the use of option contracts appear to be a cost effective alternative that can act as a measure to ensure improved water security. Water savings option contracts as an adaptation measure could be successful in its water savings function as it is an effective exchange of water rights from less vulnerable water users to more vulnerable users during extreme drought events (Vicuña *et al*., 2018). This risk sharing system could result in a lower total cost to society due to its distribution of costs among various water users (Vicuña *et al*., 2018). It has been found that option contracts can distribute transaction costs over a longer duration, increase water users' willingness to participate in water transactions, and thereby increasing the adaptive flexibility of the system (Wheeler *et al*., 2013).

Water savings option contracts is an example of socio-institutional participative water demand management through its system of considering the distinct and differentiated levels of water security within the city, and by reallocating water rights among these levels of users. "*Allocation mechanisms can be designed as tools to reallocate water from those who have a lower willingness to pay to those that require higher levels of water security*", which is an effective method of combining the components of both proactive and reactive adaptation measures, and that can therefore be a viable tool for socio-institutional water demand management adaptation within complex systems (MacAlister and Subramanyam, 2018:253).

#### 2.4.3.2 Case Example: Participatory Water Management, Diepsloot Informal Settlement, South Africa

The residents of the Diepsloot informal Settlement in Johannesburg, South Africa must rely on their own initiatives to address surface water runoff challenges, as the lanes that drain the storm or domestic water within the area falls outside the mandate of the City of Johannesburg municipality's stormwater management system (Fitchett, 2017). Part of a research project conducted by Fitchett (2017) was to investigate the introduction of sustainable drainage systems (SuDS) principles in the area as an adaptive approach to manage the surface water runoff, the Diepsloot community was introduced to SuDS and drawn in to solve their runoff challenges and risks. The SuDS principles imitate a

catchment's natural water management processes in urban areas which has been severely degraded (Haghighatafshar, 2018). The main aim of SuDS is to reduce flooding and water quality and related safety and health risks (Haghighatafshar, 2018). The introduction of SuDS interventions in an informal settlement requires a complex, multi-disciplinary approach because of the social, environmental and economic dimensions (Parkinson *et al*., 2007).

Residents from different sections within the settlement can be expected to have different priorities (Ziervogel and Taylor, 2008), attitudes and views on environmental responsibility. The study however found that most residents engaged in a participatory way by providing valuable insights, and through penetrating questions, in group sessions that discussed the SuDS principles and implementation strategies (Fitchett, 2017). To promote an adaptive, participatory management style, discussions on possible solutions were specifically structured to gain more knowledge and to build capacities (Fitchett, 2017). The community actively participated in the implementation activities, and joined in reflection and adapted decisions as the project progressed (Fitchett, 2017).

The results of this project were an increased quality of life for the community through a considerable improvement in water quality and runoff at the research sites (Fitchett, 2017). Apart from this, the additional benefits of improved social cohesion, learning and adaptive capacity building were achieved (Fitchett, 2017). The research on the project found that through intensive engagement and participation, the residents portrayed attitudes of high commitment to the project (Fitchett, 2017; Harrison *et al.,* 2014). The project is an example of the viability of adaptive initiatives within urban areas (Fitchett, 2017). The research on the project proved that a firm relationship with the community can be established through participative engagement, which provides a platform for adaptive capacity building, trust and project success (Fitchett, 2017).

### 2.4.4 Conclusions

The above section on participation provided insight on how participation as an adaptation response can provide improved water demand management initiatives with greater success, and speaks to the second part of Objective 1 as well as Objective 2 as in Chapter 1.7 of this thesis, which reads:

- ***Objective 1:*** *"To conduct a theoretical investigation into adaptation theory* ***and its potential contribution towards an improved understanding of participative water demand management as an adaptive response***".

- **Objective 2:** *"To understand the implications of a complex systems approach on socio-institutional adaptive capacity and its potential to increase and improve adaptive capacity*".

According to the literature, the participation between society and the water management institution will ensure improved water demand management initiatives. This is essential in creating an adaptive water resource management environment. The literature indicated that, through participation and engagement, an understanding of both sides can be created. This can ensure water demand management measures adapted towards each other (society and water management institutions), resulting in decreasing socio-institutional conflict, creating a relationship of socio-institutional trust, and ensuring a higher acceptance rate of initiatives and success rate.

The literature showed that the institutional dimension refers to the norms and procedures governing the relationships and interdependencies among actors and resources. It spoke to the necessity of water management institutions to increase their adaptive capacity for future water security. The institutional barriers of adaptation were discussed and the literature indicated the importance of overcoming these barriers if water management initiatives are to be effective and productive. Barriers to effective socio-institutional communication, partnerships and collaborations were indicated as being crucial for an institution to identify and understand its development and future

issues, to address them effectively, to learn from past experiences, and to accumulate knowledge.

The literature also indicated that social participation is greatly influenced by politics. If there is a lack of political agenda, will or understanding, the inclusion of participation within water resource management policies, then it will not be part of the implementation agendas of local water management institutions. The adaptive capacity of an institution therefore political will, learning, flexibility, experimentation, the adoption of new innovative solutions, and the development of flexible responses to new and uncertain challenges.

The literature also indicated that the social capacity to adapt also played a key role in water demand management adaptation. Society consist of social groups with different behaviours, perceptions, norms, belief systems and political influences. Societies need to adapt their water use behaviours in order to reduce the demand for water. The capacity of societies to adapt however depends on their belief systems. Through the strengthening of engagement processes the capacity of water users can be increased due to an improved knowledge, understanding and acceptance of initiatives, resulting in a general willingness to participate in water use reduction initiatives and actions.

The literature indicated that water demand management strategies can have a positive impact on certain water user groups, but also a negative impact on other water user groups, especially the poor and vulnerable. Water demand management strategies can impact negatively on livelihoods through a restricted supply of water, high water tariffs, and enforced strategies.

The literature pointed to the need to consider a socio-institutional systems approach that consider society and institutions as a whole system with different interacting components. As indicated by the literature, using systems thinking approaches can generate insights into ways that can assist to better understand institutional and social adaptive capacities, how to overcome adaptive capacity barriers within water demand management, and how to increase socio-institutional adaptive capacities.

## 2.5 The Need for a Paradigm Shift

Some of the earliest work on the concept of paradigms was done by Thomas Kuhn (1970) in his book 'The Structure of Scientific Revolutions'. Kuhn was recognised as the most significant contributor to early literature on the understanding of the concept of paradigms (Kearns, 2014). He defined the term 'paradigms' *as the "entire constellation of beliefs, values, and techniques*" that are mutual to a specific community (Kuhn, 1970:175). Within water resources management, the authors Ohlsson and Turton (1999) made a significant contribution to the field of paradigm shifts, in their paper called 'The Turning of the Screw', in which they investigated water scarcity and adaptation. The authors described the concept of a paradigm shift as derived from three steps as recognized through existing knowledge of the progression of water management practices. These steps consisted of the process to identify bottlenecks, the appropriate social tools to meet the challenges, and finally dealing with created conflicts in new ways of using water resources (Kearns, 2014). These three paradigms were simplified and labelled on their management style as 1) supply management, 2) demand management, and 3) allocative efficiency. Paradigms are therefore based on the specific dominant aims and objectives of water resources management during one of these specific stages. The change to a management system from one stage to the next, usually due to the need for greater efficiency and sustainability, is referred to as a paradigm shift within water resources management (Kearns, 2014).

Cortner and Moote (1994) identified the emergence of a paradigm shift in water resources management, and the concept is still ongoing as documented by more recent publications (Pahl-Wostl *et al*., 2006). Pahl-Wostl *et al*. (2006:04) defined a paradigm shift as "*a set of basic assumptions about the nature of the system to be managed, the goals of management and the ways in which these management goals can be achieved*". During the past three decades, as early as 1994, a selection of authors, (Table 6), have been advocating for a paradigm shift in water resource management.

**Table 7:** A sample of literature that referred to a paradigm shift in water resource management.

| **Author/s** | **Year** | **Reference** |
|---|---|---|
| Cortner and Moote | (1994:167) | Identified the emergence of a paradigm shift in land and water resources management. |
| Ward | (1995:02) | Highlighted in his forward to a special issue on "Integrated Watershed Management - A New Paradigm for Water Management" the need for change. |
| Ohlsson and Turton | (1999) | Made a significant contribution to the field of paradigm shifts in their paper called 'The Turning of the Screw'. |
| Gleick | (2000:127) | Talks of a 'changing water paradigm'. |
| US Army Corps of Engineers on Adaptive Management | (2004) | Highlighted the need for a paradigm shift. |
| Pahl-Wostl *et al*. | (2006:04) | Referred to a paradigm shift as a set of basic assumptions and management goals. |
| Siebrits *et al*. | (2014) | Referred to water research paradigm shifts in South Africa. |
| Vairavamoorthy *et al*. | (2015) | Highlighted the need for a paradigm shift towards management strategies that increase urban water system resilience. |

Vairavamoorthy *et al*. (2015) stated that with increasing pressures originating from global change such as urbanisation and climate change, as well as existing unsustainable factors and risks inherent to conventional urban water management, future cities will find it more and more difficult to manage less reliable and scarcer water resources. In order to meet these challenges, there needs to be a paradigm shift towards management strategies that increase urban water system resilience, interventions that considers the entire urban water cycle, re-assess water use and water recycling efficiency strategies, and that involves greater application of natural water purification and recycling systems (Vairavamoorthy *et al*., 2015). A paradigm shift firstly involves all the learning processes which have to start at the level of mental models (Pahl-Wostl *et al*., 2006). A critical reflection on paradigms is needed, as well as their impacts on actors, the problem domain, and current and future uncertainties. A paradigm of new water management approaches should be based on sound and unbiased debates.

Over the past two decades, new and more integrated approaches to water management have been developed to address perceived shortcomings in earlier approaches. For example, the principle of integrated water resource management has developed during the last decade (GWP-TEC, 2000). The implementation of an integrated resource management approach however "*does not account for the complexity and inter dependencies of human- environment- technology systems"* (Pahl-Wostl *et al*., 2006:11). The increasing awareness of this complexity within water resource management has encouraged the development of new management approaches (Pahl-Wostl *et al*., 2006). As stated by Pahl-Wostl *et al*., 2006:11), "*a paradigm shift in water management from a prediction and control to a management as learning approach*" is needed.

Water resources management forces constant learning due to its multi-dimensional (human, society and environment), multi-level (national, regional and local), multi-sectoral (energy, food, drinking) and multi-disciplinary (hydrology, ecology, law) aspects (Hashemi, 2012). Implementing sustainable water resources management poses five main challenges: 1) the integration of complex adaptive dimensions, 2) dealing with the dynamism of a complex systems approach, 3) the measurement of sustainability, 4) dealing with various decision-makers and their level of ethics and values, and 5) the creation of a collaborative and participatory approach (Hashemi, 2012). To deal with these challenges, a paradigm shift towards adaptive management and stakeholder participation (Merrey, 2008), social learning (Warner, 2007), and an emphasis on social culture and ethics (Daniels and Endfield, 2009), is needed.

A conventional approach to water resources management attempted a hierarchical and centralised control through highly regulated top-down governance and large scale technologies (England, 2012). Institutional change is needed which involves a paradigm shift from a main focus on traditional water resources management, to a reformed, adaptive, more sustainable water governance (Merry *et al*., 2007), which includes an integrated and adaptive inter-sectorial collaborative approach. It is focused on decentralisation, privatisation and promoting participatory approaches for water management (England, 2012). A paradigm shift that considers adaptive water resources

management, complex systems analysis as well as a reliance on social participatory processes and stakeholder involvement is necessary in order to manage water resources sustainably over the long term and under increasing unpredictability (Hashemi, 2012).

### 2.5.1 Adaptation within the Complexity Paradigm

The term ‘complexity paradigm’ is used to describe the increasing complexity of water resource management challenges expected in the future (Simonovic, 2009). Complexity means that there are dynamics arising from the interactions between system parts which results in both endogenous and exogenous, non-linear changes in the parts and the whole (Eppel, 2009). The systems approach is concerned with systems and interrelationships among their components to reveal emergent properties that are only evident at the systems level (Duru, 2013). Complex systems operate at a holistic level where, apart from the different interacting parts, there is an interdependent and interactive dynamism between the parts such that the whole cannot be understood as the sum of its parts, nor reduced to its parts to assist understanding (Eppel, 2009). Many complex systems are nested within larger complex systems, which in turn are part of even larger complex systems, which if taken together, constitute a system whole. The dynamics of complex systems arise from the influence that each constituent has on each other which can result in the emergence of new patterns (Eppel, 2009). According to Simonovic (2009), a systems approach is viewed as one of the most important advances in the field of water resources management.

A complex systems theory can add knowledge to existing theories of policy processes, because the whole is not ignored (Ma’ayan, 2017). The primary emphasis of a systems approach in water resources management is on providing an improved basis for decision making. The study of complex systems reconsiders rigid, inflexible organisational dynamics and acknowledges new relationships between determinism and predictability (Parnell, 2012). Water resource management needs dynamic tools that can assist in dealing with adapting to an increasing complexity of water resource problems, social and environmental impacts and sustainability. The systems approach

may be considered such a tool (Simonovic, 2009). It can assist to determine preferred strategies and designs for complex, often large-scale, systems. It combines knowledge with practice to better understand the root causes of practical implementation challenges. The application of the complexity theory also has the potential to integrate a number of other existing theories of policy processes in a way that adds to these theories, thereby providing dimensions to each not focused on in the original form (Jones and Baumgartner, 2005). Innovation, the emergence of new phenomena and self-organisation may occur when a system is not in equilibrium (Eppel, 2009).

Haggis (2008:169) views complexity as an ontology in providing "*a way of thinking about institutions, cultures, groups and individuals as systems of interactions which are, in some important ways, always unique*". This unique systems of interactions is partially established by the interactions of larger systems of governance, for example, of culture, language, policy or politics. Davis and Sumara (2008:50) states that "*complexity science is argued to compel a different sort of positioning, one that requires accommodation and participation rather than problematized assimilation and application*". What is required is a model that considers linkages that interconnect with the social and institutional aspects across multiple system levels. According to McCarthy (2006), complex systems contain several key properties such as:

- Non-linearity, where a system behaves as whole;
- Hierarchical, where understanding comes from multiple perspectives of different types and scales;
- Internal causality, where a system is self-organising and characterised by goals, positive and negative feedback, emergent properties and surprise;
- Multiple steady states, where multiple attractors can be possible in a given situation;
- Catastrophic behaviour, where a system considers unpredictable behaviour, sudden discontinuity and shifting steady states, and;

- Window of vitality, where a system has enough complexity but not too much.

A water management system consists of complex technologies, social challenges, institutional challenges, stakeholder relations, environmental factors and paradigms that are highly interconnected, and together it must fulfil a societal function (Pahl-Wostl, 2007). Water management systems continuously regenerate and realise the network of processes that produce them through their interactions and transformations to act as a concrete unity in space (McCarthy, 2006).

Socio-institutional interactions are not stable and the relevant patterns are constantly changing (Parnell, 2012). Figure 5 is an example of the different categories that are constantly interacting within an urban water system. According to Harremoës (1997), all interacting categories within a complex system should be properly analysed when assessing sustainable urban water.

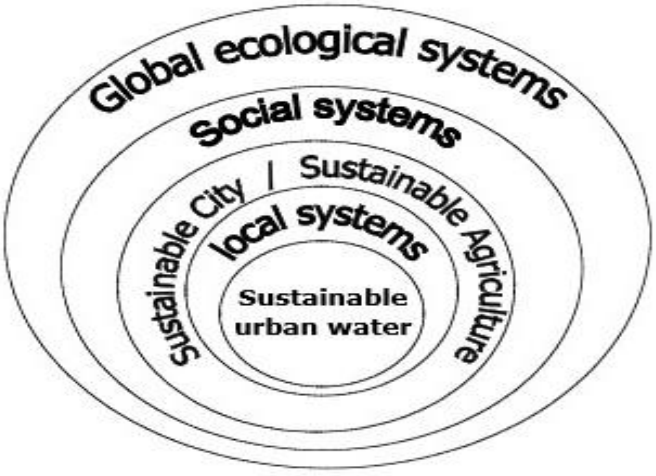


**Figure 5:** An example of the different interacting categories within an urban water system (Fane, 2005).

Simonovic (2009) elaborates on seven guiding principles of the systems view, such as adaptation, participation, integration, partnership, uncertainty and reliance on reliable data. The dynamic complexity of natural and water resources systems is a result of a system structure and the interaction between system elements in time. According to

Herzog, 2014, three main categories of complex systems can be identifies, such as complexity relating to human behavior, systems behavior, and ambiguity (Herzog, 2014) (Figure 6).

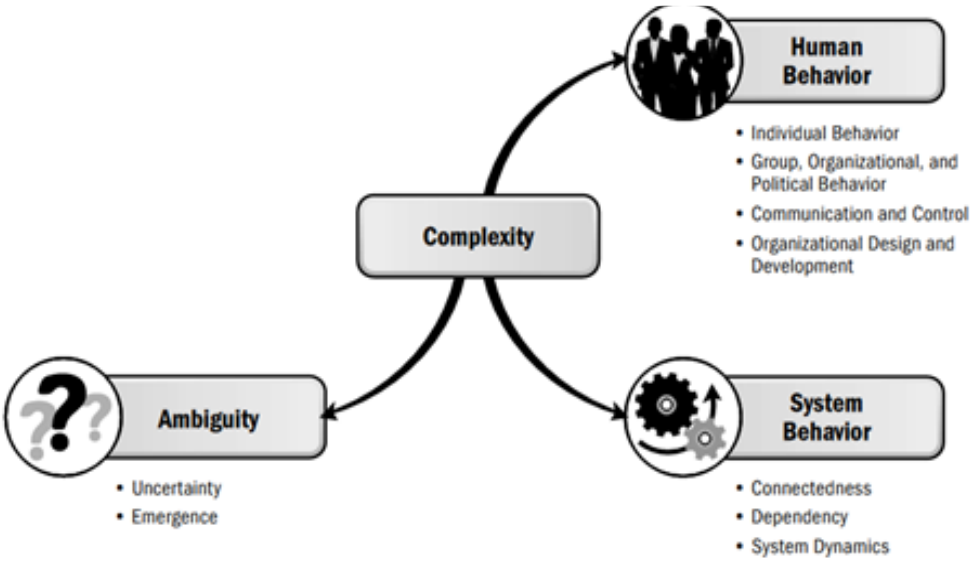


**Figure 6:** Categories of complexity and their causes (Herzog, 2014).

Systems thinking can provide the conceptual tools for understanding complexity within social and institutional learning. Consciousness, learning, and language are phenomena arising from the complexity of human social systems which are important for the understanding of the interactions between socio-institutional processes (Eppel, 2009). Davis and Sumara (2006) stated that complexity thinking leans towards the production of new, more useful interpretive possibilities.

#### 2.5.1.1 The Panarchy Model

The management of water resource systems requires a deep understanding of the interconnected components and complexities around water systems (Roux and Biggs, 2010). The panarchy model is a good example of a model that describes the theory of complex system dynamics which includes the adaptive cycle (Holling and Gunderson,

2002). According to Walker *et al*. (2004), the levels that forms part of complex systems exist as ‘panarchies’, which is adaptive cycles interacting across multiple scales. Panarchy refers to the states and dynamics of above and below cross-scale interactions, which can increase a system’s resilience (Walker *et al.*, 2004). According to Walker *et al*. (2004:05), a measure of an institutions adaptability can be attributed to its “*ability to either control the trajectory of the system (change precariousness), change the topology of the stability landscape (latitude and resistance), or change the processes in response to dynamics at other scales (panarchy response)*”. Institutional transformation can be achieved through attributes such as novelty, human capital and diversity (level of education, expertise, and occupations), social trust, strengths, variety in institutions, and cross-scale communication, all within the panarchy and between other systems elsewhere.

Different adaptive cycles within water management may interconnect and overlap and in a variety of ways. The model as shown in Figure 6 describes four phases of an adaptive cycle within a complex water management system, namely a rapid development phase (r), a typically longer, relatively stable conservation phase (K), a decay phase(Ω), followed by a chaotic reorganization phase (α)of adaption to changes in the socio-ecological-economic setting” (Redman and Kinzig, 2003; Holling and Gunderson, 2002). As an adaptive system shifts from the α phase to the r phase, some of the elements leave the system (Ω), to be replaced by new elements which enters the system, reorganising themselves (α), until a new established system is formed (r). The adaptive system cycles repeats itself sustainably over time and comprises of the ability to adapt to change, and to be able to respond in a flexible way to uncertainty and surprises (Redman and Kinzig, 2003; Holling and Gunderson, 2002).

The cycles can be illustrated as an empirical model with connectedness on the *x* axis and potential on the *y* axis (Holling and Gunderson, 2002). The term ‘connectedness’ refers to the strength of internal relationships that mediate external variability while the term ‘potential’ refers to the capability for change through accumulated resources. The length of the arrows between the phases indicates the speed of transition. In the model

it can be seen that the system moves quickly from exploitation to conservation, and more slowly from conservation to release and from release to reorganization (Figure 7) (Bohensky, 2006; Redman and Kinzig, 2003; Holling and Gunderson, 2002).

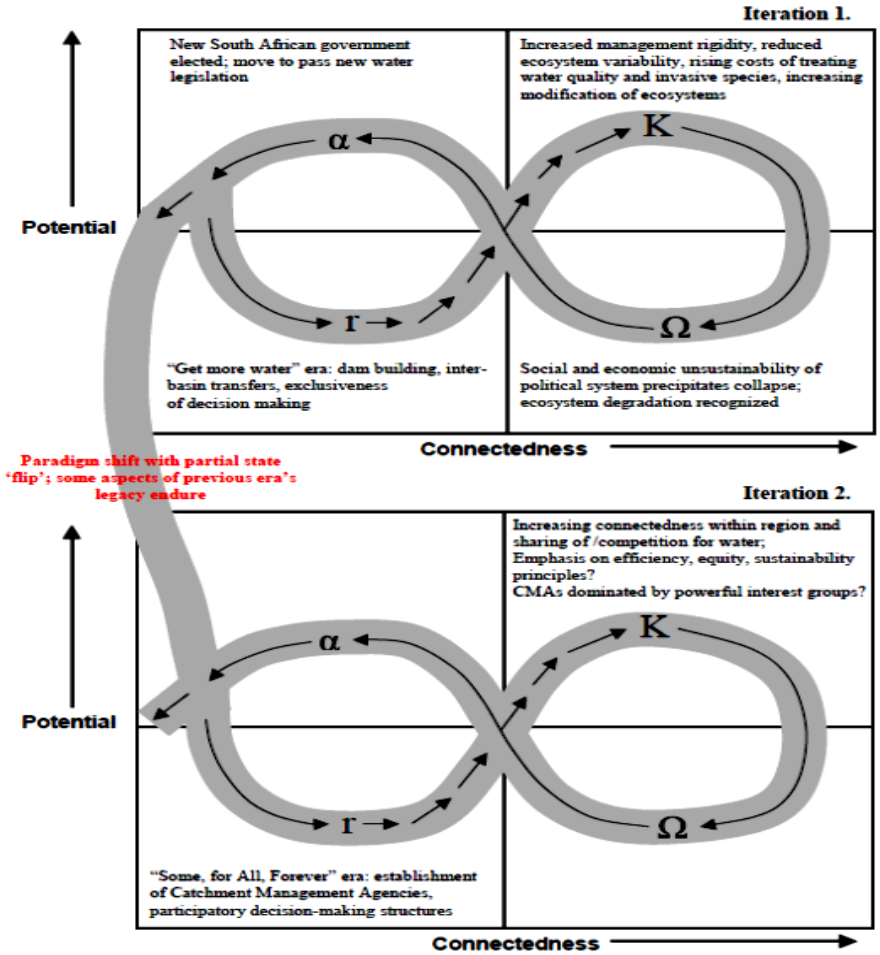


**Figure 7**: The panarchy model depicting system dynamics (Bohensky, 2006; Redman and Kinzig, 2003; Holling and Gunderson, 2002).

In Figure 7 the South African water management example is used to explain the model in more detail. Two iterations are shown with the first portraying the previous era of management as one full phase of the adaptive cycle. During the exploitation phase, increasing investment is made in large infrastructure which leads to greater management rigidity. Forces such as social discontent, political pressure and economic decline leads to collapse, after which the system reorganises with extensive

consultation as its basis. The second iteration of the cycle begins where the overall system undergoes a paradigm shift but only a partial change in configuration. According to Bohensky (2006), the Water Act marks a phase of reorganisation, but the system is lumbered by high-cost responses which severely limits flexibility. Although the system has endured some partial emergencies and collapses, it has not been entirely overwhelmed because of sufficient social resilience to buffer the effects of disturbance (Bohensky, 2006; Redman and Kinzig, 2003; Holling and Gunderson, 2002).

As water management moves into the second iteration, there is increasing connectedness within the social-institutional system. The fundamental change from the first to second iteration is the capacity of water provision managers to understand and accept the inter-connectedness within systems (Bohensky, 2006; Gunderson and Holling, 2002). Regional and local processes have always influenced water resource dynamics in South Africa, but were previously ignored by managers who treated the system as closed (Bohensky and Lynam, 2005). The social aspects within water resources management need more development with a breaking down of the barriers that have traditionally separated the study of social and institutional systems.

#### 2.5.1.2 Transition Management Theory

Transition management is an approach that was developed to facilitate and accelerate sustainability transitions through a participatory process of experimentation, visioning, and learning (Djalante and Djalante, 2012); Foxon *et al*., 2008; Meadowcroft, 2009; Rotmans, *et al*, 2001). The authors Kemp *et al.* (2007 defined transition management as an approach for dealing with the complexity of sustainable development which is recognised by its multi-dimensional, multi-actor, dynamic and multi-level challenge factors that are in a constant state of fluctuation. It seeks to combine multiple viewpoints and multiple approaches in a ‘transition arena' (Osunmuyiwa *et al*., 2018). Transition theory is closely related to the multi-level perspective (MLP) socio-technical transitions theory of Geels (2011).

The MLP theory is depicting technological transitions that consist of the interaction between the concepts of 1) niche level, which involves a network of new technologies in the incubation stage, 2) the regime level, that represents the engine of systems as it includes the governance structures, institutions, and associations, and 3) the landscape level, which includes the various external pressures that affect transition processes (Geels, 2014; Osunmuyiwa *et al*., 2018). It is a heuristic model developed to better understand the socio-technical processes of development (Geels, 2011; Osunmuyiwa *et al*., 2018). The need for a model that considers the extent of multi-actors, multi-levels and multi-domains within water governance systems is however required (Loorbach, 2007).

Transition management theory considers a societal system as a starting point for analysis (Djalante and Djalante, 2012). It is a model that considers the social dimension as a whole system, as well as the complexity within such systems, and the transition management theory is therefore considered as being better able to address the complex challenges relating to the multiple levels and dimensions present within water resource management in developing countries (Djalante and Djalante, 2012).

Transition management does not seek to control the uncertainties of change, but rather to indirectly influence and redirect the choices of actors towards sustainability (Loorbach, 2007). It is a governance approach based on the analytical perspective of society as a patchwork of complex adaptive systems.

Transition management theory was first formulated as a collaboration between Rotmans, Kemp, Geels, Verbong and Molendijk (Rotmans *et al.,* 2000), but was fundamentally developed by Kemp (multi-level concept) and Rotmans (multi-phase concept). The concept evolved into an operational model and is currently being developed as a governance theory and as an operational governance approach (Djalante and Djalante, 2012). It is a multi-actor management approach that contains the main characteristics of new forms of governance such as interactivity, network management, a multi-level focus, pluralism, and social learning. Transition management advocates multi-level networks at various levels (Loorbach, 2007). It recognises that by

adaptation, participation, negotiation, and debate, actors can perceive challenges differently by changing their vision, behaviour, and redefine their own position. The model can be used as a strategy for new types of interaction and cycles of learning. Transition management views the interaction between all relevant actors on different societal levels as a means of social change within the context of a changing societal landscape (Loorbach, 2007). The dynamics that exist in society is an important perspective of transition management theory as it relates to the complex adaptive systems paradigm.

The inherent complexity of social systems, such as their difference of perspectives, norms and values requires a new form of governance (Loorbach, 2007). The transition management approach seeks to broaden social participation by encouraging a bottom-up governance approach (Djalante and Djalante, 2012). The synergy gained from utilising transition management to provide a novel approach to the complex issue of sustainable natural resource management is essential for progress (Foxon *et al*., 2008).

Transition management theory views society as a complex adaptive system and therefore advocates governance that makes use of complex systems theory (Djalante and Djalante, 2012). Based on theoretical knowledge and practical experience with complexity theory, the following key elements are recognised by transition management theory (Foxon *et al*., 2008; Loorbach, 2007):

- Participation, through a multi-actor approach to incorporate societal beliefs and values,
- A long-term perspective, thereby creating a range of visions in which short-term objectives can be identified,
- Learning at the niche level, with experiments that can identify how successful a particular pathway could be, and,
- A systems thinking approach, which considers challenges as being complex, and its extent across multiple domains, levels and actors.

Transition management has the power to steer water demand management towards a path of improved sustainability. The goal of transition management is to enable, facilitate, and steer social and technical transformations towards sustainability (Kemp and Loorbach, 2003). The sustainability of the urban water supply may be significantly influenced by the decisions and adaptations of policymakers and water users (Kanta and Zechman, 2014). Water demand management policies are not independent but are influenced by a complex system which involves the availability of water resources and the individual decisions of water users as they adapt to the perceived or actual availability of water (Giacomoli and Berglund, 2015).

#### 2.5.1.3 Complex Socio-Institutional Systems

The sustainability of water resources depends on the dynamic interactions among the institution, technological, environmental, and social characteristics of the water system (Giacomoli and Berglund, 2015). The theory used to describe these complex interactions is sometimes referred to as a non-linear 'complex systems theory or complexity theory. Within this thesis both of these terms are used to describe the behaviour in complex socio-institutional systems. The reference made within the thesis to an "institution" as part of the term "socio-institutional" refers to a 'water management institution', which is defined as a water services provider that consists of broad categories such as 1) laws, by-laws, rules, regulations and operational plans and procedures, 2) administrative structures and core values, 3) political structures and processes, 4) economic and financial arrangements, and 5) norms, traditions, practices, organisational culture and customs (Hashemi *et al*., 2007; Ivey *et al*., 2006). Like all institutions, water management institutions can be viewed as being "*subjective, path dependant, hierarchical, nested both structurally and spatially and embedded within a cultural, social, economic and political context*" (Saleth and Dinar, 2005:02). The complexity of a socio-institutional systems perspective arises from the interaction of variables, governing structures and processes that drive system behaviour (Gunderson and Holling, 2002). Socio-institutional systems behave as complex adaptive systems (Walker *et. al*., 2002), which tend to be non-linear, uncertain, unpredictable, and

adaptive to change (Bohensky, 2006). Part of the complexity of socio-institutional systems is the variation in human responses to different situations across different scales and levels of organisation (Bohensky, 2006).

Society and public institutions are complex systems of interacting human responses that are being influenced by the other, with their internal system components being influenced by external factors such as an increasing population density, environmental degradation, political challenges, and economic challenges, amongst others (Sherman and Ford, 2013). It is common for water services institutions to implement strategies that differ from the priorities identified by communities (Bohensky, 2006). A review study conducted by Sherman and Ford (2013) on stakeholder engagement in adaptation interventions within different countries indicated that project consultations on adaptation programmes commonly included only experts and high-level government officials, and that alignment with communities' needs were lacking. This can hinder the communities' acceptance of these programmes and thereby reduce their success rates.

A socio-institutional system can be regarded as a complex system component within a complex system. Sustainable water demand management depends on the balance within socio-institutional systems as well as that of external system components. A socio-institutional system consists of a complex network of interrelated relationships, transactions, knowledge, and flows between the institutional entity and the social system (Herzog, 2014). Figure 8 is a graphic example portraying an interrelated socio-institutional system.

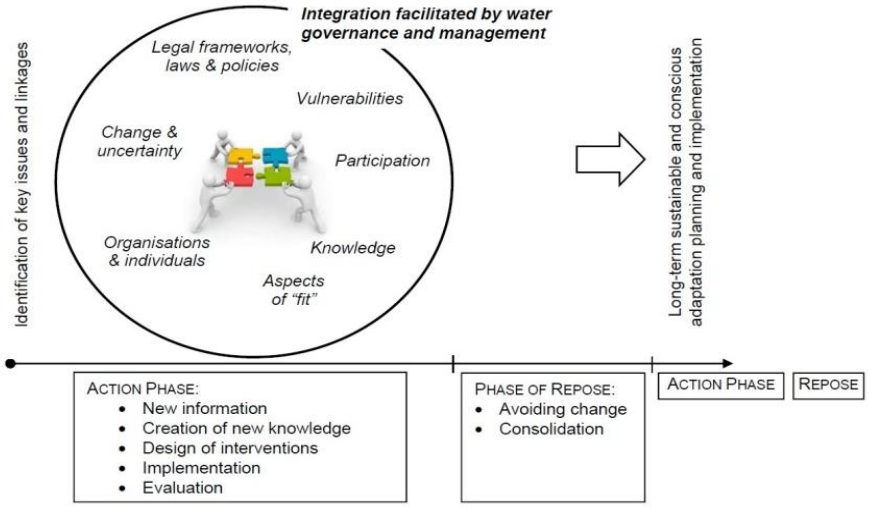


**Figure 8:** An example of a framework that can portray a socio-institutional system (Stuart-Hill, 2015)**.**

Socio-institutional systems can be understood through the study of complexity theory. Complex systems theory offers a deeper understanding of the structure and dynamics of both social and institutional systems and could provide institutions with the foundations to look critically at social learning (Nelson, 2001; McCarthy, 2006). "*A complexity-based view of collaborative planning and governance systems leads to policy making that is adaptive, innovative and intelligent"* (Connick and Innes, 2003:180).

A match between change and socio-institutional systems can guide transformations at the socio-institutional level. There are however inertial forces which causes a socio-institutional system to be more resistant to change and slow to adapt to new conditions (Perez, 2004). In his work, Perez (2004) asks the question as to what guides the adequacy of change in the institutional sphere, and suggested that, through time, the generation of best practice principles serves as a conscious or unconscious paradigm for steering institutional change and for designing the social tools with which to master change. Within the context of this thesis, the concept of best practice principles would include a socio-institutional participative focus with a complex systems view of water demand management.

A modification of Perez's Interpretation of "*The Traditional vs the New Paradigm*" (Perez, 2004:14), is shown in Table 7 to explain the concept of adaptive socio-institutional systems within the context of water demand management.

**Table 8:** A modification of Perez's (2004:14) interpretation of "*The Traditional vs the New Paradigm*".

| | **Conventional Approach** | **Complex Socio-Institutional Systems Approach, New Adaptive Principles and Practices** |
|---|---|---|
| Command and Control | Centralised command; vertical control; cascade of supervisory levels "management knows best". | Central goal-setting and coordination; local autonomy; horizontal self-control; self-assessing/self-improving units; participatory decision making. |
| Structure and Growth | Stable pyramid, growing in height and complexity as it expands. | Flat, flexible network of very agile units; remains flat as it expands. |
| Parts and Links | Clear vertical links; separate, specialised functional departments. | Interactive, cooperative links between functions, departments, sub-departments, sections, stakeholders and water users. |
| Style of Operation | Optimised, smooth running organisations; standard routines and procedures; "one best way" approach; definition of individual tasks; single function specialisation; supply-side orientation; single top-down line of command; single bottom-up information flow. | Continuous learning and improvement; flexible system and adaptable procedures; "a better way can always be found" approach; definition of group tasks; multi-skilled personnel and *ad hoc* teams; allocative efficiency orientation; widespread delegation of decision making; multiple horizontal and vertical flows. |
| Suppliers, Clients and Competitors | Separation from the outside world; foster competition among stakeholders and other water institutions; exclusion of water users in decision making process, strategies and operations; a "closed system" institution. | Strong interaction with outside world; collaborative links with stakeholders and other water institutions; inclusion of water users in decision making process, strategies and operations; an "open system" institution. |
| Personnel and Training | Labour as variable cost; market provides trained personnel; people to fit the fixed posts; discipline as main quality. | Labour as human capital; in-house training and re-training; variable posts and adaptable people; initiative, collaboration and innovation. |

| | | |
|---|---|---|
| Equipment and Investment | Dedicated equipment; optimum solution of large scale infrastructural schemes; Each scheme anticipates demand growth separately; strive for economies of scale for mass water provision. | Adaptable, programmable and flexible equipment; decentralised systems; smaller efficient resources; combination of technical and social awareness initiatives; holistic anticipation of demand growth. |

An approach of “sense and respond” rather than “command and control” is needed within water demand management. Large scale projects, policies and decisions should be reduced to smaller initiatives that consider a socio-institutional systems approach. This can assist in the successful navigation of a changing and only partly predictable system (Roux and Biggs, 2010).

Water demand management plays out within a complex socio-institutional system which involves the inclusion of principles such as the interaction and collaboration between an institution and its water users or stakeholders, a decentralised approach, social networking, continuous improvement, water user and stakeholder participation in initiative implementation and consensus building, amongst others (Turton and Meissner, 2002). The social costs and consequences of traditional approaches to water demand management are profound (Xiao, 2017). It is when the social pressures for change are clearly felt that the ineffectual strategies and initiatives of traditional approaches applied by water institutions are revealed, and that the need for a new adaptive, socio-institutional renewal becomes evident (Turton and Meissner, 2002).

### 2.5.2 Conclusions

The above section on the need for a paradigm shift concluded the literature review that speaks to Objective 2 in Chapter 1.7 of this thesis, which reads:

– *“**Objective 2:** Understand the implications of a complex systems approach to socio-institutional adaptive capacity and its potential to increase and improve adaptive capacity*”.

The literature indicated that a paradigm shift towards a complex systems approach is

needed in order to ensure future sustainability of water provision and demand. As indicated in section 2.4 of this thesis, socio-institutional adaptation can only be effective if considered as part of a complex, interactive system. The literature suggested that the adaptive capacity of an institution cannot be increased if considered to be in silo.

A water management institution can only increase its capacity if it has a greater understanding of the different social parameters that can influence the success of its strategies and initiatives, and by understanding that the social aspects form an integrative and interactive part of the institutional aspects, and together they are part of a socio-institutional system, which in turn are part of a complex water resource management system. Similarly, social adaptive capacity can only be increased if the institutional aspects are also included and considered as being part of a socio-institutional system. The literature indicated that if water demand management decisions are to be effective, it should be based on the complex socio-institutional relationships and the engagements that exists within the water resource management environment.

# 3 Research Methodology

The research methodology will attempt to add evidence to the thesis aim and will therefore examine and analyse the key theoretical concepts around adaptation theory, participative water demand management as an adaptive response, as well as the complexity of a socio-institutional system and the interactions between the different components of this system, within a practical case study approach of a large metropolitan municipality in a developing country such as South Africa.

To analyse the role participative water demand management plays in an adaptive socio-institutional complex system, an in-depth case study of the large metropolitan municipality in South Africa, namely the City of Cape Town, was conducted by utilising a combination of primary and secondary data from different sources, including policy and document analysis as well as surveys. The research methodology involved three main components that will include both qualitative and quantitative data and information collection methods, namely a theoretical literature review, a detailed case study which includes a South African and CCT legislative and policy analysis, and a survey analysis as part of the case study component.

The case study component of the research consisted of the collection of information based on primary and secondary qualitative and quantitative data collected from documents and survey data. The secondary data was obtained through desk reviews of documents and reports from the CCT, other Government institutions, academic research, and other institutions in charge of water resource management and planning. This information commonly consisted of documents relating to water management policy and legislation, water demand management data and figures, and the 2015 to 2018 Cape Town drought, amongst others.

As part of the water legislation and policy assessment, the presence of the commonly implemented “command and control” approach to social interaction, better known as the “attitude, behaviour and choice” (ABC) model, within the CCT’s policy will be assessed,

relative to more progressive and open social science principles, as per the critical work of the author Shove (2010). In her research work she addresses the need to go beyond the dominant paradigm of the ABC model. Getting people to respond to water conservation is not just as simple of getting them to change their behaviours, attitudes and choices. As represented in the United Kingdoms "Framework for pro-environmental behaviours" produced by their Department for Environment, Food and Rural Affairs (DEFRA) ((2008), the extent to which people adopt pro-water conservation behaviours depends upon a mixture of positive "motivators" and negative "barriers".

Society is generally motivated by "*the feel good factor, social norm, individual benefits (e.g. health, financial outlay); ease, being part of something*", and can often also be compromised by equally common barriers, such as "*external constraints (infrastructure, cost, working patterns, demands on time), habit, skepticism, disempowerment*", amongst others (DEFRA, 2008:07). The author Stern (2000:418) has listed a number of contextual factors that can influence society's motivation to conserve water, which goes far beyond the generally accepted ABC model, such as "*interpersonal influences, community expectations, advertising, government regulations, legal and institutional factors, monetary incentives and costs, the physical difficulty of specific actions, the capabilities and constraints provided by technology and the built environment, the availability of public policies to support behavior, and various features of the broad social, economic, and political context"*, amongst others. The consideration of society's motivators and barriers will have an impact on the level and quality of socio-institutional participation within the CCT's water resource management. It is therefore considered relevant to also investigate the progressiveness of the South African water policy framework to move beyond the commonly implemented ABC model.

For a more detailed assessment of the conditions relating to socio-institutional participation capacities, knowledge and information sharing between residents and the municipality, and policy implementation, the researcher made use of survey data. The information collected during the case study will add evidence to the study objectives. The survey component consisted of both primary and secondary survey information

obtained from a collaborative City of Cape Town metropolitan municipality (CCT) and University of Cape Town student/researcher survey study, known as the City of Cape Town Customer Satisfaction Survey, as well as data obtained from a report on the findings of a CCT survey based on the perceptions and attitudes relating to the installation and use of water management devices (water allocation meters) within some areas of Cape Town.

The final thesis results will be informed by both the theoretical literature review and the case study, thereby providing a situational understanding of the socio-institutional adaptive capacities, or the challenges relating thereto, between a public water provision institution and its users, and an understanding of the complex socio-institutional relationships and interactions pertaining to participative water demand management, which will provide more insight to the objectives of this thesis, as listed in Chapter 1.7.

### 3.1 The Case Study Approach

The author Gerring (2007:30) defined a case study as "*an intensive, observational study of a single case or a small number of cases which also promises to shed light on a larger population of cases*". Research by case study can therefore be described as an observational form of analysis. Within this thesis, the qualitative case study research approach was used.

The qualitative case study methodology provides tools for researchers to study complex phenomena within their contexts (Gerring, 2007). This type of case study approach was chosen to be the most appropriate for this research study because it fosters a better situational analysis of the socio-institutional experiences when it comes to adaptive water demand management, and will therefore facilitate the exploration of participation as an adaptive water demand management response within a socio-institutional setting.

The essential elements of a qualitative case study research process are generally defined as including a theoretical perspective, methodology, and epistemology (Crotty, 1998). This case study's epistemology is framed by the concept of constructivism. It

asserts that people construct meaning in different ways, even if they are experiencing the same event (Crotty, 1998). The author Crotty (1998) identified a number of assumptions of constructivism, of which three has been identified as being fundamental to this research:

1) Meaning is constructed by human beings as they engage with the world around them, and-

2) make sense of it based on their historical and social perspectives, and that-

3) the basic generation of meaning arises from the interaction with a human community.

Stake (1995) defines constructivism as a belief that knowledge is made up largely of social interpretations rather than awareness of an external reality. This idea fits in well with the theory behind participation, and constructivism was therefore used as the philosophical framework for this research.

### 3.1.1 The Survey Research Design

The surveys were designed to indicate levels of factors such as understanding, perceptions and attitudes, socio-institutional collaboration, as well as communication and communication channel efficiency, in other words the adaptive capacities relating to knowledge gained through participation, between both actors (the CCT and its residents). These factors can then be taken as an indication of the level of socio-institutional participation and consequent adaptive capacities, as through participation and engagement sufficient knowledge can be gained which will result in an increased adaptive capacity. The case study research was designed to connect data to propositions. This connection was made as themes emerged after the data collection phase. The themes that emerged in this study thus served as answers to the research objectives as posed in Chapter 1.

The survey research was managed by the main researcher and author of this thesis, as well as employee of the CCT at the time, on behalf of the CCT. So in the case where the survey research is referred to as that of the CCT, it must be taken into consideration

that the researcher was mainly involved with the survey, and conducted it as per the objectives of this thesis, but on behalf of the CCT who financed the survey research at the time. Research assistants were recruited by means of the CCT's Mayoral Expanded Public Works Project (EPWP) on a contract basis (see Annexure C). The EPWP programme is a Mayoral initiative where unemployed residents within the targeted survey areas were employed on a part-time basis. The intention of the CCT was to simultaneously provide community upliftment and capacity building within the low income areas. The duties of the EPWP research assistants consisted of field data collection as well as survey questionnaire data capturing. The EPWP research assistants were provided with training and issued with certificates as part of the capacity building component of the research (see Annexure D).

The survey data was used to establish the current socio-institutional relationships, the effectiveness of participative management and implementation approaches, and the capacity of water users to understand, accept and adapt to these approaches, which will inform Objective 1 of this thesis. The survey information also provided a more in-depth view of the complex system challenges between the residents and the CCT, as per the Objective 2 in Chapter 1.7 of this thesis.

### 3.1.2 Survey Methodology

The survey methodology involved data collection intended to strengthen and add evidence to the study objectives. The main data collection components consisted of primary and secondary data collection from two surveys, namely a City of Cape Town Customer Satisfaction survey as well as a CCT Water Management Device Perceptions survey. These surveys were designed to collect qualitative data. The purpose of acquiring the survey information was to explore the trends, attitudes, and perceptions that residents have (therefore their adaptive capacity) of a water demand management initiative such as the installation of water management devices to regulate and control water usage, and the levels of communication, information delivery and knowledge gained, as well as resident involvement and participative decision making.

The surveys were conducted as face-to-face survey interviews which provided a free-exchange of ideas as well as a platform to ask more complex questions and getting more detailed responses. Existing literature on methods showed that face-to-face interviews remain the most frequently used technique in research as it has a higher response rate than most of the other research methods. The face-to-face interviews are a data collection method where the interviewer directly communicates with the respondent in accordance with the prepared questionnaire. This method involves the collection of factual information, attitudes, insights, preferences, evaluations, and other information coming from the conversation between the surveyer and the respondent. The interviews were conducted with the head of the household who was required to be 18 years or older.

The main advantage of face-to-face interviews are that the interviewer is able to directly converse with the respondent, which makes it easier for the respondent to request the clarification of questions or other type of enquiries. The face-to-face interviews were therefore conducted with the respondents in order to gather the nuanced views through direct questioning on feedbacks provided. The interviewers were able to request explanations and more detailed backgrounds to certain reported aspects, and were even showed the actual situation on the ground, for instance faulty and leaking meters, backyard dwelling situations and challenges, financial challenges experienced, amongst others, thereby providing a better understanding of the actual ‘real life’ situation and challenges that are being experienced by the residents, which would otherwise have been lost in a telephonic or online survey.

The CCT survey research instrument comprised of questionnaire sheets developed to enable comparable data to be captured from different research areas (suburbs) across the CCT. The study area included sampled suburbs across the entire city. The CCT’s survey interviewers were deployed throughout these districts, within randomly chosen suburbs according to a stratified sampling methodology, which included suburbs representative of different income level categories such as informal, low income, middle income, high income and business categories (refer to Annexure A). This enabled the

assessment of the potential differences, if any, in perceptions and needs across these categories. Separate types of questionnaires were developed to facilitate the collection of category specific data and specific target respondents. Given the linguistic variation across the study areas, the questionnaires were developed in English and translated by research assistants fluent in the main language of the given area.

The CCT Customer Satisfaction survey questionnaires were structured to obtain information on water user satisfaction, perceptions and feedback relating to water services (see Annexure M). The questions were coded and structured according to the Likert Scale with levels of satisfaction ranging on a scale from 1 - 5; 1 being very dissatisfied and 5 being very satisfied with the initiative. The survey questionnaire was loaded on cellular mobile devices and analysed with the computer software programmes “Computer-Assisted Personal Interviews (CAPI)” and “Mobenzi Researcher” (Figure 9), in order to improve the turnaround time and to target accurate and complete results. A 20% validation check was done by CCT on all fieldwork that was done by each interviewer to ensure accuracy and authenticity.

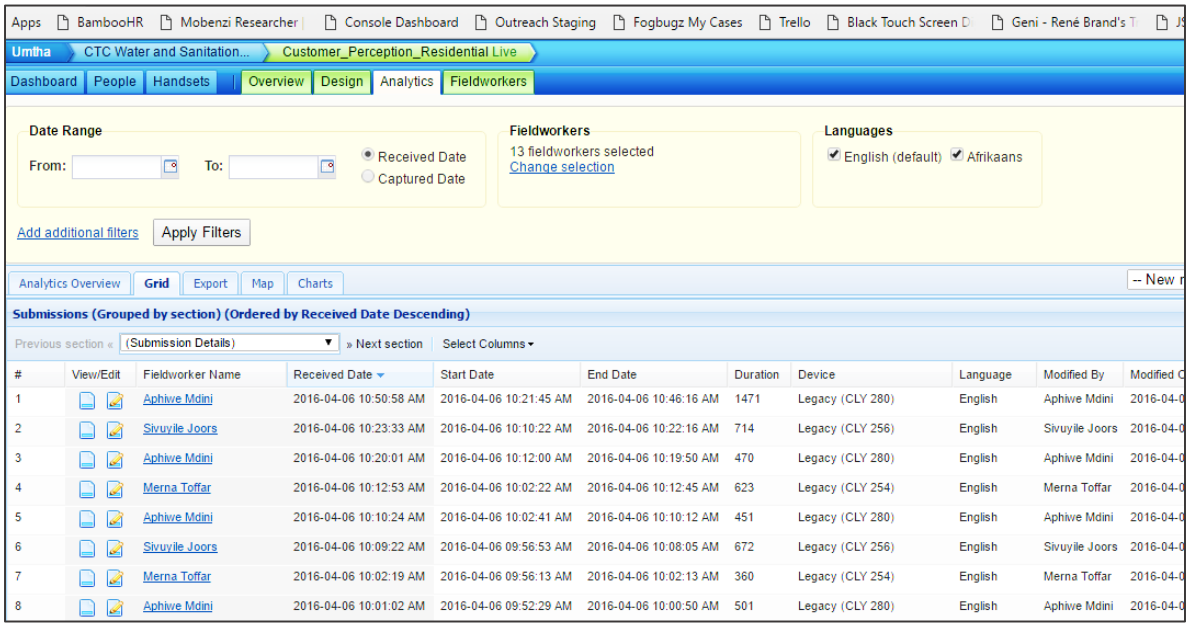


**Figure 9:** The Mobenzi Researcher software programme was used to collect and analyse the survey data.

After the survey the data was downloaded as *.csv files and analysis was completed using Microsoft Excel. This method of data collection ensured that validation of the collection of data could be done as well as assisting with streamlining the process.

### 3.1.3 Survey Sample sizing

The survey sample sizing was assessed to ensure representativeness.
This ensured that:

- All constituencies in the population had an equal chance of being selected, and;
- That the sample contained the same characteristics as that of the population.

The following formula was used to establish the required sample size per suburb that was needed to be 95% confident that the sample estimate was within ± 10% of the true population value:

$$N_S = \frac{(NP)(P)(1-P)}{(NP-1)\left(\frac{B}{C}\right)^2+(P)(1-P)}$$

Where:

$N_S$ = the sample size required

$N_P$ = the size of the population

P = the proportion of the population expected to answer in a certain way (50% or 0.5 is most conservative)

B = the acceptable level of sampling error (margin of error) (0.1 = ±10% of the true population value)

C = the Z statistic associated with the confidence interval (1.960 = 95% confidence level)

According to the calculated sample size a survey matrix was designed to incorporate the different suburbs to be surveyed within each of the districts (see Annexure A).

### 3.1.4 Ethical Considerations

As part of the ethical considerations during this thesis a confidentiality clause was added on the survey sheets where the participants could sign or tick their option to participate or to decline. Letters were also sent ahead of the survey to inform residents of the planned survey (please see Annexures F and B). The participants were also provided with a verbal explanation of what the survey was all about, that their participation were voluntary and that their confidentiality was ensured. Identity cards were also shown by the EPWP staff to the respondents as proof of employment by the CCT.

Although the City of Cape Town Customer Satisfaction survey process was managed by the main researcher of this thesis, the survey research was still considered as the intellectual property of the CCT, and permission was therefore obtained by the main researcher from the CCT to collect and use the survey data as well as any other relevant information through a comprehensive permission request process (refer to Annexure G). This included the signing of a data and information request and confidentiality agreement as well as the submission of a report subjected to scrutiny and recommendation (signed) by managers within the Water Demand Management Section, as well as the final approval signature of the Executive Director of the CCT's Utility Services Directorate.

The survey information within this thesis was financed by the CCT municipality and is the intellectual property of the CCT, and was therefore subjected to the strict ethical values of the CCT. The main researcher, and also employee of the CCT at the time, was subjected to strict ethical values and had to sign acknowledgement of a "Code of Conduct" as part of the conditions of employment (refer to Annexure H). Within this

code, the CCT's information, as well as that of its water users, is protected. All employees that took part in the survey process had to abide by the CCT's ethical code of conduct, and in the event of this code being breached, an employee would have been subjected to a strict disciplinary process, with the possibility of the loss of employment as a potential outcome.

Due to the survey data and information considered as part of the CCT's intellectual property, and their strict ethical processes, the researcher was not required to conduct a separate ethical application to the University of Cape Town's Ethics Committee.

### 3.1.5 Benefits of the Survey Research for Participants

The surveys provided the direct benefit of education and awareness on water demand management issues such as water conservation measures and alternative water usage. The participants could also directly enquire from CCT's staff conducting the survey with regards to account problems, problem or complaints reporting, reporting contact numbers and water consumption and conservation issues. The survey staff was also provided with training on how to report problems on site to the CCT's Technical Operations Centre. Financial issues were addressed by providing contact details/referral persons to the participants. Any water conservation enquiries were immediately addressed by providing water conservation advice and tips and how to check for water leaks on a property. Water conservation educational material was also provided to the participants as part of capacity upliftment (please see Annexure E).

## 3.2 Case Study: City of Cape Town Metropolitan Municipality

The intent of the case study approach was to provide results that reflected a multi-level and multi-scale understanding of a socio-institutional systems approach and its relationship to participation as an adaptive response within water demand management. A participative water demand management approach forms part of adaptive water resource management. Adaptive management must therefore actively support

participative and collaborative socio-institutional knowledge sharing and implementation. The gathered case study and survey information was used to assess the status of participation between the residents and the CCT at the time of the research, or the need thereof.

### 3.2.1 The Case Study Area

The City of Cape Town (CCT) metropolitan municipality is located in the Western Cape Province region of South Africa (Figure 10). The city has over 5 million inhabitants and spans a total area of approximately 2 474 km$^2$, with a coastline of 371 km long (CCT, 2013). It is the the administrative and economic centre of the Western Cape Province and the legislative capital of South Africa. The CCT is part of the Western Cape Water Supply System (WCWSS) which consists of a system of dams that supply the urban areas as well as the agricultural sector with water.

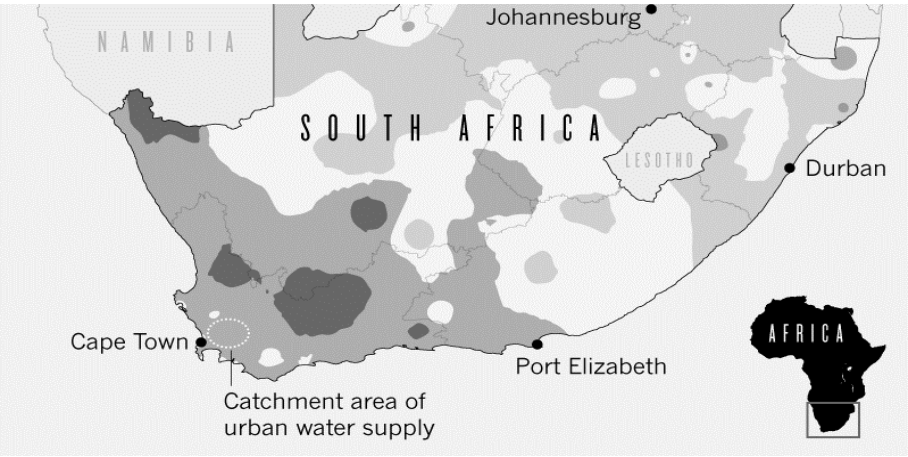


**Figure 10:** The location of the City of Cape Town.

It has a varied topography which includes flat plains, hills, and mountains. The mountains are located close to the urban edge and can exceed 1 000 m (asl) in elevation, as is the case with the famous Table Mountain. Mountains such as the Wemmershoek, Franschhoek, Hottentots-Holland, Elandskloof, Helderberg, Paarl, Du Toits, Limiet, Slanghoek, Stellenbosch, and Jonkershoek form an eastern perimeter

around the CCT (CCT, 2012).

### 3.2.2 Climate and Rainfall

Cape Town has a warm, dry summer Mediterranean climate with mild, moderately wet winters (Robinson and Henderson-Sellers, 1999; Rohli and Vega, 2011). It falls within a winter rainfall region where large cold fronts enter for limited periods from the Atlantic Ocean to cause significant precipitation. Winter months, which last from the beginning of June to the end of August, averages a maximum of 18.0°C and a minimum of 8.5 °C. In summer, which lasts from early December to March, the temperature averages a maximum of 26.0 °C and a minimum of 16.0 °C (World Weather Information Service, 2016). Due to the unique topography of the area the rainfall can vary extensively, with approximately 500 mm per annum in the valleys and coastal plains and as much as 1500 mm per annum in the mountainous areas (CCT, 2012). The summer temperature averages a maximum of 26°C (CCT, 2012). During the summer, extended dry spells frequently occur due to meteorological depressions and it is therefore during the hot, dry summers that the CCT's demand for water is at its highest. The average climatic data for the CCT, as obtained from the World Weather Information Service and the South African Weather Service, is summarised in Table 9 (World Weather Information Service, 2016).

**Table 9:** The average climate data for City of Cape Town (World Weather Information Service, 2016).

| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Record High °C | 39.3 (102.7) | 38.3 (100.9) | 42.4 (108.3) | 38.6 (101.5) | 33.5 (92.3) | 29.8 (85.6) | 29.02 (84.24) | 32.0 (89.6) | 33.1 (91.6) | 37.2 (99) | 39.9 (103.8) | 41.4 (106.5) | 42.4 (108.3) |
| Average High °C | 26.1 (79) | 26.5 (79.7) | 25.4 (77.7) | 23.0 (73.4) | 20.3 (68.5) | 18.1 (64.6) | 17.5 (63.5) | 17.8 (64) | 19.2 (66.6) | 21.3 (70.3) | 23.5 (74.3) | 24.9 (76.8) | 22.0 (71.6) |
| Daily Mean °C | 20.4 (68.7) | 20.4 (68.7) | 19.2 (66.6) | 16.9 (62.4) | 14.4 (57.9) | 12.5 (54.5) | 11.9 (53.4) | 12.4 (54.3) | 13.7 (56.7) | 15.6 (60.1) | 17.9 (64.2) | 19.5 (67.1) | 16.2 (61.2) |
| Average Low °C | 15.7 (60.3) | 15.6 (60.1) | 14.2 (57.6) | 11.9 (53.4) | 9.4 (48.9) | 7.8 (46) | 7.0 (44.6) | 7.5 (45.5) | 8.7 (47.7) | 10.6 (51.1) | 13.2 (55.8) | 14.9 (58.8) | 11.4 (52.5) |
| Record Low °C | 7.4 (45.3) | 6.4 (43.5) | 4.6 (40.3) | 2.4 (36.3) | 0.9 (33.6) | −1.2 (29.8) | −4.3 (24.3) | −0.4 (31.3) | 0.2 (32.4) | 1.0 (33.8) | 3.9 (39) | 6.2 (43.2) | −4.3 (24.3) |
| Average Precipitation mm | 15 (0.59) | 17 (0.67) | 20 (0.79) | 41 (1.61) | 69 (2.72) | 93 (3.66) | 82 (3.23) | 77 (3.03) | 40 (1.57) | 30 (1.18) | 14 (0.55) | 17 (0.67) | 515 (20.28) |

During 1982 and 1992 South Africa experienced devastating and widespread droughts. During the period of 2015 to the beginning of 2018 it once again experienced an extended period of abnormally low rainfall (CCT, 2015). This drought coincided with a particularly strong El Niño event in the Pacific Ocean and is regarded as the worst on record. The Western Cape Province was severely affected by the dry and hot conditions with its available water resources declining significantly since 2015.

Water managers within Southern Africa are experiencing heavy climate change impacts which are a major threat to water security within the country. South Africa is one of the five regions in the world most exposed to water scarcity and drought and is approaching physical water scarcity (Figure 11) (Bergkamp *et al*., 2003).

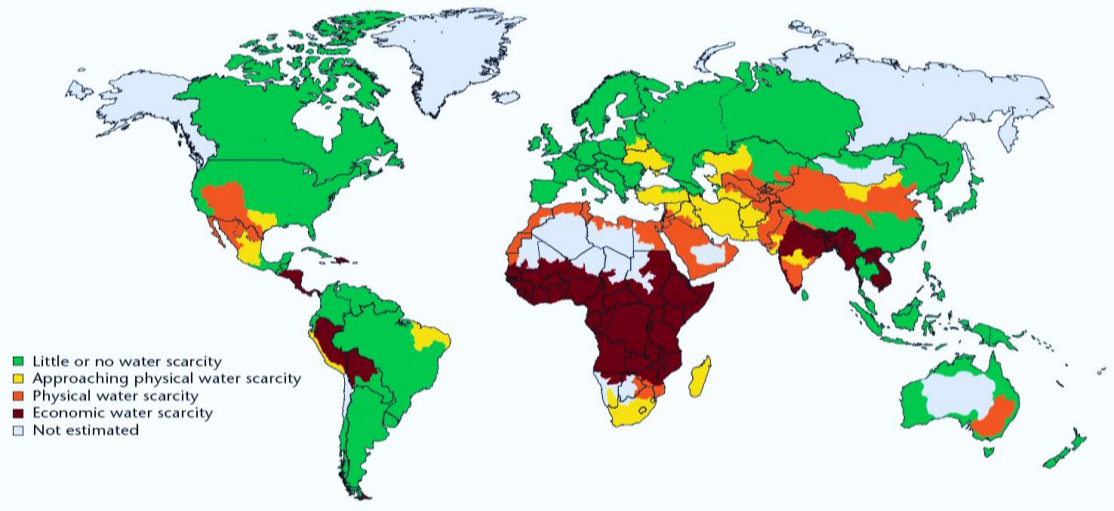


**Figure 11:** Worldwide water scarcity status (Bergkamp *et al*., 2003).

Ziervogel (2014) indicated that over the past five decades the South African mean annual temperatures have increased by at least 1.5 times the observed global average of 0.65°C. The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR5) suggest an increase in temperature of 3–6°C by 2081–2100 in the interior, relative to 1986-2005 figures (IPCC, 2014). Preliminary projections under a wide range of scenarios generated by the Massachusetts Institute of Technology (MIT),

together with the South African National Department of Environmental Affairs (DEA) Long Term Adaptation Scenarios of 2013, showed an increase in frequency of extreme rainfall events causing flooding, but with longer dry periods in between these events. The projections indicate a decrease in runoff of approximately 20% under an unmitigated emissions pathway (DEA, 2013; Ziervogel *et al*., 2014).

Atmospheric circulation trends support the evidence of certain regions in South Africa getting dryer. In 2013 the National Department of Environmental Affairs (DEA) commissioned its Long Term Adaptation Scenarios (LTAS) project (DEA, 2013). Higher frequencies of flooding and drought were the two prominent future scenario projections for the Western Cape Province. Within the water resources sector, complexities of the hydrological cycle, influences of land management and use, as well as the linkages to society, economy and health are far higher than that of other sectors (Ziervogel *et al*., 2014). If the climate was to become drier, land use impacts on water resources will become proportionally greater (Warburton *et al.*, 2012).

The South African hydrology is driven by major global systems such as El Niño events (Scholes *et al*., 2015). Figure 12 shows the El Niño Southern Oscillation (ENSO) data trends as a deviation from the mean over time (Meissner, 2010). This data was used by the author in 2012 to predict a major regional El Niño event which took place in 2015-16 and was the worst in recorded history (Crilly, 2016). This dataset shows that there is a general cyclical oscillation between the positive and negative deviations from the mean over time. It also indicates a clear upward trend in the peak values on both sides. This can be taken as evidence of global warming and that future events will be become more extreme (Crilly, 2016).

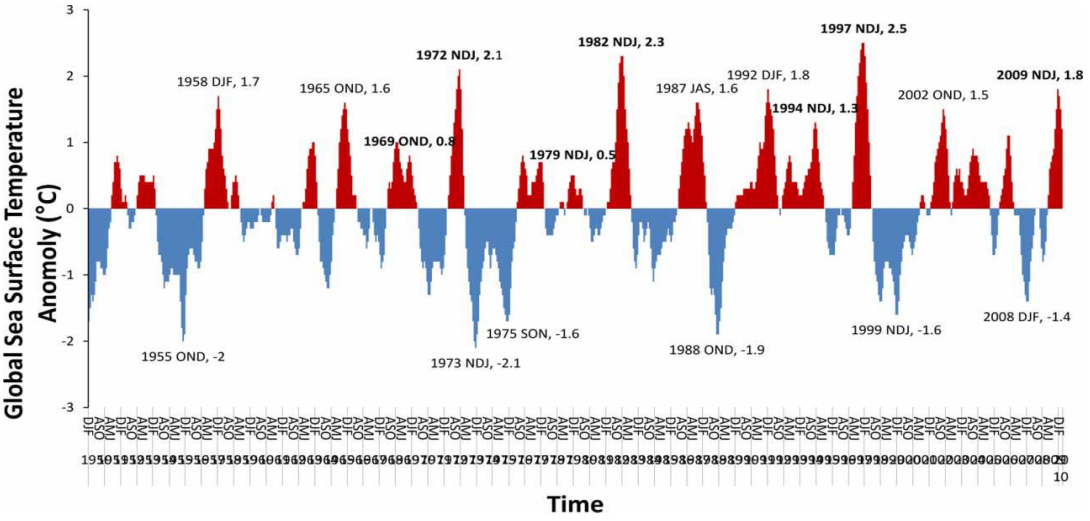


**Figure 12:** Global sea surface anomaly for the Pacific Ocean showing El Niño/La Niña events over time (Meissner, 2010).

Research conducted by the South African members of the IPCC indicate that, although a global average increase in temperature of 2 °C is survivable, South Africa will actually experience a future temperature increase of closer to 5 °C in certain parts of the country (Scholes *et al*., 2015). This will have disastrous impacts on water security within the affected areas (Reeve and Entholzner, 2016). It is estimated that by 2030, South Africa will experience a supply and demand gap of 2, 97 billion $m^3$ per annum (McKenzie and Bhagwan, 2015). The country will face a serious water crisis early in the next century if the growth in demand is not curbed (McKenzie and Bhagwan, 2015). According to McKenzie and Bhagwan (2015), the requirement for water in South Africa has grown at between 4% and 5% since the 1930's, and if the future increase in water demands continue at this rate, some parts of the country will effectively enter a state of continuous water stress within the next 50 years. As income levels within the county rise, the demand for water is increasing at a higher rate than population growth.

### 3.2.3 Water Availability in the City of Cape Town

The Western Cape Province relies predominately on surface water which forms part of a complex water supply system dominated by a matrix of dams, tunnels, pipelines, and distribution networks. The largest of these is the Western Cape Water Supply System

(WCWSS). Some of the various facilities are operated by the South African Government's Department of Water and Sanitation (DWS), and others by the City of Cape Town metropolitan municipality and directly by neighbouring municipalities such as the Drakenstein, Overstrand, Stellenbosch and Saldanha Bay municipalities. The Western Cape is a water scarce area and as it is approaching water resource limits, conflict arising from differing values and uses are increasing. Resolving this conflict increasingly requires more scientific information, new technology and adapted initiative approaches in order to facilitate management decisions concerning water management. The CCT derives the bulk of its present water supply from surface water resources and is the central water service authority for water users within this metropolitan City.

The current system is almost entirely dependent on the storage of rainfall within a network of six storage dams, of which the three largest are managed by the National Department of Water and Sanitation (DWS). The DWS is responsible for the planning and implementation of water resource schemes to meet water demand within the city. The planning by DWS usually considers a 1 in 50 year level of assurance which means that during conditions of drought with a severity of 1:50 years or more, restrictions will be imposed in order to reduce demand (CCT, 2018b). Lower than average rainfall in South Africa's Western Cape exacerbated water shortages over the past three years. The total amount of water stored in the six largest reservoirs that supply Cape Town fell to new lows each year. The availability of fresh, potable water to meet the growing water demand within CCT is a constraint on the environmental sustainability, social upliftment and economic growth of CCT (CCT, 2007).

### 3.2.4 City of Cape Town's Water Demand

Over the last 10 years, the CCT's population has grown by 21% and is expected to reach 4.2 million by 2031 (CCT, 2012). This rapid growth can be contributed to the immigration of people from rural areas looking for work opportunities and to better their lives. Cape Town's population is rapidly expanding and densification and land availability for new housing development is a serious challenge. According to a report

by Dorrington (2000), it is expected that the total Cape Town population will grow by almost 60% over a 35-year projection period. In Table 10 the 'medium' projection appears in bold as the most likely population estimates for Cape Town for the period 2011–2031 (Dorrington, 2000).

**Table 10:** Cape Town's "Medium"/"low" population growth projections as per the Dorrington (2000) report and StatsSA (2011) figures**.**

| | 2006 | 2011 | 2016 | 2021 | 2026 | 2031 | |
|---|---|---|---|---|---|---|---|
| **HIGH** | 3 186 938 | 3 646 156 | 4 008 402 | 4 292 446 | 4 538 385 | 4 769 669 | 4 976 987 |
| **MEDIUM** | **3 154 238** | **3 547 055** | **3 820 847** | **3 997 718** | **4 119 504** | **4 208 444** | **4 255 857** |
| **LOW** | 3 121 532 | 3 447 946 | 3 633 286 | 3 702 990 | 3 700 595 | 3 647 071 | 3 534 371 |

The Department of Water Affairs and Forestry (DWAF) has identified the Western Cape region as one of the first major urban regions in South Africa where the demand for water will exceed the total potential yield if the growth scenarios are realised (DWAF, 2007). The region is characterised by great variability with regards to its water resources, and in some places the rate of exploitation is unsustainable. The projected general drying of the Western Cape region has serious implications for further socio-economic development within the CCT (Mukheibir and Ziervogel, 2006). According to a demand analysis conducted by the CCT, the domestic consumption sector accounts for 48% of the CCT's water demand, as can be seen in Figure 13 (CCT, 2015).

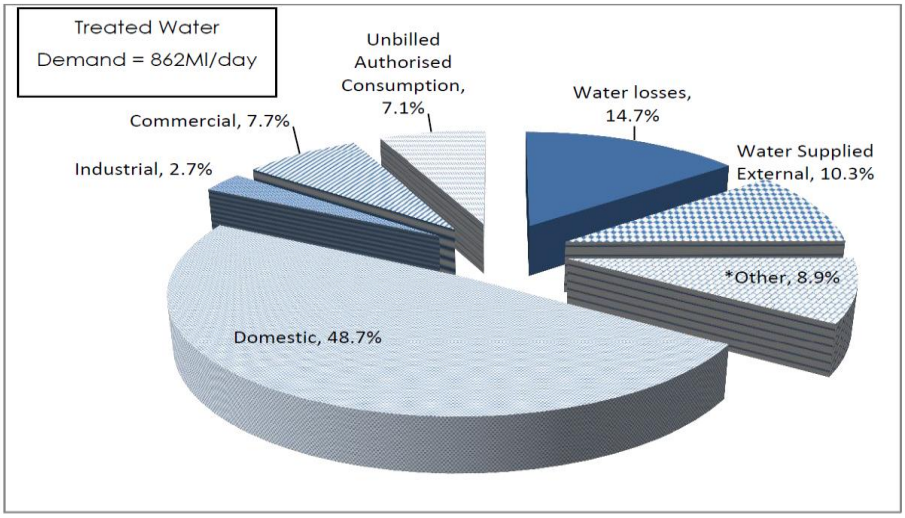


**Figure 13:** The Sectoral Water Demand for the CCT during the 2013/14 financial year (CCT, 2015).

Figure 13 indicates that the residential water demand accounts for the highest percentage overall demand (CCT, 2015). It is therefore essential to consider the domestic water users when planning any water demand management initiatives.

### 3.2.5 Water Demand Management within the City of Cape Town

The CCT established a dedicated Water Demand Management (WDM) branch in 2001, which is focused on the implementation of various water savings initiatives within the CCT. This branch is situated within the broader Department of Water and Sanitation. The core business of the branch is to equitably and efficiently provide Water and Sanitation services to all residents in a sustainable, equitable, safe, reliable, environmentally friendly and financially viable way by means of sound good governance principles (CCT, 2013).

In 2001 the CCT developed a Water Conservation/Water Demand Management (WC/WDM) strategy and implemented a number of WC/WDM initiatives based on this strategy. Some of these initiatives, such as the Khayelitsha Pressure Management project, were successful and received wide recognition. The implementation of the

strategy was however not sustainable due to numerous institutional challenges. Within the CCT's water management there was a decrease in commitment to the implementation of WC/WDM initiatives. Resources for the implementation of WC/WDM initiatives were significantly reduced during 2003/04 and again during 2006, hindering the successful implementation of initiatives (CCT, 2013). The strategy was therefore revised in 2013 to overcome these challenges, to build on experience gained and to adapt to the current socio-political, environmental and urban management imperatives (CCT, 2013). The purpose of the WC/WDM strategy was to ensure the long-term balance between available water resources and water demand, to postpone the need for expensive capital infrastructure projects for as long as it is economically viable and to minimise water wastage.

The WC/WDM strategy is in line with the provisions within the National Water Act which adopts water demand management and water conservation as a key concept (RSA, 1998a). Clause 8 within the Act makes water conservation one of the requirements of a catchment management strategy. It is also aligned with the National Water Resources Strategy, which requires decisions about water management and new technology at regional, catchment and land-use scales so that they are based on sound knowledge of the resource itself, including its social, cultural, environmental and economic values and so that they deal with uncertainty and risk (DWA, 2013).

The WC/WDM strategy identified 5 goals to achieve by 2016/17. These five goals consist of both quantitative and qualitative techniques which both have a direct and indirect impact on the CCT's water demand (Table 11).

**Table 11:** The CCT's WC/WDM strategy revised goals as set in 2013 (CCT, 2013).

| Goal | Target | |
|---|---|---|
| A | Water losses (unaccounted for water) < 15% by 2015/16 | Quantitative |
| | - Apparent losses (unbilled unauthorised consumption)<br>- Real losses | |
| D | NRW < 20%<br>- Unbilled authorised consumption<br>- Apparent losses (unbilled unauthorised consumption) | Quantitative |
| | Real losses | |
| E | Demand growth < 2% | Quantitative |
| B | On-going effective management systems and implementation of IWRP | Qualitative |
| C | Mobilise resources according to the Water Conservation and Water Demand Management Strategy | Qualitative |

According to the CCT (2013), based on an average growth in demand for water of 3% per annum within CCT and an allocation of 399 million $m^3$ per annum, the next augmentation scheme would have been required by 2016 (baseline 2011) had no further WC/WDM initiatives been implemented, as can be seen in Figure 14. It shows that the next augmentation scheme is to be implemented by 2020 (baseline 2013).

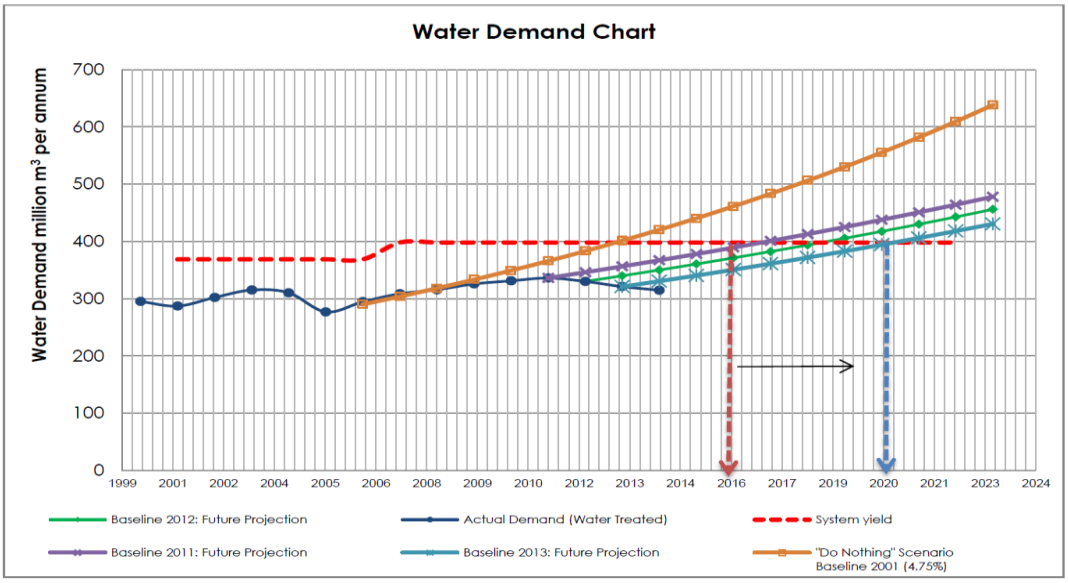


**Figure 14:** Water demand management projections based on a growth in demand for Water of 3% per annum (CCT, 2013).

Based on the above graph, it is evident that the water demand is tending toward the low water requirement curve, which exceeds the target of 2.0% as stated in goal E. This indicates that the WC/WDM was able to sustain the water demand below the target of 2.0% in spite of population growth. A large part of the water savings achieved was due to the impact of pressure management and treated effluent re-use initiatives. The projected estimated maximum potential savings of 82.02 million $m^3$/annum (which includes what was saved, since the strategy implementation, up until 2010/11) will potentially be achieved provided WC/WDM is provided with all the necessary resources to implement it (CCT, 2013). In Figures 15 and 16, the projected impact of WDM initiatives within the CCT for the low water requirement (LWR) and high water requirement (HWR) periods is shown assuming 100% and 50% water demand management success rates respectively (CCT, 2013).

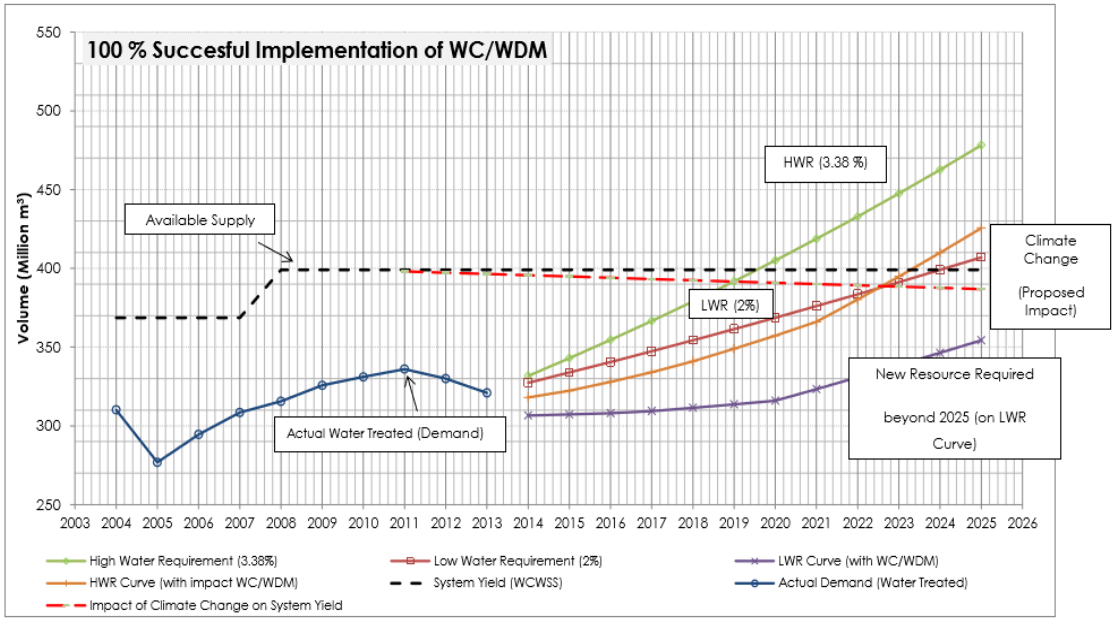


**Figure 15:** The impact of water demand management initiatives on the LWR and HWR curve on system yield assuming 100% success (includes the impact of climate change) (CCT, 2013).

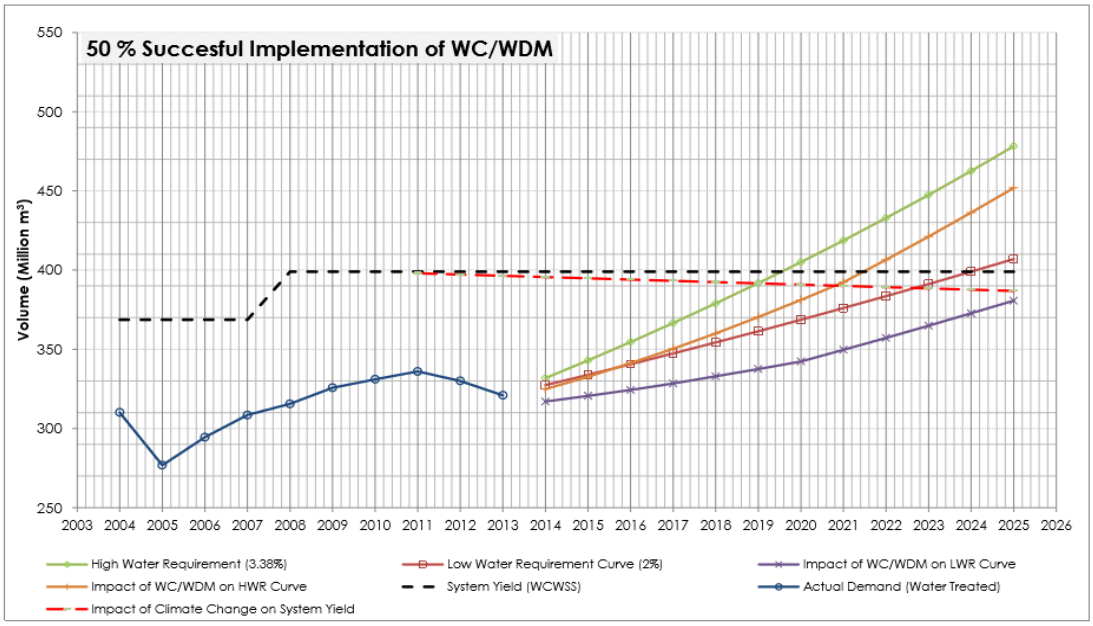


**Figure 16:** The impact of water demand management initiatives on the LWR and HWR curve on system yield assuming 50% success (includes the impact of climate change) (CCT, 2013).

It is assumed that climate change will impact on the CCT's water demand in such a manner that it will reduce the system yield by 5% over the next 25 years (DWA, 2010). More research is therefore needed to better understand the effect and impact of climate change on the availability of water resource over time.

# 4. Case Study Results

## 4.1 Policy, Document and Information Analysis

This section is structured to include two sub-sections consisting of detailed analyses of the water policies and documents of South Africa and the City of Cape Town respectively.

### 4.1.1 South African Water Policy

The newly elected democratic government of South Africa, in 1994, set out to reform its water legislation to align with its constitutional values, by developing a legal framework that governed water in a sustainable and equitable manner (Toxopeüs, 2019). The Constitution sets out the right to just administrative action in water-related decisions (RSA, 1996). It also allocates different competencies to local government in the management of water resources. Central to this is the management of water resource administration, budgeting and planning processes in such a way that gives priority to the basic needs of the public. The consequent development of a White Paper in 1997, focusing on a National Water Policy for South Africa, guided the development of a new water resource management framework (Toxopeüs, 2019). This has laid the foundation for South Africa's regulatory legal framework for water resource management in the country (Fallon, 2018).

Within the water sector, the major pieces of legislation driving water resources management and water services provision is the National Water Act (NWA) (Act 36 of 1998), the Water Services Act (WSA) (Act 108 of 1997), the National Water Resources Strategy 2 (NWRS), and to some extent the National Environmental Management Act (NEMA) (Act 107 of 1998). While the main focus of the National Water Act is on the use of water resources, the Water Services Act mainly focuses on water services supplied by lower level authorities, such as municipalities, and provides an institutional framework for the delivery of essential water and sanitation services by water authorities (RSA, 1997). The Water Services Act governs the provision of water services as well as the water management institutions that perform this function at Local Government level.

It requires that all water management authorities prepare a Water Services Development Plan (WSDP) which is an important requirement for sustainable water supply.

All South Africa's citizens are guaranteed the right of access to sufficient water for basic human needs through the South African Constitution (Republic of South Africa, 1996). The White Paper for a Water Policy (1994) stated that the water demand management function of the national Department will be strengthened and given greater priority. This recognition resulted in the creation of the Directorate: Water Conservation, now called Directorate: Water Use Efficiency. It also resulted in the Strategic Framework for Water Services (2003) recognising the role of WC/WDM in ensuring sustainable water services. The White Paper also made provisions for new approaches to water management that will focus on water use efficiency, effectiveness and demand management in each user sector, instead of a traditional prediction, planning and supply focus.

The South African national water policy was therefore developed and guided by an international policy platform based on environmental policy, sustainable development, the Millennium Development Goals (MDGs) and human development. A critical landmark in the history of the development of water resources policy and legislation was the UN Water Conference in Mar Del Plata in 1977, which set the general principles for international and national agencies (Amezaga, 2005). These principles were updated in 1992 in Dublin and contributed to the Agenda 21 recommendations (UNCED, 1992) on freshwater resources and were adopted at the UN conference on Environment and Development (UNCED) in Rio de Janeiro, 1992 (Hashemi, 2012).The Dublin Principles recognises that, 1) freshwater is a vulnerable and finite resource, 2) water resource management should be based on a participatory approach, 3) women play a central part in the management, provision, and safeguarding of water, and (4) water has an economic value in all its competing uses. These four principles have been adopted by South African water management authorities and integrated within their policy and legislative documents. Several policy and legislation documents has been promulgated

(Table 12), of which the NWA provides the overarching framework for water management within the country.

**Table 12:** Selected legislative, policy and strategy arrangements relating to water services provision in South Africa (Cardin, 2013).

| Legislation/Strategy | Act No and Year | Function |
|---|---|---|
| Constitution of South Africa | Act 108 of 1996 | Ensures access to water services and assigns responsibility to local government (RSA, 1996). |
| National Water Act (NWA) | Act 36 of 1998 | Ensures the protection of water resources as an indivisible national resource and assigns responsibility to the national government (RSA, 1998a). |
| Water Services Act (WSA) | Act 108 of 1997 | Ensuring financially and environmentally sustainable water services provision by municipalities (RSA, 1997). |
| National Environmental Management Act (NEMA) | Act 107 of 1998 | Ensures the control of activities which are likely to have a detrimental effect on the environment and provides an overarching framework for environmental management in the country (RSA, 1998). |
| Municipal Systems Act (MSA) | Act 32 of 2000 | Stipulates the formulation of IDP's and defines the operations and partnership arrangements of local government to ensure delivery of services (RSA, 2000). |
| National Water Resources Strategy | 2013 | Describes how the water resources of South Africa will be developed, used, conserved, protected, managed and controlled in accordance with the requirements of the policy and law (DWA, 2013). |
| National Water Conservation / Water Demand Management Strategy Framework | 2000 | Lays out the key principles that would guide a national water conservation and demand management strategy (DWAF, 2000). |
| Drinking Water Quality Regulation Strategy | 2005 | Ensuring high quality drinking water by providing the Department of Water and Sanitation and Water Services Authorities with regulation strategies. |
| Strategic Framework for Water Services (SFWS) | 2003 | Ensuring the progressive improvement of water services by setting out an institutional framework for water service provision in SA. |

South African water resources management is mainly guided by the South African National Water Act (Act 36 of 1998) (NWA). This Act promotes the use of water as 'everybody's business' (NWA, 1998). It recognises that since we all have a right to water, we also have a right to participate in the way it is managed and allocated, with participation being organised in terms of catchments in Chapters 2 and 7 of the NWA (NWA, 1998; Hiagh *et al*., 2010). The main objective of this Act, as defined in Section 2

of the Act, is to ensure that the country's water resources are protected, developed, used, managed, conserved and controlled, taking into account sustainability, equitable access and enhancement of economic development, amongst others (RSA, 1998a). It regulates water management in the most socially and economically advantageous way, ensuring water wastage reduction and that everyone has access to water (Cardin, 2013). The Act considers water "*as public property*" and places water in the care of the state (Saleth and Dinar, 2000:186). The National Water Act also aims to balance long-term water resource protection and water resource utilisation, whilst promoting economically sound development, and ensuring that all water use is equitable and sustainable in the long-term (Ashton and Haasbroek, 2001). The National Water Act replaces water use rights, based on land ownership, with a system of administrative authorisations. This change is a critically important approach to the country's water resource management policies. All water will now be managed within the framework of the Integrated Water Resource Management (IWRM) philosophy, on a catchment basis, through appropriate institutions including the Department of Water Affairs and Forestry, Catchment Management Agencies and Water User Associations. The National Water Act recognises the essential role that water conservation and water demand management (WC/WDM) play in water resource management. The National Water Act also required that the Department of Water Affairs (DWA) establishes a National Water Resource Strategy (NWRS), to be reviewed after every five years.

The National Water Resource Strategy (NWRS) serves as a progressive and binding framework to manage water resources strategically and on a national scale. All authorities and institutions that exercise powers in terms of the NWA must give effect to it (Toxopeüs, 2019). The first NWRS was published in 2004, after which an updated version was published in 2013, known as the National Water Resource Strategy II (NWRSII). The NWRSII is framed to achieve three core objectives: that water is protected, conserved, used, developed, managed and controlled sustainably and equitably, that water supports development and the elimination of poverty, and that water contributes to the economy and job creation (NWRSII, 2013; Toxopeüs, 2019). The objectives are supported by key themes including water conservation and demand

management, resource protection, climate change, water resources planning, development and infrastructure management, and regulation and international water resource management (NWRSII, 2013; Toxopeüs, 2019). The NWRSII document is also set up to consider the social component to enable continued interaction in order to grow and change as the capacity, understanding and needs of South Africa's people change. This indicates a policy that goes beyond the generally accepted education and awareness approach, known as the changing of attitudes, behaviours and choices (ABC) model, to also consider all aspects relating to the human component within participation strategies.

The central objective of the NWRSII is to manage water resources and to ensure that it is used to support equitable and sustainable social and economic transformation and development (DWA, 2013). It sets out the aims for South Africa to achieve integrated water resource management (IWRM) and describes the policies and strategies to achieve these aims. The NWRSII defines water demand management as "*the adaptation and implementation of a strategy or a programme by a water institution or water user to influence the water demand and usage of water in order to meet any of the following objectives: economic efficiency, social development, social equity, environmental protection, sustainability of water supply and services and political acceptability*" (DWA, 2013:52). The NWRSII indicated that measures to reconcile demand and supply, in order provide for all our goals, should be made a top priority.

The NWA mainly deals with water as a resource, whereas the Water Services Act 108 of 1997 (WSA) deals with regulating access to water and the delivery of water services. The WSA provides for the right of access to basic water supply and sanitation services in order to secure constitutionally entrenched rights to sufficient water (WSA, 1997). The Act defines basic water services as "*the prescribed minimum standard of water supply services necessary for the reliable supply of a sufficient quantity and quality of water to households, including informal households, to support life and hygiene*" (Toxopeüs, 2019:03; WSA, 1997).

The WSA acknowledges the mandate of local government to ensure efficient, affordable, economical and sustainable access to water services (Toxopeüs, 2019). The challenge however, is that the WSA does not emphasise cooperative and participative governance strategies at local level (Toxopeüs, 2019). This is a flaw in the legislation of local governance as most municipalities are basing their governance regimes according to the principles set out in the legislation that is directly affecting their governance at local level.

Another challenge is that the local governance is mostly working in a silo approach. The Water Service Departments are only focused on the local legislation directly impacting on Water and Sanitation services. It is for this reason that the principles in essential environmental legislation, which is interlinked with water resource management, is ignored. For instance, the National Environmental Management Act 107 of 1998 (NEMA) is South Africa's environmental legislation which gives effect to the environmental rights enshrined in the Constitution and governs cooperative environmental governance (NEMA, 1998; Toxopeüs, 2019). It provides for principles intended to inform environmental management including effective public participation, transparency, public trust, accountability and access to information, amongst others (NEMA, 1998; Toxopeüs, 2019). NEMA also sets out procedures for integrated environmental management and cooperative governance (Toxopeüs, 2019). Water resource management forms an integral part of environmental resources and this legislation can therefore be used as a cornerstone in the framing of participative management strategies for water resources management within water policies.

Local government has a significant role to play in water management and in engaging local communities to participate in IWRM processes due to its strategic placement between the national and provincial spheres of government, and the public that receives the services. Hiagh *et al*. (2010) observed that municipal officials tend to function within their directorates without sufficient cross-directorate interaction. Municipal officials are traditionally pre-occupied with delivering water and sanitation to households and

generally do not want to consider social participation as part of their sphere of responsibility (Hiagh *et al*., 2010).

To meet the objectives of the National Water Act and the NWRSII, the Department of Water and Sanitation (DWS), (previously known as the Department of Water Affairs (DWA), has developed a National Water Conservation and Water Demand Management (NWC/WDMF) strategy framework, which is a fundamental step in promoting the efficient use of water in South Africa (DWA, 2000). The Department launched the National Water Conservation and Water Demand Management Framework (NWC/WDMF) in 1999, which consists of the development of rational strategies for water conservation and water demand management (DWAF, 1999). The generic objectives of the NWC/WDMF strategy are listed in Table 13.

**Table 13:** The National Water Conservation / Water Demand Management Framework objectives (DWA, 2000).

| **Objective** | **Description of Objective** |
|---|---|
| Objective 1 | To facilitate and ensure the role of WC/WDM in achieving sustainable, efficient and affordable management of water resources and water services. |
| Objective 2 | To contribute to the protection of the environment, ecology and water resources. |
| Objective 3 | To create a culture of WC/WDM within all water management and water services institutions. |
| Objective 4 | To create a culture of WC/WDM for all water users. |
| Objective 5 | To support water management and water services institutions to implement WC/WDM. |
| Objective 6 | To promote the allocation of adequate capacity and resources by water institutions for WC/WDM. |
| Objective 7 | To enable water management and water services institutions to adopt integrated planning. |
| Objective 8 | To promote international co-operation and participate with other Southern African countries, particularly basin-haring countries, in developing joint WC/WDM strategies. |

The NWC/WDMF is a major step in promoting water use efficiency and the effective management of water resources. DWA has also developed various Reconciliation Strategies, of which WC/WDM is an integral part. Within these studies, targets to reduce water demand were set for all the major demand centres. The National Water Policy framework is also placing high priority on WC/WDM and this requires that the DWA, South African Local Government Association (SALGA), and the Department of

Cooperative Governance (DCoG), among others, provide the necessary leadership and guidance (DWA, 2013).

The Department of Water and Sanitation is the regulatory body that provides leadership, guidance, oversight and monitoring to ensure that effective WC/WDM measures are implemented across all sectors. The South African national policy and legislative development is however still following a linear model of policy development (Cardin, 2013). Social and stakeholder challenges identified according to political and institutional perspectives will usually be addressed by the political agenda without consideration and participation from the society that it is impacting on (Cardin, 2013). South African water policy and legislation is therefore developed by water authorities and politicians in response to perceived social issues which in many cases is not the actual social issues experienced, or it may only touch on the depth of social issues experienced (Cardin, 2013).

The implementation of the water legislation is a major challenge for government, as it requires sufficient financial resources and political will (Toxopeüs, 2019). Most municipalities at local governance level are experiencing severe financial constraints as a result of mismanagement (Toxopeüs, 2019). So despite its progressive water legislation framework, South Africa can only manage water resources and services to the extent that it has the necessary capacity to do so (Toxopeüs, 2019).

### 4.1.2 City of Cape Town Water Policy and Legislation

The CCT is a large metropolitan municipality which falls under the jurisdiction of the South African local government. According to Section 40 of the Constitution of South Africa (No. 108 of 1996), local government is a distinct sphere of government with executive authority in the area of jurisdiction (RSA, 1996). Local government has water services roles derived from Schedule 5 of the Constitution, The Water Services Act (RSA, 1997), and the Local Government: Municipal Structures Act (RSA, 1998b).

The Water Services Act requires that all water service authorities (WSA's) such as municipalities prepare a Water Services Development Plan (WSDP) (SALGA, 2011; Cardin, 2013). Regulations promulgated in 2001 in terms of the WSA stipulate that water loss management initiatives must be reviewed annually. Within the CCT, water savings and losses due to large infrastructural initiatives are largely assessed and reviewed by means of quantitative calculations and projections. Very little consideration is however given to the qualitative, social impacts of water demand management initiatives. Water resource management strategies within the CCT are mostly polarised in nature with a main focus on large infrastructural projects which can supply all of its residents during periods of water stress (Cardin, 2013). The CCT has not considered the mid- to long term impacts of smaller, decentralised sources of water as well as the impacts of qualitative, social initiatives on water demand management within the CCT.

The water service provider (WSP) and WSA functions have always been provided internally by CCT and there is thus no effective separation of functions between the WSA and the WSP. The separation of the WSA and WSP functions and powers are however mentioned in the CCT's Water Services Development Plan (WSDP) (CCT, 2017). According to the WSDP, CCT is looking at separating the service authority and service provision function to establish a municipal entity (CCT, 2017). The council's decision to institute this separation has however not been implemented due to some debate as to whether or not the separation of the WSA and WSP will indeed result in improved service delivery (SALGA, 2011).

Within the CCT's WSDP, critical challenges to the provision of sustainable and fair urban water provision were identified, such as rapid urban population growth and developmental activities causing increased demand, handling the resultant increase in wastewater effluent and pressures on wastewater treatment plants, the provision and maintenance of quality infrastructure to meet the development growth, the financial sustainability of water services and cost recovery, affordability of services, debt recovery and implementing assistance to indigent water users as planned for in the CCT's indigent policy (SALGA, 2011).

Under the Municipal Systems Act (Act 32 of 2000) (RSA, 2000), the CCT is mandated with a range of roles and responsibilities, with the development and enforcement of by-laws as one of these. Its by-laws incorporates the requirements of the WSA and includes requirements for water demand management. Some of the CCT's primary by-laws are shown in Table 14.

**Table 14:** The City of Cape Town's by-laws affecting water services (SALGA, 2011; CCT, 2010).

| By-law | Date Promulgated | Short Description | Effect on Water Services |
|---|---|---|---|
| Water By-law | Jan. 2011 | To control and regulate water services in the CCT. | More effective management of the use of water and sanitation services by users. |
| Treated Effluent By-law | July 2010 | To control and regulate the use of treated effluent within the CCT. | More effective management of the use of treated effluent by users. |
| Stormwater Management By-law | September 2005 | To provide for the regulation of the stormwater management system. | More effective management of the discharge of stormwater by users. |
| Credit Control and Debt Collection By-law | 2004 (original version)<br>2011 (updated version) | To give effect to the Council's credit control and debt collection policy. | Water services is more financially sustainable. |

The CCT attempts to address its many challenges through its by-laws. These by-laws are however imposed on its residents without much consultation or communication and the successes achieved with these by-laws are variable (Cardin, 2013).

In 1998 the Cape Metropolitan Council (CMC) established a water demand management unit in an effort to reduce water demand and to control water use within the CCT. The purpose of this unit is to manage and implement WDM strategies and initiatives by means of various projects such as, amongst others, repairing leaks, replacement of pipes, recycling of treated effluent, pressure management, and water conservation education and awareness. In order to guide the planning and implementation strategies of water demand management within the CCT, the unit adopted the proposed development of a long-term WC/WDM strategy. Due to funding

and institutional constraints, the development of the strategy was however postponed until 2005 when it was re-initiated. The final draft of the WC/WDM strategy was finally available early in 2006, and an updated, revised version was released in 2015. Although the water resource situation in the Western Cape was the main motivation for initiating this strategy, equitable access to water services, financial efficacy, environmental sustainability and water use efficiency were significant thrusts of the strategy (DWAF, 2007). The CCT's long-term WC/WDM strategy is the main piece of legislation use by the CCT's water demand management unit to manage water demand within the CCT.

The WC/WDM strategy is based on five goals, Goals A, B and E relate to the implementation objectives that will result in the direct reduction of water demand, and goals C and D relates to an enabling action plan. Thirteen implementation objectives have been developed under the goals A, B and C (Table 18), and seven enabling action plan objectives have been developed under goals C and D (Table 15) (CCT, 2007).

**Table 15:** The implementation objectives developed under the goals A, B and E of the WC/WDM Strategy (CCT, 2007).

| Policy Goal | Objective Number | Description |
|---|---|---|
| A | A1 | Reduce and maintain low levels of water losses through the reticulation system. |
| | A2 | Reduce and maintain low levels of non-revenue demand by water users. |
| | A3 | Adopt and implement proactive operation and maintenance measures. |
| | A4 | Reduce and maintain low levels of billing and metering losses. |
| B | B1 | Promote the efficient use of water to residents. |
| | B2 | Regulate and enforce the prevention and wastage of water. |
| | B3 | Ensure the efficient use of water in new connections and developments. |
| | B4 | Introduce more equitable tariffs and informative billing. |
| | B5 | Assist and capacitate water users to be water-efficient, including the introduction of leak repair and retrofitting projects. |
| | B6 | Reduce and maintain low levels of inefficient water use by the municipality. |
| E | E1 | Promote alternative water resources and technologies. |
| | E2 | Conservation of existing water resources. |
| | E3 | Ensure the quality of treated effluent is of suitable standards. |

The enabling action plan consists of two goals as shown in Table 16. Goal C mainly relates to ensuring adequate information, whilst Goal D relates to ensuring adequate resources and the capacity to implement WC/WDM (DWAF, 2007).

**Table 16:** The enabling action plan objectives developed under the goals C and D of the WC/WDM Strategy (CCT, 2007).

| Policy Goal | Objective Number | Description |
|---|---|---|
| C | C1 | Establish appropriate district management areas and monitor the unaccounted-for water. |
| | C2 | Ensure adequate information and policies to support decision-making. |
| | C3 | Ensure all decisions are supported in terms of Integrated Resources Planning (IRP). |
| | C4 | Monitor the impact of WC/WDM measures and KPI's. |
| D | D1 | Ensure adequate financial resources. |
| | D2 | Ensure adequate human resources and processes. |
| | D3 | Ensure adequate transparency, stakeholder buy-in and commitment. |

Apart from large scale, financially costly water augmentation schemes, projects also made provision for in the CCT's WC/WDM strategy includes the promotion of alternative water resources and user education and awareness initiatives and campaigns. There is however a clash between the CCT's Water by-law and its intentions to promote alternative water resources. The CCT's water by-law indicates that the use of alternative water resources is not allowed for indoor purposes and forbids the indoor plumbing of alternative water infrastructure. Within its educational and awareness initiatives the use of alternative water resources for flushing, showering or washing purposes is however widely promoted, thereby creating conflicting messages and confusion amongst the CCT's water users.

As per the goals in the WC/WDM Strategy as set out in Table 15 above, it is clear that the CCT's Water Demand Management section is implementing a policy which is in line with the widely accepted, but tunnel vision view, of the attitude, behaviour and choices (ABC) model as described by Shove (2010), which is in contrast with the more progressive view as mentioned in national policy, such as the NWRSII (2013), in which

a wider range of factors that can influence society's water conservation efforts are recognised.

Within the CCT's updated WC/WDM Strategy of 2014/2015, social participation, or the consideration of all the elements that can motivate or serve as barriers to the human component, is not included as part of its list of defensive strategies mentioned in the document. It is also mentioned in the Strategy that one of the core functions of the CCT's Water Demand Management section is behavioural change in the form of education and awareness programmes, which is a more bureaucratic management style according to the changing of attitudes, behaviour and choices model as identified by the author Shove (2010) as being a major challenge within water policies.

Within the City of Cape Town's Water Services Development Plan (WSDP) (2017), there is also no mention made of any public participation initiatives, except the thirty day required public participation process as part of the development of the Plan, where the public can provide their inputs on the strategy. The main emphasis is once again on a command and control strategy, with a strict implementation of the ABC model. The public is being controlled by reducing their water supply through the installation of water management devices, forcing them to use less water. They are being told they must change their behaviours, attitude and choices, and education and awareness is the main strategy mentioned within the document in an attempt to achieve this.

Within the CCT, water savings and losses due to large infrastructural initiatives are largely assessed and reviewed by means of quantitative calculations and projections. Very little consideration is however given to the qualitative, social impacts of water demand management initiatives. Water resource management strategies within the CCT is mostly polarised in nature with a main focus on large infrastructural projects which can supply all of its residents during periods of water stress (Cardin, 2013).
One of the main objectives of the CCT's water management policy is education and awareness. No mention is made of participation or any other strategies other than education and awareness, which can be described as the provision of information and

teaching the public how to conserve water. Anything beyond that is not recognised at all within any of its policy and legislation documents.

This indicates a water resource management style that strictly follows the ABC model, with the changing of behaviours, attitudes and choices at the forefront. The citizens are seen as the problem, and if they can be changed the CCT's water conservation challenges can be alleviated. Other social, institutional, economic, and environmental aspects are completely ignored, such as failing infrastructure and governance methods, social values, norms and cultures, social traditions, politics, crime, education and employment challenges, as well as economic challenges. According to Shove (2010), relevant societal change is that in which currently acknowledged rules of the game are eroded, in which the status quo is called into question and in which more sustainable governance relating to routines, forms of knowledge, conventions, and expectations takes hold across all domains of daily life. These aspects can have an interlinked and combined impact on water consumption.

## 4.2 The Major 2015 - 2017/18 Cape Town Drought

The worst drought in living memory has plagued the CCT since 2015 to the beginning of 2018. The CCT's dam levels have been critically low due to a lack of winter rainfall, increasing temperatures, a rising population density, placing enormous stress on the limited water resources within the City (CCT, 2018b). Over the past five years the Western Cape has experienced major drought conditions. In Figure 17 it can be seen that the water levels in the dams supplying water to the CCT were at their lowest in 2015 - 2017 since the year 2009.

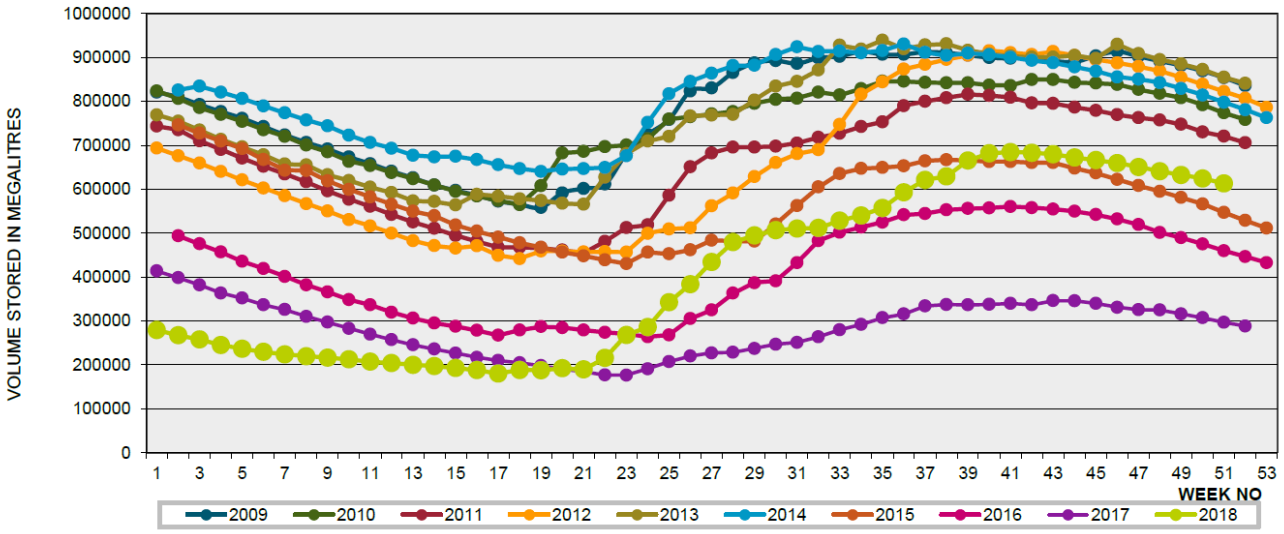


**Figure 17:** Ten year (2009 - 2018) trends in the water levels in dams providing water to the City of Cape Town (CCT, 2018b).

For the period 2012 to 2017, a comparison of the mean water levels (expressed as a percentage of maximum capacity) in the five dams and one river from which the City of Cape Town obtains its water revealed the following. The mean water levels (73.2%, n = 6) were significantly higher (Repeat-measures ANOVA, Tukey's test, F = 17.39, p = 0.006) in 2014 compared to the other five years. Mean water levels in 2016 and 2017 were significantly lower (Repeat-measures ANOVA, Tukey's test, F = 17.39, p = 0.03 - < 0.0001) than in the previous four years as can be seen in Figure 17 (Wolski, 2018).

### 4.2.1 Wolski's Drought Severity Analysis

Within a short space of time, the City of Cape Town has recorded the hottest day ever recorded in Cape Town in March 2015, with a temperature of 42 degrees Celsius (Figure 18), (SAWS, 2015), as well as the longest and worst drought in living memory.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cape Town | Tue 14:09 | | 42 °C | Algiers | Tue 13:09 | | 19 °C | La Paz | Tue 08:09 | | 7 °C |
| Yangon | Tue 16:39 | | 36 °C | Harare | Tue 14:09 | | 19 °C | Berlin | Tue 13:09 | N/A | 6 °C |
| Dar es Salaam | Tue 15:09 | | 34 °C | Jerusalem | Tue 14:09 | | 19 °C | Belgrade | Tue 13:09 | | 6 °C |
| Bangkok | Tue 19:09 | | 32 °C | Lahore | Tue 17:09 | | 19 °C | Copenhagen | Tue 13:09 | | 6 °C |
| Accra | Tue 12:09 | | 31 °C | New Orleans | Tue 06:09 | | 19 °C | Paris | Tue 13:09 | | 6 °C |
| Manila | Tue 20:09 | | 30 °C | Addis Ababa | Tue 15:09 | | 18 °C | Prague | Tue 13:09 | | 6 °C |
| Kolkata | Tue 17:39 | | 30 °C | Adelaide * | Tue 22:39 | | 18 °C | Tokyo | Tue 21:09 | N/A | 6 °C |
| Singapore | Tue 20:09 | | 29 °C | Taipei | Tue 20:09 | | 18 °C | Dallas | Tue 06:09 | | 6 °C |
| Asuncion * | Tue 09:09 | | 28 °C | Athens | Tue 14:09 | | 17 °C | Almaty | Tue 18:09 | | 5 °C |
| Kinshasa | Tue 13:09 | | 28 °C | Beirut | Tue 14:09 | | 17 °C | Amsterdam | Tue 13:09 | | 5 °C |

**Figure 18:** In March 2015 the City of Cape Town experienced the hottest temperature ever recorded **(**SAWS, 2015).

The South African Weather Service (SAWS) has compiled a dataset of monthly average rainfall per province for all 9 provinces dating back to 1904. This dataset was analysed by the researcher Wolski (2018), who calculated the annual total rainfall (Jan - Dec) for South Africa over the 112 year period, from 1904 to 2015. The data analysed revealed that the annual average rainfall for South Africa, calculated over the full 112 years, is 608 mm (Wolski, 2018). It also indicated that the year with the lowest annual total rainfall since the year 1904 was 2015, with an annual total of only 403 mm (Wolski, 2018). Table 17 below shows the 13 years when the annual total rainfall for South Africa was below 500 mm.

**Table 17:** The years when the annual total rainfall for South Africa was below 500 mm (Wolski, 2018).

| Year | Annual Total Rain (mm) |
|---|---|
| 2015 | 403 |
| 1945 | 437 |
| 1992 | 440 |
| 2003 | 446 |
| 1935 | 451 |
| 1919 | 451 |
| 1965 | 452 |
| 1926 | 468 |
| 1916 | 476 |
| 1927 | 488 |
| 1912 | 493 |
| 1982 | 496 |
| 1941 | 496 |

Wolski's (2018) analysis of the long-term SAWS data means of the Western Cape Water Supply System (WCWSS) dam region (Figure 19) indicated that the period between 2015-2017 was the driest since 1933. He then translated this into a drought return period of once in 84 years, possibly rarer.

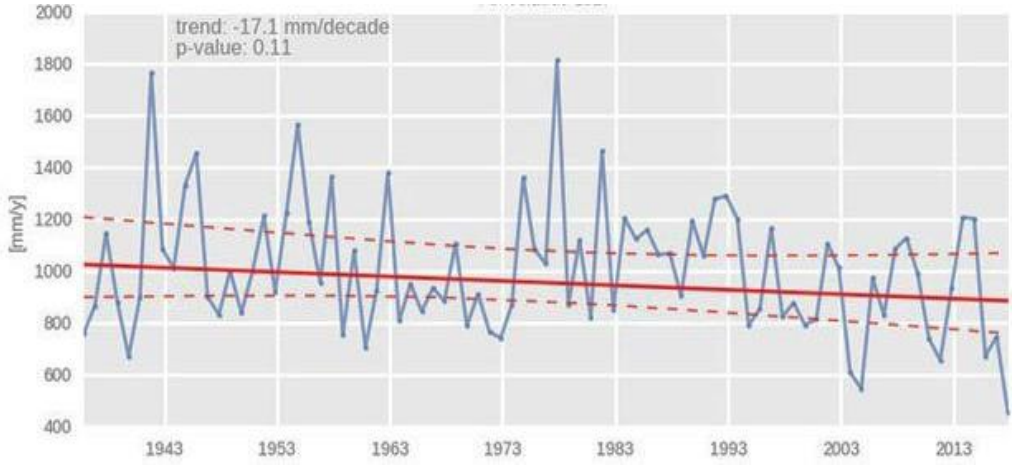


**Figure 19:** SAWS 1933 -2017 data of the running means of three stations in the WCWSS dam region (Wolski, 2018).

This analysis is further illustrated in the Figure 20 below. According to Wolski (2018), the distribution function that best fits the data is the Gamma distribution, as shown in the graph on the left. Estimates of return interval based on this distribution, fit those based on data and are illustrated by the agreement of the solid line and the data-based dots in the graph on the right in Figure 20 below (Wolski, 2018). The graph on the right is a Gumbel plot which shows observed data (markers) that are plotted in a way that takes into account the uncertainty of observations and the derived return interval (Wolski, 2018).

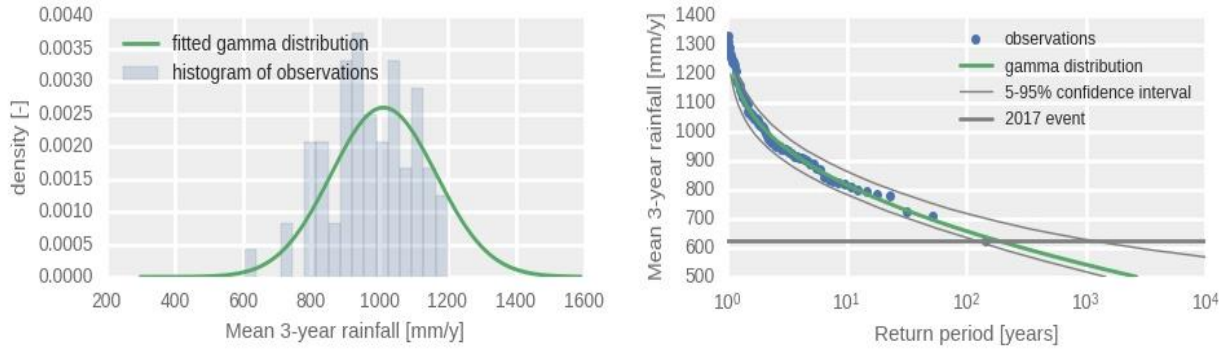


**Figure 20:** The SAWS Gamma distribution and Gumbel plot graphs of the means of three rainfall stations in the WCWSS dam region for the period 1933 – 2017 (Wolski, 2018).

The 90% confidence interval was plotted in the graph on the right by a stationary bootstrapping procedure in order for the confidence interval to account for the auto-correlation in data (Wolski, 2018).

Wolski (2018) concluded that his findings revealed that this kind of drought occurs once in 311 years, with 90% confidence limits that it falls between 105 and 1 280 years. He referred to the robustness of the data and confirmed that care was taken in the preparation of the dataset to find continuous, long-term data. By making use of the averages of several stations the chance of data errors were reduced (Wolski, 2018). Wolski (2018) however recognised that his results might have been influenced by the rainfall stations' representivity, differing observations or data errors that might have crept in.

The analyses results revealed that the drought between the years of 2015 - 2017 was very severe and rare, but likely less severe in the coastal plains and in Cape Town itself (Wolski, 2018). A possible reason for that might be a weaker penetration of cold fronts that bring winter rainfall to the region, into the higher and distant inland regions (Wolski, 2018).

### 4.3 Water Use Restrictions

During periods of severe drought the implementation of water restrictions are used by the CCT to reduce water consumption and wastage to a target of a certain set percentage. For example, in 2000 the Minister of Water Affairs and Forestry announced that due to the poor rainfall experienced during the winter season, level 1 water restrictions would be implemented by CCT at the end of 2000, aiming at a 10% reduction in water consumption (Kastrils, 2000). According to the CCT (2006), a 15.5% water usage reduction was achieved which was attributed to the large number of water users who changed their consumption habits. A comprehensive water demand analysis study, conducted by Jacobs *et al*. (2007), on the effectiveness of water restrictions within Cape Town during the 2004 and 2005 drought periods, showed that significant water savings were achieved, specifically within the residential water usage category.

According to the CCT (2018b) Water Outlook Report, due to severe drought conditions experience throughout the Cape Town region in 2015 to 2018, the CCT lifted its level 3 water restrictions (as at 2016) to level 6 restrictions which were enforced from 1 January 2018, and 6B from 1 February 2018 (Table 18). The urban water demand target was reduced to 450 million litres per day (MLD) (CCT, 2018b). This meant that more drastic measures were put in place requiring a demand curtailment of 45% for urban users.

**Table 18:** The different levels of water restrictions and their descriptions (CCT, 2018b).

| Water Restriction Level | Year Implemented | Description |
|---|---|---|
| Level 1 Restrictions | 2015 | To achieve a demand curtailment of 10% (standard restriction). |
| Level 2 Restrictions | 2016 | To achieve a demand curtailment of 20%. |
| Level 3 Restrictions | 2016 | To achieve a demand curtailment of 30%. |
| Level 4 Restrictions | 2017 | Allows for an urban demand of 600 million litres per day (MLD). |
| Level 5 Restrictions | 2017 | Allows for an urban demand of 500 million litres per day (MLD). |
| Level 6 and 6B Restrictions | 2018 | Allows for an urban demand of 450 million litres per day (MLD). Daily individual consumption must be limited to a maximum of 50 litres per day. |

This drought-induced shortage of water placed stress on the water supply and management within the CCT, resulting in the severe water crisis that culminated in 2017 to the beginning of 2018, and the consequent increasing of its water restrictions from level 2, 2015/16 to level 6 in 2017/18. This resulted in a dramatic drop in water demand within the CCT which prevented the dwindling water levels in the major storage dams from running empty (Figure 21). It was announced that the so called ‘Day Zero’ would be 12 April 2018 (Maxmen, 2018). The term ‘Day Zero’ became well known within this period and its meaning was commonly recognised as the point at which the dam levels would reach 13.5%. By reaching this dam level percentage, it meant that all taps in the city were required to be shut off and severe water rationing (25 litres) would have to be implemented (The Independent, 2018). The implications of this would have been that residents be placed in groups of 25,000 based on their location, and they would only receive water rations from one location out of two hundred water stations throughout the CCT.

During the summer of 2015, the peak water consumption in Cape Town was 1 200 MLD, whereas during the summer of 2015/16, when level 2 water restrictions were implemented, it reduced to a peak of 1 100 MLD (CCT, 2018b). Similarly, under level 3 water restrictions in 2016/17, a peak summer consumption of 900 MLD was achieved

(CCT, 2018b). Between the months of June to December 2017 the peak consumption was brought down even lower to 600 MLD, and at January 2018 the CCT achieved a reduced demand of 500 MLD under the level 6B water restrictions (CCT, 2018b) (Figure 21).

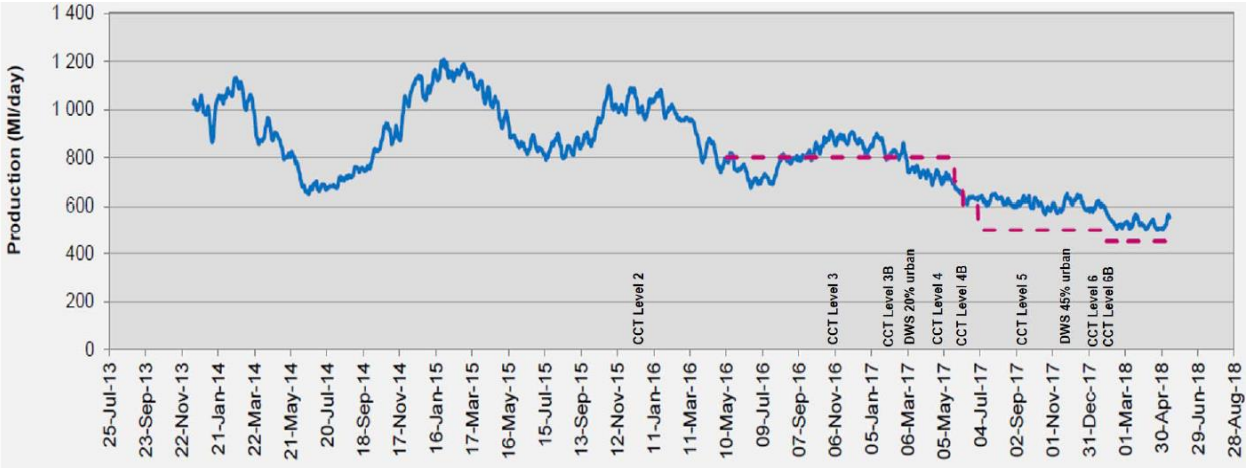


**Figure 21:** Water usage in the City of Cape Town has gradually decreased from the middle of March until present (CCT, 2018b)**.**

The CCT therefore effectively managed to reduce its water consumption by nearly half, from a billion litres a day to between 500 and 520 million. The goal was to reduce this figure even further to 450 million litres, to provide the best possible opportunity for the reservoirs to carry the CCT through the winter period.

### 4.3.1 Increased Water Tariffs

According to the CCT (2018b) Water Outlook Report, a reduction in water demand due to water restrictions imposed would result in reduced revenue streams for the municipality. The CCT therefore increased its water and sanitation tariffs to recover the anticipated loss in revenue. The revised tariffs resulted in a greater percentage increase in tariffs than the percentage reduction in demand (CCT, 2018b). Due to the tariff increases revenue needed to be recovered from a lower base, and the water saved during the restrictions was therefore sold at higher tariff rates within the middle to higher

step tariff blocks. The net effect of this was that high users of water had to save more water in order to keep their water accounts more or less the same as before the implementation of the level 2 restrictions, or they would have to pay considerably more for the same volume of water consumed (CCT, 2018b). Restriction tariffs are part of managing demand in times of drought. For many years, the City had 3 restriction levels, providing for a saving in consumption of 10%, 20% and 30% respectively (or Level 1, 2 & 3) (CCT, 2018b). In the 2017/18 budget process, the City added the Level 4 restriction tariffs to be introduced from 1 July 2017. At the time it was not foreseen that further restriction tariffs would be required. As the rainfall of 2017 was at a record low, further restriction tariffs were required and Level 5, 6 and 7 were introduced by Council at the end of January 2018 in line with a special directive from the Minister of Finance (CCT, 2018b).

When Level 4 was introduced from 1 July 2017, the first 6 kl was priced at a subsidised cost of R4 across all restriction levels (CCT, 2018b). Prior to this, all households received 6 kl at no cost. Now the average household of 4 should use no more than 6 kl, with the result of there being a deficit in higher step tariff income to subsidise the bulk of domestic consumption. The increase at levels 1-4 would have resulted in a far smaller shortfall if 2017 had seen average rainfall but the persistent drought resulted in structural changes to the tariff being urgently needed, specifically having the first step (0-6 kl) cost reflected (CCT, 2018b).

### 4.4 Mass Media Communication

The CCT launched numerous communication campaigns to assist people in reducing their consumption during the 2015 – 2018 drought period. The newly set level 6B restrictions were largely communicated by means of the media such as air (radio), social media (Twitter and Facebook), online communication (CCT website), printed media (newspapers, flyers, posters, and municipal water account inserts) (see Annexures I and J for an example of a newspaper clipping, media release and municipal water account insert used by the CCT). Some of the other communication

and awareness channels that were also used were road campaigns, call centres, and the direct engagement with certain key sectors and water users. The communication process was however curtailed to a certain degree due to some challenges, especially resulting from a lack of internal communication. The different departments, sub-departments and sections were not conveying the same information with the result of information reaching the communication channels containing different messages. One of these conflicting messages that were communicated by the CCT through the media was that if water users reduced their water consumption by 10% their accounts would stay the same. Account tariff calculation periods however changed to longer periods which were not explained to the water users and this resulted in creating confusion, misunderstanding and conflict between the CCT and its water users. At the initial stages of the level 2 implementation period high numbers of water users contacted the CCT's call centre to complain and question their water accounts, with the end result of creating an atmosphere of conflict and mistrust.

### 4.4.1 Social Media Example - Twitter

A study by Pettersson (2018) analysed a selection of Twitter hashtags in order to assess the influence of social media during the 2015 to 2018 Cape Town drought. Hashtags such as #CPTWaterCrisis, #CapeTownWaterCrisis, #WatershedWednesday, #CapeTownDrought, #DefeatDayZero, #50litreLife, and, #ThinkWaterCT were selected due to their common reference link to the term 'Day Zero' (Pettersson, 2018). An estimated total number of 260 tweets were selected for analysis by the author. These tweets often contained more than one of the above hashtags posted between the dates 29 Dec 2016 to 13 May 2018 (Pettersson, 2018). Table 19 indicates the frequency by which each of the hashtags occurred during Pettersson's research.

**Table 19:** The frequency of each of the hashtags during Pettersson's (2018) research.

| Hashtag | Number of times it occurred during Pettersson's research study |
|---|---|
| #DayZero | 159 |
| #CapeTownWaterCrisis | 57 |
| #CPTWaterCrisis | 23 |
| #CapeTownDrought | 22 |
| #50LitreLife | 12 |
| #DefeatDayZero | 10 |
| #ThinkWaterCT | 8 |
| #WatershedWednesday | 6 |

It was common to refer to the Cape Town drought as a crisis on social media platforms, and information and news were shared by the media as well as government actors through these platforms (Pettersson, 2018). One example which was picked up during the research analysis was that of Mmusi Maimane of the political party known as the Democratic Alliance, who has shared important information on the drought through five tweets (Pettersson, 2018). This is an example of the important role that social media can play as a communication platform between water users and government institutions during times of crisis.

### 4.4.2 Online Communication Example – The City Water Map

In order to facilitate behavioural change and to encourage water conservation, the CCT developed an online tool known as the City Water Map (Figure 22). This tool was introduced on the CCT's website in January 2018 at the height of the Cape Town drought crisis. The main purpose of the map was to normalise and incentivise water conservation behaviour through the public acknowledgement of households that saved water (CCT, 2018a).


**Figure 22:** The City of Cape Town's Water Map (CCT, 2018a).

The City Water Map visually marked properties with dark green and green dots that related to the water consumption on that property. This visual display of individual household water consumption was an effort to incentivise residents to keep within the allowed water use limits and to drive behaviour change.

### 4.4.3 Printed Communication Example - Municipal Water Account Inserts

Brick and Visser (2017) conducted a study to estimate the impact of an adapted awareness strategy implemented by the City of Cape Town between the periods of June 2014 to February 2017. Instead of using its usual water use reduction strategy consisting of printed material containing water conservation information, the City adapted the awareness strategy to a specific water user group, where an information insert was sent together with the water users' water accounts to specific water users with excessively high water demands. The awareness strategy only focused on high water users with water demands of greater than 50 kl. These water users are notoriously more resistant to the usual strategies such as water conservation awareness, physical restrictions and tariff hikes (Brick and Visser, 2017). The inserted material deviated from the usual water conservation information to a strategy where

messages comparing the specific user's water consumption to that of their neighbours, together with a punitive threat which cautioned against the specific water user's excessive and above-average water consumption, was implemented. The strategy therefore adapted its usual delivery methods from normal media messages and pamphlet distribution to that of direct postal message delivery with the water user's water account. It also adapted its messages to be more punitive in nature, focusing only on specific non-responsive water users.

The study results indicated that this adaptive water demand management strategy achieved a consistent average of 3% reduction in water consumption by these specific water users (Brick and Visser, 2017). The initiative therefore indicated an effective adaptive response to eliciting a group of households that were price insensitive and slow to respond to higher tariffs and physical restrictions (Brick and Visser, 2017). These results were realised against the backdrop of a severe drought period with the resultant implementation of increasingly stringent physical restrictions and high tariff hikes by the municipality. It can be concluded that the adaptation of conventional demand-side-management tools to suit specific conditions and parameters can have more effective water demand reduction results, particularly in a time of crisis (Brick and Visser, 2017).

## 4.5 City of Cape Town Survey Assessment

In order to assess communication and participation between the City of Cape Town and its residents, survey information was obtained from the CCT's Customer Satisfaction survey, as well as its Water Management Device Perception survey reports. The researcher of this thesis was also personally involved within the design, implementation, and analysis of the CCT's Customer Satisfaction survey, as part of a student and CCT agreement. It must be noted that the student was also an employee of the CCT at the time, and the CCT also financed the survey research. The student therefore did this research as part of the required academic purposes, as well as on behalf of the CCT.

The survey was however mainly structured according to the requirements of this thesis' research aim and objectives.

### 4.5.1 Water Management Device Survey

The CCT has been installing water flow regulation meters, commonly referred to as a water management device (WMD), on the properties of indigent households with high water account debts as part of its water demand management programme. During the 2015 - 2018 drought period, this programme was however revised to also include those non-indigent, high water usage households that have not reduced their water consumption. The device works by allocating a certain limited volume of water to a household per day. If this limit is reached on the specific day, the meter will restrict any further flow to that household until the next day when the new allocation for that day starts. As part of the programme, all account arrears were written off for households where the device were installed, and all leaks occurring on those properties were fixed at no cost to the owners before the device was installed. The city has installed nearly 300 000 of these water management devices over the past decade. The CCT has conducted a survey in 2016 that targeted the indigent households in order to assess the perception and attitudes of the residents on the device. Below are a few summarised results taken from the CCT (2016a) report on the results of the survey.

- **Communication, Consultation and Involvement in Decision Making**

The survey was conducted within selected indigent areas across four districts within the city, namely the South Peninsula, Helderberg-Khayelitsha-Mitchells Plain (80%), Northern, and Cape Flats districts. As part of the survey, a question was asked whether the residents' were made aware of the purpose of the water management device (WMD), its workings, as well as whether they were consulted and involved before its installation on their properties, or its set allocation of water per day.

Within the Cape Flats district specifically, 63% of the respondents indicated that, if given a choice, they would not have elected to have the WMD installed on their properties. Most of the respondents in Cape Flats (64%) were also of the perception that there was no adequate consultation before the installation of the WMD on their properties. The findings showed that across all four districts, 59% of respondents did not know about the WMD before its installation on their properties, and 41% were aware of the WMD before its installation (Figure 23). It can be observed that most of the respondents only became aware of the WMD as a result of its installation on their properties.

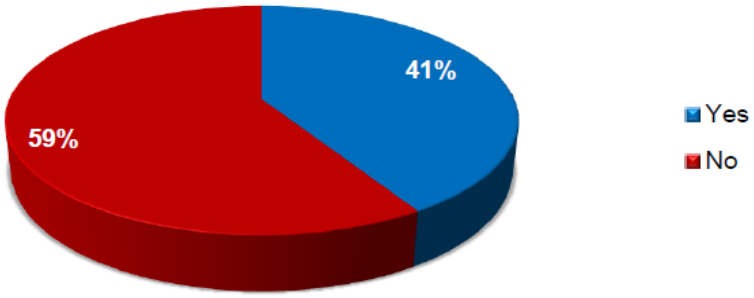


**Figure 23:** The residents' indication of awareness and consultation provided on the WMD before installations (CCT, 2016a)**.**

Across all of the districts, most of the respondents reported that they did not have any say on the volume of water allocated to them, or whether they agreed to the installation of the water management devices on their properties (Table 20).

**Table 20:** The say of residents on the amount of water delivered by the water management device (CCT, 2016a).

| District | Yes | No | Total |
|---|---|---|---|
| Cape Flats (n=230) | 28% | 72% | **100%** |
| Helderberg-Khayelitsha-Mitchells Plain (n=935) | 20% | 80% | **100%** |
| South Peninsula (n= 287) | 34% | 66% | **100%** |
| Northern (n=1 096) | 25% | 75% | **100%** |

These findings are an indication of the low level of awareness and participative consultation between the CCT and its residents, with a consequent low acceptance rate of the WMD in the Cape Flats district. These findings seems to suggest the need for adequate awareness, consultation and participation before the installation of the devices in this district if the level of acceptance is to be improved.

The residents were also asked to indicate their preference to the continuity of the water management device on their properties if they had a choice. It can be seen in Table 21 that the Cape Flats district once again had the lowest percentage (37%) of respondents indicating that they would like to continue with the programme.

**Table 21:** Consultation regarding the continuity of the water management device usage (CCT, 2016a).

| District | Yes | No | Total |
|---|---|---|---|
| Cape Flats (n=231) | 37% | 63% | **100%** |
| Helderberg-Khayelitsha-Mitchells Plain (n=935) | 76% | 24% | **100%** |
| South Peninsula (n= 287) | 60% | 40% | **100%** |
| Northern (n=1 097) | 63% | 37% | **100%** |

The results obtained indicates that there is limited knowledge or acceptance of the WMD in the Cape Flats area. This can be interpreted as the cause of the severe socio-institutional conflict relating to the WMDs within this area at the time.

The survey question was added to gauge the socio-institutional communication relating to the reporting of any challenges experienced with water allocation volumes, malfunctioning water management meters, or general enquiries, as well as the communication of the relevant contact details within the CCT departments. The findings revealed that 50% of the respondents knew where to find the relevant contact information, as well as which contact mechanisms to use for specific issues (Figure 24).

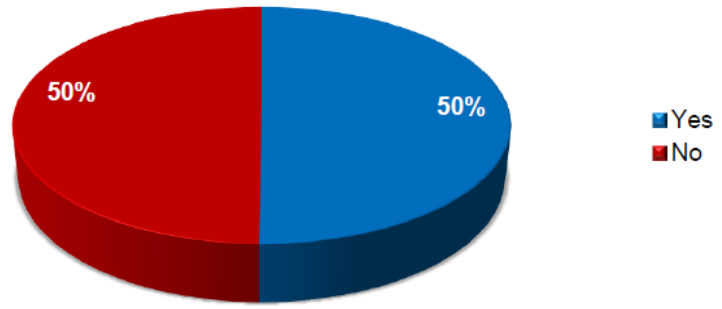


**Figure 24:** The awareness levels of residents relating to where problems and enquiries can be lodged (CCT, 2016a).

This finding is an indication of the lack of capacity of the CCT to understand the importance of effective and reachable awareness of communication channels, as well as making available proper and accessible communication channels to the public.

– **Perceptions Regarding Punitive and Restrictive Enforcement**

The survey required respondents to also indicate the extent to which they agree or disagree with the statement "I regard the WMD as a mechanism of restriction and punishment of households with water account arrears". The findings are illustrated in the table below. The findings indicated that within the Cape Flats (73%) and South Peninsula (58%) districts (Table 22), the respondents regarded the WMD as a mechanism of restriction and punishment due to high arrears on water accounts.

**Table 22:** Perception on whether or not WMD is a restrictive and punitive mechanism (CCT, 2016a).

| District | Agree | Neither agree nor disagree | Disagree | Total |
|---|---|---|---|---|
| Cape Flats (n=229) | 73% | 20% | 6% | **100%** |
| Helderberg-Khayelitsha-Mitchells Plain (n= 925) | 44% | 26% | 30% | **100%** |
| South Peninsula (n=284) | 58% | 32% | 10% | **100%** |
| Northern (n= 1 089) | 32% | 45% | 23% | **100%** |

This finding indicated that the respondents in these two districts felt that the WMD was specifically installed in their households simply because they had unpaid water accounts. This related once again to the CCT's lack of capacity to effectively communicate with residents and to involve them within the decision making process. This is also a huge factor when it comes to socio-institutional conflict with regards to the WMD, as the residents consider it an unequal process between the affluent and the indigent communities and therefore a type of discrimination, thereby turning it into a political issue.

### 4.5.2 Customer Satisfaction and Feedback Survey

Since 2002, the CCT's Water and Sanitation department has been commissioning research to determine their water users' needs, perceptions and satisfaction with its services. This information is crucial for the development of effective policies, strategies and initiatives. The main contact between a water provision institution and its water users is through a network of communication channels. The question however is whether these channels are effective in reaching the water users, or specific water user categories. Figure 25 depicts the main communication channel considerations for effective socio-institutional communication (CCT, 2016b).

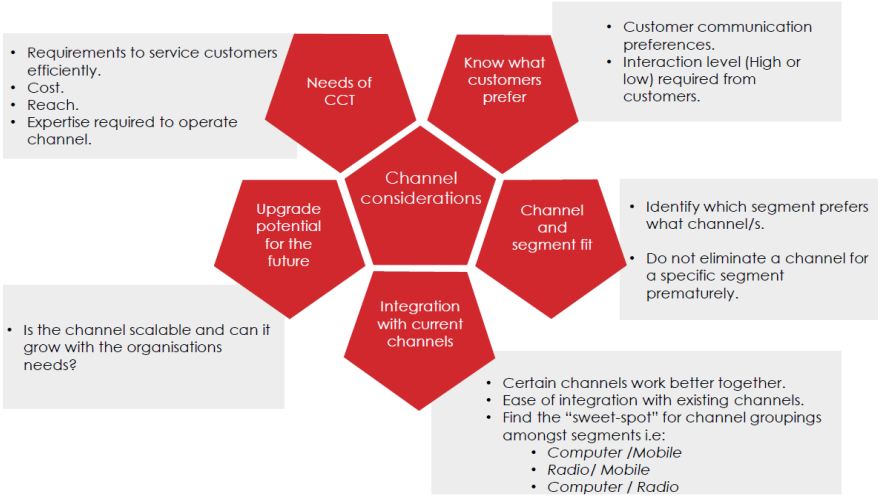


**Figure 25:** Adaptation within communication channels between consumers and City of Cape Town (CCT, 2016b).

The success of communication depends largely on how well matched the audience is to the communication channel (CCT, 2016b). The CCT's residents are on a spectrum of different segments or sectors that relates to economic status, main languages spoken, residential location, community crime levels and social issues, as well as cultural and political aspects. The ideal is to find an integrated and adaptive communication approach for each different water user sector and to optimise the complex socio-institutional processes between residents and the CCT.

A message targeted at a certain segment could have great effect but the same message could have no effect if targeted at a different segment. A "one size fits all" approach will therefore be ineffective and communication channels and messages should therefore be adapted to reach specific segments most effectively. With this in mind, the survey method included a stratified sampling approach, focusing on different administrative districts, income level and main languages spoken. Each suburb was randomly selected according to the income level, i.e. a single suburb per income level per district was selected in a random process using a random number generator.

By analysing the CCT's 2015/16 customer satisfaction and feedback survey, a general indication was provided on the level of satisfaction, trust and acceptance of the CCT's water resource management. It also provided an overview of level of social adaptive capacity within the CCT at the time of the survey. The number of positive responses to questions asking the water users about their knowledge of a specific subject, i.e., their awareness of prescribed allowable watering times or problem reporting contact channels, as well as their viewpoint pertaining to how they perceive the effectiveness of services, can provide a picture of the level of understanding as well as perceptions of the water users, which may be interpreted as their capacity to adapt to water management within the CCT. For instance, if a certain number of water users still do not know the allowable watering times after awareness has been raised, it can provide an indication of the numbers of water users that were unable to adapt to change against those that did have the capacity to do so. These figures also provided a good indication of the adaptive capacity levels amongst differing water user categories.

- **Socio-institutional Communication, Access and Understanding**

As part of the survey the residents were asked to indicate whether they were satisfied with the CCT's communication, as well as the different modes of communication channels used. As can be seen in Table 23 that the respondents within the informal category indicated a satisfaction level of only 54% with the CCT's communication strategies.

**Table 23:** The overall **s**atisfaction with the CCT's communication strategies (CCT, 2016b).

| Category | Rating | Discussion |
|---|---|---|
| Formal residential (n = 1287) | 88% | New Rest (Gugulethu) has the highest "poor" ratings. All low income suburbs had an increased number of negative ratings |
| Informal residential (n = 486) | 54% | Siyahlala-Du Noon has the highest number of "poor" ratings, although all the informal areas with the exception of Siyahlala-Langa have high (> 30%) "poor" ratings |
| Business (n = 307) | 99% | Only "Poor" ratings in Khayalitsha and Kuilsrivier |
| Average | 80% | |

The results show that the communication of the CCT with its informal water users is not that effective. This can be an indication of the CCT's lack of capacity to communicate information to the informal residents, or of their lack of providing communication in an accessible or understandable fashion. This can also be explained through the results on the modes of communication channels used. In many instances, the mode of communication used is not accessible to the residents, or cannot be understood due to language challenges (CCT, 2016b).

The respondents were asked through which modes they received communication from the CCT, and which of the listed options they would rather prefer (Figure 26).

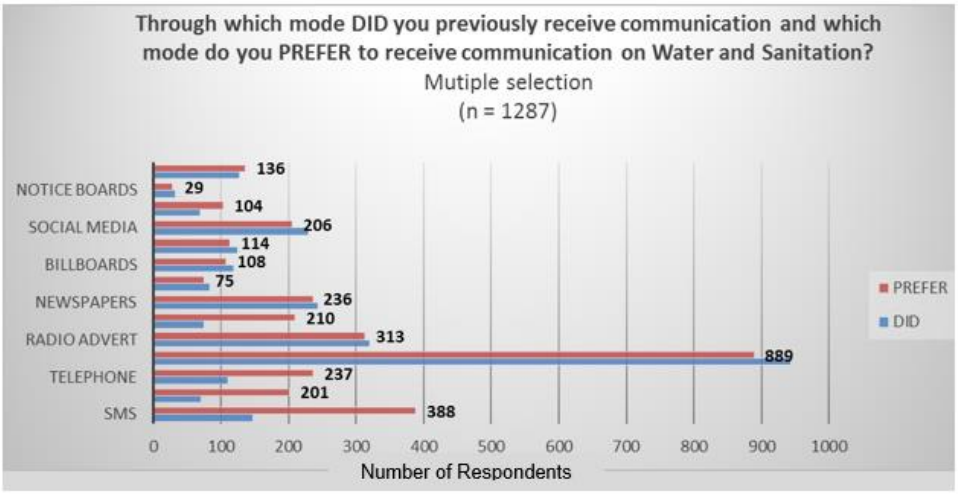


**Figure 26:** Preferred communication mode (per district) (CCT, 2016b).

The survey results revealed that the notice boards mode of communication displays the least difference between what the respondents prefer versus what has been used in the past. The communication modes of telephone, email and SMS display the largest difference between what the respondents prefer and how they have received communication in the past. Most respondents prefer their municipal account as the preferred communication channel, with SMS as the second highest preference. The least preferred communication channel is that of notice boards.

The area of Khayelitsha consists of suburbs as well as large informal areas, and very few respondents indicated that they preferred the use of telephone or email as communication channels (CCT, 2016b). The CCT is however promoting its call centre number as the main source of contact between itself and the residents within these areas. The use of this number is not free of charge and subjected to the costs of making a phone call, which is much higher in the case of costs associated with mobile phones. The above mentioned districts are characterised by suburbs and informal areas with very serious socio-economic challenges, and the residents often do not have the financial means available to make a call or to report water problems or issues experienced within these areas.

The respondents were asked whether they knew who to contact in the case of specific problems experienced. Within the CCT, all problems experienced with the water reticulation pipeline after the water meter and the meter itself should be reported to the CCT for repairs. Before the meter, however, on the water user's side; the water user is responsible for the costs of repairs and a relevant plumber should be contacted. This principle is however not understood by many residents within the CCT (Figure 27), resulting in contacting CCT for problems which should be at own cost. This may cause frustration and conflict when the problem is not being resolved through the means of contact.

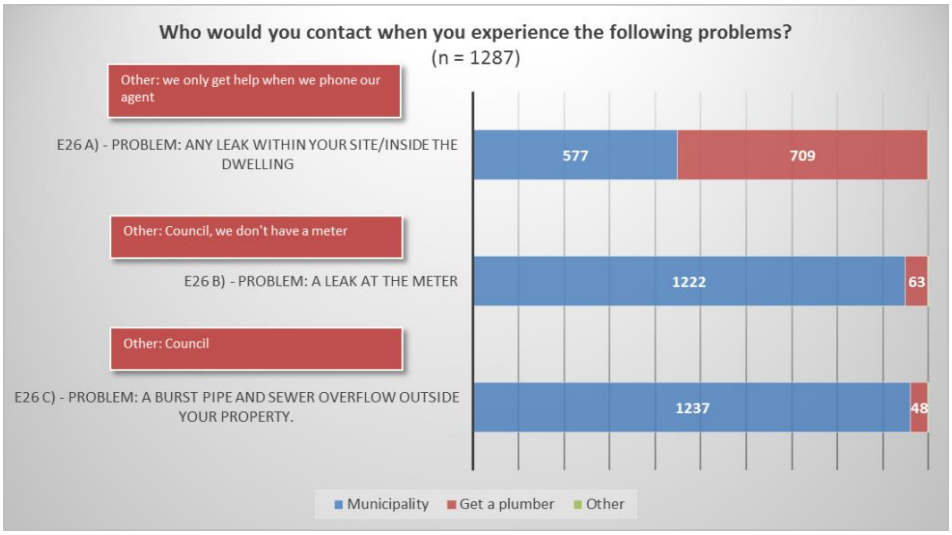


**Figure 27:** Relevant contact per problem (all districts) (CCT, 2016b).

The results indicated that most respondents will report a leak at the meter and outside the property to the municipality (95% and 96%), however 45% of respondents will report a leak inside the property to the municipality and 55% to a plumber. The district where the most respondents will report a leak on the property to the municipality was the South Peninsula. Reporting a leak at the meter to a plumber is the highest in the Klipfontein district. Respondents in Klipfontein will also report a burst pipe/sewer overflow to a plumber rather than the municipality (CCT, 2016b).

The respondents were also asked how they perceived the contact experience with CCT in an effort to assess the levels of conflict and acceptability among the CCT's residents. The aspects which the respondents gave the most negative responses to were 1) that the problem was not resolved in a reasonable time, and 2) that there was no follow-up to find out if the problem had been resolved. The respondents in the Tygerberg/Bellville and Cape Flats (Mitchells Plain) district, where large numbers of indigent residents reside, rated the contact more negatively than the other districts (CCT, 2016b).

- **Water Users' By-Law Obligations**

The results showed that 57% of the respondents were unaware of their obligations regarding the CCT's by-laws (Figure 28). The district with the highest amount of respondents who were aware of their obligations was the South Peninsula, which is a very affluent district. It was mostly the low income areas within the CCT, such as the Klipfontein area, which indicated a lack of awareness relating to their by-law obligations (CCT, 2016b).

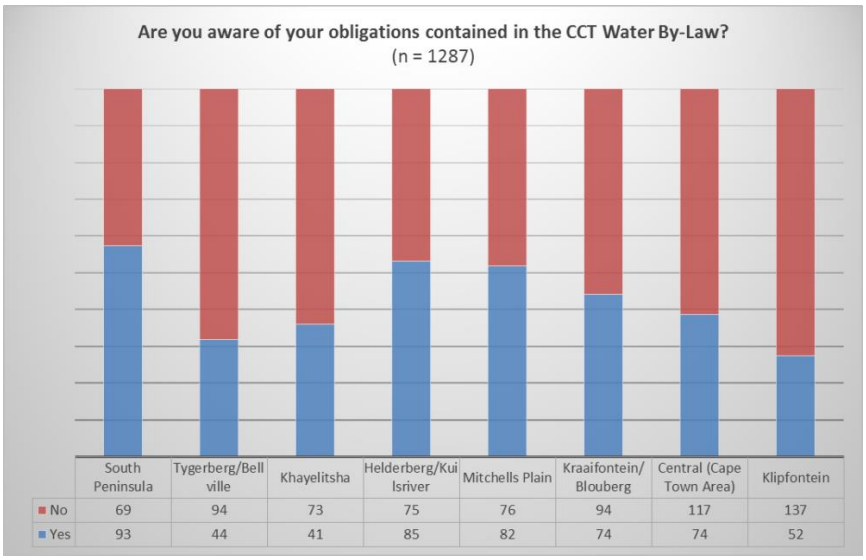


**Figure 28:** CCT By-law obligations (per district) (CCT, 2016b).

It is important that water users' awareness of the CCT's legislation is assessed. A lack of knowledge on legislation may cause unintentional water use transgressions and water wastage, which could have otherwise been avoided. A lack of awareness could also sprout out of a disinterest on the water users' side due to various perceptions such as the notion that by-laws are punitive and restrictive.

- **Feedback from Respondents**

The survey also included a section for the respondents' feedback within the questionnaires. The respondents were also asked to verbally state some general comments that they felt the CCT needed to hear. The main water user feedback results received during the survey are summarised in Table 24 below.

**Table 24:** The main feedback comments received from respondents during the Customer Satisfaction survey (CCT, 2016b).

| Main Comments as Received Across All Water User Sectors | Number of Comments |
|---|---|
| The CCT needs to listen to the needs of the community | 181 |
| Need more responsiveness and feedback from the CCT | 123 |
| Need more community meeting with, and visits from, the CCT | 75 |
| The CCT must adopt new technologies for better service delivery | 75 |
| The CCT's staff need to improve their competence and skills for better water user support | 71 |
| The CCT need to improve their advertising and marketing strategies | 44 |
| The residents need improved collaboration between the communities and the CCT | 43 |
| The CCT need to improve its service delivery | 42 |
| The CCT needs to use various forms of communication channels | 34 |
| There is a need for reliable community representatives from CCT | 29 |

It can be seen in Table 24 that the CCT's residents feel that the CCT does not consider their needs. The results indicated a clear desire for better two-way communication and collaboration between the CCT and its residents.

## 4.6 Case Study Analysis

In order to assist with the information obtained from the case study analysis, the data and information from the reviewed documents and surveys were coded into variable categories corresponding to the objectives of this research and analysed using the Microsoft Excel program. For each of the thesis objectives, the variables related to the objectives were compared and the results were descriptively indicated as either absent (−), partially or moderately present (0), fully present (+), or as insufficient information (?) as per Tables 25 to 29. Evidence of the results, as presented in the case study, is also set out within the Tables. Although a wide array of variable evidence might be found within the case study, only a few were abstracted and included within the Tables as part of the case study analysis.

**Table 25:** Presence of the variables relating to the objective parameter: implementation of adaptation theory within water demand management.

| Objective Parameter | Variable Category | Evidence | Assessment Result |
|---|---|---|---|
| To conduct a theoretical investigation into adaptation theory and its potential contribution towards an improved understanding of participative water demand management as an adaptive response.<br><br>Assess the influence of an **adaptive approach on the improvement and efficacy of water demand management** outcomes through a case study approach. | Adaptation within collaborative partnerships and learning. | Section 4.5.1, Table 20 indicates the results of the say of residents on the amount of water delivered by the water management device (WMD) (CCT, 2016a). The findings indicated a low level of awareness and a lack of participative consultation between the CCT and its residents, with a consequent low acceptance rate of the WMD in the Cape Flats district. This finding seems to suggest the need for adequate awareness, consultation and participation before the installation of the devices in this district if the level of acceptance is to be improved.<br>Table 21 indicates the results of the public consultation regarding the continuity of the water management device usage. It indicates that there is a very low knowledge capacity or acceptance of the WMD in the Cape Flats area, which indicates a lack of consultation and collaboration with the residents. This can be the cause of the severe socio-institutional conflict relating to the WMD experienced within this area at the time (CCT, 2016a).<br>Table 24 indicates the results of the main feedback comments received from respondents during the Customer Satisfaction survey (CCT, 2016b). It can | (-) |

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| | | be seen in Table 24 that the CCT's residents feel that the CCT does not consider their needs and expressed a clear desire for better communication and collaboration between the CCT and its residents. | |
| | Inclusion of both expert and local knowledge. | The Section 4.4.3 on a printed communication example of municipal water account inserts indicates the partial inclusion of expert knowledge in the CCT's water resource management initiatives. The results of the collaborative research study by the CCT and the researchers Brick and Visser (2017), indicated that the adaptation of conventional demand-side-management tools to suit specific conditions and parameters can have more effective water demand reduction results, particularly in a time of crisis. | (0) |
| | The CCT has the capacity to understand the different complex situations on the ground, and can adapt their initiatives to these conditions. | The results of Figure 24 and 26, which relates to preferred communication channels and the use of appropriate communication channels by the CCT, indicates the lack of capacity of the CCT to understand the importance of effective and reachable awareness of communication channels, as well as making available proper and accessible communication channels. The CCT seems to be unable to adapt its communication strategies to the complex situations experienced within different communities.<br>The findings in Table 22, which relates to the perception on whether or not the WMD is regarded by residents as a restrictive and punitive mechanism (CCT, 2016a), indicates the CCT's lack of capacity to effectively communicate with residents, to involve them within the decision making process and to adapt its initiatives to the needs of the community. | (-) |
| | The water users have the means and capacity to adapt to the CCT's initiatives. | Section 4.5.1, Table 22 which relates to the perception of residents on whether or not the WMD is a restrictive and punitive mechanism (CCT, 2016a), indicates their partial capacity to adapt to some of the CCT's initiatives. The Cape Flats district residents however regard the WMD as an unequal process between the affluent and the indigent communities and therefore a type of discrimination, thereby turning it into a political issue. | (0) |

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| | Public education and awareness programmes. | Section 4.4 on mass media communication indicates a high presence of education and awareness initiatives within the CCT's strategies. The CCT has launched numerous communication campaigns to assist people in reducing their consumption during the 2015-2018 drought period. The newly set level 6B restrictions were largely communicated by means of the media such as air (radio), social media (Twitter and Facebook), online communication (CCT website), printed media (newspapers, flyers, posters, and municipal water account inserts) (see Annexures I and J for an example of a newspaper clip, media release and municipal water account insert used by the CCT). Some of the other communication and awareness channels that were also used were road campaigns, call centres, and the direct engagement with certain key sectors and water users.<br>On page 120 it indicates that within the CCT's updated WC/WDM Strategy of 2015/2016, it is mentioned that one of the core functions of the CCT's Water Demand Management section is behavioural change in the form of education and awareness programmes. | (1) |
| | Information and knowledge are easily and equally accessible. | Figure 24 shows the results of the awareness levels of residents relating to where problems and enquiries can be lodged (CCT, 2016a). The findings revealed the lack of knowledge of residents relating to where to find the relevant contact information, as well as which contact mechanisms to use for specific issues This finding is an indication of the lack of capacity of the CCT to understand the importance of effective and reachable awareness of communication channels, as well as making available proper and accessible communication channels.<br>Table 23 which relates to the overall satisfaction with the CCT's communication strategies (CCT, 2016b), show that the communication of the CCT with its informal water users is not that effective. This can be an indication of the CCT's lack of capacity to communicate information to the informal residents, or of their lack of providing communication in an accessible fashion. This can also be explained through the results on the modes of communication channels used. In many instances, the mode of communication used is not accessible to the residents, or cannot be understood due to language challenges (CCT, 2016b). | (-) |
| | Information and knowledge are | Table 22, which indicates the results of perception levels on whether or not the WMD is a restrictive | (0) |

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| | communicated in an understandable manner. | and punitive mechanism (CCT, 2016a), indicate the partial understanding of some of the CCT's initiatives. Respondents within the Cape Flats and South Peninsula districts felt that the WMD was specifically installed in their households simply because they had unpaid water accounts. This is also a huge factor when it comes to socio-institutional conflict with regards to the WMD, as the residents consider it an unequal process between the affluent and the indigent communities and therefore a type of discrimination, thereby turning it into a political issue.<br>The results of Table 23, which relates to the overall satisfaction with the CCT's communication strategies (CCT, 2016b), indicates the partial effectiveness of communication strategies within the CCT. The Table shows that the communication with its informal water users is not that effective. This can be an indication of the CCT's lack of capacity to communicate information to the informal residents, or of their lack of providing communication in an accessible or understandable fashion. This can also be explained through the results on the modes of communication channels used. In many instances, the mode of communication used is not accessible to the residents, or cannot be understood due to language challenges (CCT, 2016b). | |
| | Knowledge and information systematically influence strategies, policy formulation or adjustment. | The last paragraph on page 120 indicates the lack of new knowledge and information within the CCT's strategies, policy formulation or adjustment. The paragraph states that within the CCT, water savings and losses due to large infrastructural initiatives are largely assessed and reviewed by means of quantitative calculations and projections. Very little consideration is however given to the qualitative, social impacts of water demand management initiatives. Water resource management strategies within the CCT is mostly polarised in nature with a main focus on large infrastructural projects which can supply all of its residents during periods of water stress (Cardin, 2013). The CCT has not considered the mid-to long term impacts of smaller, decentralised sources of water as well as the impacts of qualitative, social initiatives on water demand management within the CCT. | (-) |
| | Continuous learning and improvement. | Section 4.5.1 relating to the water management device survey, as well as section 4.5.2 on the customer satisfaction and feedback survey, indicates a partial willingness of the CCT to learn from its residents on whether their initiatives was | (0) |

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| | | successful, but improvement strategies are however questionable and limited.<br>Pages 120 and 121 indicates that the CCT is still struggling to learn from its mistakes and to improve its strategies. The last paragraph on page 120 indicates that within the CCT, water savings and losses due to large infrastructural initiatives are largely assessed and reviewed by means of quantitative calculations and projections. Very little consideration is however given to the qualitative, social impacts of water demand management initiatives. Water resource management strategies within the CCT is mostly polarised in nature with a main focus on large infrastructural projects which can supply all of its residents during periods of water stress (Cardin, 2013). | |
| | Collaborative links with stakeholders and other water institutions. | There seems to be a general lack of collaboration between the CCT and its stakeholders due to its large focus on education and awareness strategies only. In the second paragraph on page 120 it states that within the CCT's updated WC/WDM Strategy of 2015/2015, social participation, or the consideration of all the elements that can motivate or serve as barriers to the human component, is not included as part of its list of defensive strategies mentioned in the document. It is also mentioned in the Strategy that one of the core functions of the CCT's Water Demand Management section is behavioural change in the form of education and awareness programmes, which is a more bureaucratic management style according to the changing of attitudes, behaviour and choices model as identified by the author Shove (2010) as being a major challenge within water policies.<br>Another challenge is that the local governance is mostly working in a silo approach. The second paragraph on page 113 indicates that the Water Service Departments is only focused on the local legislation directly impacting on Water and Sanitation services. It is for this reason that the principles in essential environmental legislation, which is interlinked with water resource management, is ignored. In the last paragraph on page 113 it states that the authors Hiagh *et al*. (2010) observed that municipal officials tend to function within their directorates without sufficient cross-directorate interaction. | (-) |

Results of the implementation of adaptation theory within water demand management:

(-) = 5/10 = 50%

(0) = 4/10 = 40%

(1) = 1/10 = 10%

**Table 26:** Presence of the variable relating to the objective parameter: how water demand management can be more participatory and engaging with water users.

| Objective Parameter | Variable | Evidence | Assessment Result |
|---|---|---|---|
| To conduct a theoretical investigation into adaptation theory and its potential contribution towards an **improved understanding of participative water demand management as an adaptive response.** | Involvement of institutional actors in bottom-up decision making. | A challenge is that the local governance is mostly working in a silo approach. The second paragraph on page 113 indicates that the Water Service Departments is only focused on the local legislation directly impacting on Water and Sanitation services. It is for this reason that the principles in essential environmental legislation, which is interlinked with water resource management, is ignored. In the last paragraph on page 113 it states that the authors Hiagh *et al*. (2010) observed that municipal officials tend to function within their directorates without sufficient cross-directorate interaction. | (-) |
| | Involvement of communities in defining and executing initiatives. | Table 20 can also be used as an example to show the lack of involvement of residents in defining and executing the CCT's initiatives. The table indicates the lack of participative consultation between the CCT and its residents, with a consequent low acceptance rate of the WMD in the Cape Flats district. | (-) |
| | Frequent socio-institutional interaction, participation and collaboration at different levels. | Section 4.5.1, Table 20 indicates the results of the say of residents on the amount of water delivered by the WMD (CCT, 2016a). The findings indicated that only partial communication between the CCT and its residents is occurring, with no evidence of participation. This finding seems to suggest the need for adequate awareness, consultation and participation before the installation of the devices in this district if the level of acceptance is to be improved.<br>Table 24 indicates the results of the main feedback comments received from respondents during the Customer Satisfaction survey (CCT, 2016b). It can be seen in Table 24 that the CCT's residents feel that the CCT does not consider their needs and expressed a clear desire for better communication and collaboration between the CCT and its | (0) |

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| | | residents. | |
| | Legal provisions supporting social participation in policy development. | The last paragraph on page 119 indicates that, as per the goals in the WC/WDM Strategy as set out in Table 15, it is clear that the CCT's Water Demand Management section is implementing a policy which is in line with the widely accepted, but tunnel vision view, of the attitude, behaviour and choices (ABC) model, as described by the author Shove (2010), which is in contrast with the more progressive view as mentioned in national policy, such as the NWRSII (2013).<br>The second last paragraph on page 117 indicates that the CCT's by-laws are mostly imposed on its residents without much consultation or communication, and the successes achieved with these by-laws are therefore variable (Cardin, 2013). | (-) |
| | Involvement of residents/communities in formulation of rules that directly affect them. | The second last paragraph on page 117 indicates that the CCT's by-laws are mostly imposed on its residents without much consultation or communication, and the successes achieved with these by-laws are therefore variable (Cardin, 2013).<br>The second paragraph on page 115 states that within municipal water policy, challenges identified will usually be addressed by the political agenda, without consideration and participation from the society that it is impacting on (Cardin, 2013). The water policy and legislation is therefore developed by water authorities and politicians in response to perceived social issues, which in many cases is not the actual social issues experienced, or it may only touch on the depth of social issues experienced (Cardin, 2013). | (-) |
| | Initiatives by residents/communities for solving water demand management problems. | The second paragraph on page 115 states that within municipal water policy, challenges identified will usually be addressed by the political agenda, without consideration and participation from the society that it is impacting on (Cardin, 2013). The water policy and legislation is therefore developed by water authorities and politicians in response to perceived social issues, which in many cases is not the actual social issues experienced, or it may only touch on the depth of social issues experienced (Cardin, 2013).<br>The first paragraph on page 120 states that one of the main objectives of the CCT's water management policy is education and awareness. No mention is made of participation or any other strategies. Anything beyond that is not recognised at all within any of its policy and legislation documents. | (0) |

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| | Inclusion of residents in decision making process. | Section 4.5.1, Table 20 indicates the results of the say of residents on the amount of water delivered by the WMD (CCT, 2016a). The findings indicated that only partial communication between the CCT and its residents is occurring, with no evidence of participation within the decision making process. The second last paragraph on page 117 indicates that the CCT's by-laws are mostly imposed on its residents without much consultation or communication, and the successes achieved with these by-laws are therefore variable (Cardin, 2013). | (-) |

Results of how water demand management can be more participatory and engaging with water users:

(-) = 5/7 = 71%

(0) = 2/7 = 29%

(1) = 0/6 = 0%

**Table 27:** Presence of the variables relating to the objective parameter: socio-institutional complex systems approach.

| Objective Parameter | Variable | Evidence | Assessment Result |
|---|---|---|---|
| Understand the implications of a **complex systems approach** to socio-institutional adaptive capacity and its potential to increase and improve adaptive capacity.<br><br>Understand the **complex challenges and interactions between a public water management institution and society** within a large metropolitan city | Recognising the complexity of socio-institutional systems. | The last paragraph on page 119 indicates that, as per the goals in the WC/WDM Strategy as set out in Table 15, it is clear that the CCT's Water Demand Management section is implementing a policy which is in line with the widely accepted, but tunnel vision view, of the attitude, behaviour and choices (ABC) model, as described by the author Shove (2010), which is in contrast with the more progressive view as mentioned in national policy, such as the NWRSII (2013).<br>In the second paragraph on page 120 it states that within the CCT's updated WC/WDM Strategy of 2015/2016, social participation, or the consideration of all the elements that can motivate or serve as barriers to the human component, is not included as part of its list of defensive strategies mentioned in the document. It is also mentioned in the Strategy that one of the core functions of the CCT's Water Demand Management section is behavioural change in the form of education and awareness | (-) |

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|---|---|---|---|
| | | programmes, which is a more bureaucratic management style according to the changing of attitudes, behaviour and choices model, as identified by the author Shove (2010) as being a major challenge within water policies.<br>The second paragraph on page 120 states that the CCT is following a water resource management style that strictly follows the ABC model, with the changing of behaviours, attitudes and choices at the forefront. The citizens is seen as the problem, and if they can be changed the CCT's water conservation challenges can be alleviated. Other social, institutional, economic, and environmental aspects are completely ignored, such as failing infrastructure and governance methodologies, social values, norms and cultures, social traditions, politics, crime, education and employment challenges, as well as economic challenges. | |
| | Diversity of knowledge. | The last paragraph on page 120 indicates that, within the CCT, water savings and losses due to large infrastructural initiatives are largely assessed and reviewed by means of quantitative calculations and projections. Very little consideration is however given to the qualitative, social impacts of water demand management initiatives. Water resource management strategies within the CCT is mostly polarised in nature with a main focus on large infrastructural projects which can supply all of its residents during periods of water stress (Cardin, 2013). The CCT has not considered the mid-to long term impacts of smaller, decentralised sources of water, as well as the impacts of qualitative, social initiatives on water demand management within the CCT.<br>The second paragraph on page 120 states that the CCT is following a water resource management style that strictly follows the ABC model, with the changing of behaviours, attitudes and choices at the forefront. The citizens is seen as the problem, and if they can be changed the CCT's water conservation challenges can be alleviated. Other social, institutional, economic, and environmental aspects are completely ignored, such as failing infrastructure and governance methodologies, social values, norms and cultures, social traditions, politics, crime, education and employment challenges, as well as economic challenges. | (0) |
| | Full integration of water demand management | As per the goals in the WC/WDM Strategy as set out in Table 15, which only partially addresses water demand management issues, it is clear that the CCT's Water Demand Management section is | (0) |

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| | issues into water-related planning. | implementing a policy which is in line with the widely accepted, but tunnel vision view, of the attitude, behaviour and choices (ABC) model, as described by the author Shove (2010), which is in contrast with the more progressive view as mentioned in national policy, such as the NWRSII (2013), in which a wider range of factors that can influence society's water conservation efforts is recognised. | |
| | Horizontal and vertical integration. | The last paragraph on page 113 states that the authors Hiagh *et al.* (2010) observed that municipal officials tend to function within their directorates without sufficient cross-directorate interaction. The second paragraph on page 113 states that a challenge is that the local governance is mostly working in a silo approach.<br>In the second paragraph on page 115 it states that the South African national policy and legislative development is still following a linear model of policy development (Cardin, 2013). | (-) |
| | Frequent sectoral interaction and collaboration on water-related issues. | A challenge is that the Water Services Act (WSA) does not put emphasis on cooperative and participative governance strategies at local level (Toxopeüs, 2019). This is a flaw in the legislation of local governance as most municipalities are basing their governance regimes according to the principles set out in the legislation that is directly affecting their governance at local level.<br>The second paragraph on page 113 indicates that local governance is mostly working in a silo approach.<br>In the second paragraph on page 115 it states that the South African national policy and legislative development is still following a linear model of policy development (Cardin, 2013). | (0) |
| | Consensus resolution to social conflicts. | Table 22, which indicates the results of perception levels on whether or not the WMD is a restrictive and punitive mechanism (CCT, 2016a), shows that the respondents in these two districts felt that the WMD was specifically installed in their households simply because they had unpaid water accounts. This related once again to the CCT's lack of capacity to effectively communicate with residents and to involve them within the decision making process. This is also a huge factor when it comes to socio-institutional conflict with regards to the WMD, as the residents consider it an unequal process between the affluent and the indigent communities, and therefore a type of discrimination, thereby turning it into a political issue. In spite of this very | (-) |

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| | | little is done by the CCT to seek consensus resolution to this conflict. | |
| | Equal perception and behaviours across the high to low income levels. | Within section 4.5.1 and 4.5.2 the Tables 20 to 23, which indicates the survey results across the district, shows unequal perception and behaviours across the high to low income levels, with the Cape Flats district consisting mostly of very low income households, indicating very low levels of perceptions. | (-) |
| | High levels of socio-institutional conflict within certain categories. | Table 21 indicates the results of the public consultation regarding the continuity of the WMD usage. It indicates that there is a very low knowledge capacity or acceptance of the WMD in the Cape Flats area, which indicates a lack of consultation and collaboration with the residents. This can be the cause of the severe socio-institutional conflict relating to the WMD experienced within this area at the time (CCT, 2016a).<br>Section 4.5.1, Table 20 indicates the results of the say of residents on the amount of water delivered by the WMD (CCT, 2016a). The findings indicated a low level of awareness and a lack of participative consultation between the CCT and its residents, with a consequent low acceptance rate of the WMD in the Cape Flats district.<br>Table 22 which indicates the results of perception levels on whether or not WMD is a restrictive and punitive mechanism (CCT, 2016a), indicate that the respondents in these two districts felt that the WMD was specifically installed in their households simply because they had unpaid water accounts. This related once again to the CCT's lack of capacity to effectively communicate with residents and to involve them within the decision making process. This is also a huge factor when it comes to socio-institutional conflict with regards to the WMD, as the residents consider it an unequal process between the affluent and the indigent communities, and therefore a type of discrimination, thereby turning it into a political issue. | (-) |
| | Flexible system and adaptable procedures. | As per the goals in the WC/WDM Strategy as set out in Table 15, which only partially addresses water demand management issues, it is clear that the CCT's Water Demand Management section is implementing a policy which is in line with the widely accepted, but tunnel vision view, of the attitude, behaviour and choices (ABC) model as described by the author Shove (2010), which is in contrast with the more progressive view as | (-) |

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| | | mentioned in national policy, such as the NWRSII (2013), in which a wider range of factors that can influence society's water conservation efforts is recognised.<br>The last paragraph on page 120 indicates that within the CCT, water savings and losses due to large infrastructural initiatives are largely assessed and reviewed by means of quantitative calculations and projections. Very little consideration is however given to the qualitative, social impacts of water demand management initiatives. Water resource management strategies within the CCT is mostly polarised in nature, with a main focus on large infrastructural projects which can supply all of its residents during periods of water stress (Cardin, 2013). The CCT has not considered the mid-to long term impacts of smaller, decentralised sources of water, as well as the impacts of qualitative, social initiatives on water demand management within the CCT. | |
| | Strong interaction with outside world. | Table 13 shows the National Water Conservation / Water Demand Management Framework objectives. Its objective 8 ensures the promotion of international co-operation and participation with other South African countries, particularly basin-sharing countries, in developing joint WC/WDM strategies (DWA, 2000). This objective is however absent from the CCT's WC/WDM Strategy, as can be seen in Table 15 on page 118. | (-) |

Results of a socio-institutional complex systems approach:

(-) = 7/10 = 70%

(0) = 3/10 = 30%

(1) = 0/10 = 10%

**Table 28:** Presence of the variables related to the objective parameter: communication, knowledge and information sharing.

| Objective Parameter | Variable | Evidence | Assessment Result |
|---|---|---|---|
| Understand the **complex challenges and interactions between a public water management** | Involvement of diverse actors in research. | The Section 4.4.3 on a printed communication example of municipal water account inserts indicates the partial inclusion of expert knowledge in the CCT's water resource management initiatives. The results of the collaborative research study by | (0) |

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| **institution and society** within a large metropolitan city<br><br>• Collaborative knowledge production<br>• Diversity of knowledge<br>• Knowledge and information sharing<br>• Knowledge and information utilisation | | the CCT and the researchers Brick and Visser (2017), indicated that the adaptation of conventional demand-side-management tools to suit specific conditions and parameters can have more effective water demand reduction results, particularly in a time of crisis. | |
| | Inclusion of both local and expert knowledge. | The Section 4.4.3 on a printed communication example of municipal water account inserts indicates the partial inclusion of expert knowledge in the CCT's water resource management initiatives.<br>The results of the collaborative research study by the CCT and the researchers Brick and Visser (2017), indicated that the adaptation of conventional demand-side-management tools to suit specific conditions and parameters can have more effective water demand reduction results, particularly in a time of crisis. | (0) |
| | Multiple research disciplines and implementation. | Section 4.4 on printed communication and section 4.2.1 on Wolski's drought severity analysis serves as some examples of the partial presence of multiple research disciplines and implementation within the CCT's water resources management. | (0) |
| | Public awareness programmes that communicate water problems to government and social actors. | Within section 44, the presence of partial awareness programmes were indicated. An example of this is a study by Pettersson (2018) who analysed a selection of Twitter hashtags in order to assess the influence of social media during the 2015 to 2018 Cape Town drought.<br>One example which was picked up during the research analysis was that of Mmusi Maimane of the political party known as the Democratic Alliance, who has shared important information on the drought through five tweets (Pettersson, 2018). This is an example of the important role the social media can play as a communication platform between water users and government institutions during times of crisis. | (0) |
| | Information and knowledge are accessible and actively shared between government sectors and departments. | The last paragraph on page 120 indicates the lack of new knowledge and information within the CCT's strategies, policy formulation or adjustment.<br>The second paragraph on page 113 indicates that local governance is mostly working in a silo approach. Even if new information becomes available, it is not communicated between government sectors and departments. | (-) |
| | Information and knowledge are accessible to | The results of Table 23, which relates to the overall satisfaction with the CCT's communication strategies (CCT, 2016b), indicates the partial | (0) |

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|---|---|---|---|
| | society and actively disseminated to the public. | effectiveness of communication strategies within the CCT. The Table shows that the communication with its informal water users is not that effective. This can be an indication of the CCT's lack of capacity to communicate information to the informal residents, or of its lack of providing communication in an accessible or understandable fashion. This can also be explained through the results on the modes of communication channels used. In many instances, the mode of communication used is not accessible to the residents, or cannot be understood due to language challenges (CCT, 2016b). | |
| | Knowledge and information systematically influence decision-making, and policy formulation or adjustment. | The last paragraph on page 120 indicates the lack of new knowledge and information within the CCT's strategies, policy formulation or adjustment. The paragraph states that, within the CCT, water savings and losses due to large infrastructural initiatives are largely assessed and reviewed by means of quantitative calculations and projections. Very little consideration is however given to the qualitative, social impacts of water demand management initiatives. Water resource management strategies within the CCT is mostly polarised in nature with a main focus on large infrastructural projects which can supply all of its residents during periods of water stress (Cardin, 2013). The CCT has not considered the mid-to long term impacts of smaller, decentralised sources of water as well as the impacts of qualitative, social initiatives on water demand management within the CCT. | (-) |
| | Collaborative links with stakeholders. | Table 20 indicates the results of the say of residents on the amount of water delivered by the WMD (CCT, 2016a). The findings indicated that only partial communication between the CCT and its residents is occurring, with no evidence of collaboration between the CCT and its residents, with a consequent low acceptance rate of the WMD in the Cape Flats district.<br>Table 24 indicates the results of the main feedback comments received from respondents during the Customer Satisfaction survey (CCT, 2016b). It can be seen in Table 24 that the CCT's residents feel that the CCT does not consider their needs, and expressed a clear desire for better communication and collaboration between the CCT and its residents. | (0) |
| | Strong interaction with outside world. | Table 13 shows the National Water Conservation / Water Demand Management Framework objectives. Its objective 8 ensures the promotion of | (-) |

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| | | international co-operation and participation with other South African countries, particularly basin-sharing countries, in developing joint WC/WDM strategies (DWA, 2000). This objective is however absent from the CCT's WC/WDM Strategy, as can be seen in Table 15 on page 118. | |

The results of communication, knowledge and information sharing:

(-) = 3/9 = 33%

(0) = 6/9 = 67%

(1) = 0/9 = 0%

**Table 29:** Presence of the variables relating to policy development and implementation as part of socio-institutional adaptive capacity**.**

| Objective Parameter | Variable | Evidence | Assessment Result |
|---|---|---|---|
| Understand the implications of a complex systems approach to **socio-institutional adaptive capacity and its potential to increase and improve adaptive capacity** | Involvement of society in decision-making. | The second paragraph on page 113 states that the challenge is that the WSA does not put emphasis on cooperative and participative governance strategies at local level (Toxopeüs, 2019). This is a flaw in the legislation of local governance as most municipalities are basing their governance regimes according to the principles set out in the legislation that is directly affecting their governance at local level.<br>Table 20 indicates the results of the say of residents on the amount of water delivered by WMD (CCT, 2016a). The findings indicated that only partial communication between the CCT and its residents is occurring, with no evidence of participation within the decision making process.<br>The second last paragraph on page 117 indicates that the CCT's by-laws are mostly imposed on its residents, without much consultation or communication, and the successes achieved with these by-laws are therefore variable (Cardin, 2013). | (-) |
| | Involvement of diverse actors in defining and executing policy strategies. | The second paragraph on page 113 states that the WSA does not put emphasis on cooperative and participative governance strategies at local level (Toxopeüs, 2019). This is a flaw in the legislation of local governance, as most municipalities are basing their governance regimes according to the principles set out in the legislation that is directly affecting their governance at local level. | (-) |

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| | | As per the goals in the WC/WDM Strategy as set out in Table 15, it is clear that the CCT's Water Demand Management section is implementing a policy which is in line with public education and awareness only, and the presence of participation within policy formulation is mostly absent. | |
| | Legal provisions supporting public participation in policy formulation. | The second paragraph on page 113 states that the WSA does not put emphasis on cooperative and participative governance strategies at local level (Toxopeüs, 2019). This is a flaw in the legislation of local governance, as most municipalities are basing their governance regimes according to the principles set out in the legislation that is directly affecting their governance at local level.<br>As per the goals in the WC/WDM Strategy as set out in Table 15, it is clear that the CCT's Water Demand Management section is implementing a policy which is in line with public education and awareness only, and the presence of participation within policy formulation is mostly absent. | (-) |
| | Involvement of water users in formulation of strategies that directly affect them. | The second last paragraph on page 117 indicates that the CCT's by-laws are mostly imposed on its residents, without much consultation or communication, and the successes achieved with these by-laws are therefore variable (Cardin, 2013). | (-) |
| | Initiatives by water users for solving water demand management challenges. | This is only partially occurring within the CCT, as it is restricted to academic research initiatives only, which in itself is very limited. An example of this is the initiatives by researchers Brick and Visser (2017) as well as Wolski (2018), who participated in research initiatives and/or analysis in order to provide solutions to the water demand management challenges, as described in sections 4.2.1 and 4.4.3. | (0) |
| | Formation of a policy network beyond the formal structure. | As per the goals in the WC/WDM Strategy, as set out in Table 15, it is clear that the CCT's Water Demand Management section is implementing a policy which is in line with the widely accepted, but tunnel vision view, of the attitude, behaviour and choices (ABC) model, as described by the author Shove (2010). Its policy is lacking the more progressive view as mentioned in national policy, such as the NWRSII (2013), in which a wider range of factors that can influence society's water conservation efforts is recognised.<br>The last paragraph on page 120 indicates that within the CCT, water savings and losses due to large infrastructural initiatives are largely assessed | (-) |

| | | | |
|---|---|---|---|
| | | and reviewed by means of quantitative calculations and projections. Very little consideration is however given to the qualitative, social impacts of water demand management initiatives. Water resource management strategies within the CCT is mostly polarised in nature, with a main focus on large infrastructural projects which can supply all of its residents during periods of water stress (Cardin, 2013). The CCT has not considered the mid-to long term impacts of smaller, decentralised sources of water, as well as the impacts of qualitative, social initiatives on water demand management within the CCT. | |
| | Systematic integration of climate change in policies and planning. | As per the goals in the WC/WDM Strategy of 2007, as set out in Table 15, it is clear that the CCT's Water Demand Management section is not integrating climate change within its policy and planning. The recent drought event has however seen the partial incorporation of climate change within its policy updates such as the CCT's updated WC/WDM Strategy of 2015/2016. | (0) |
| | Planning and implementation of diverse solutions to specific challenges. | The last paragraph on page 120 indicates the lack of new knowledge and information within the CCT's strategies, policy formulation or adjustment. The paragraph states that within the CCT, water savings and losses due to large infrastructural initiatives are largely assessed and reviewed by means of quantitative calculations and projections. Very little consideration is however given to the qualitative, social impacts of water demand management initiatives. | (-) |
| | Development and execution of policy evaluation programmes that incorporate social feedbacks. | Table 24 indicates the results of the main feedback comments received from respondents during the Customer Satisfaction survey (CCT, 2016b). Section 4.5.1, relating to the water management device survey, as well as section 4.5.2 on the customer satisfaction and feedback survey, indicates a partial willingness of the CCT to learn from its residents on whether their initiatives was successful, but the implementation of improvement strategies is however still limited. | (0) |

The results of policy development and implementation as part of socio-institutional adaptive capacity:

(-) = 6/9 = 67%

(0) = 3/9 = 33%
(1) = 0/9 = 0%

According to the case study analysis results as indicated in Table 25, it can be concluded that there is a 50% absence of the implementation of adaptation theory within the CCT. Adaptation within collaborative partnerships and learning is mostly absent within the CCT's Water Demand Management section. The Department is mostly functioning within a silo approach, with inflexible, linear strategies. Table 25 also indicated an absence in the ease and accessibility of information and knowledge within certain areas of the CCT. Within the survey analysis, it became clear that the same messages are sent out to different water user groups (CCT, 2016a), and the messages are therefore not adapted to their specific target audiences, with the result of ineffective communication and low understanding or interest by water users. The results also indicated that adaptation within collaborative partnerships and learning seems to be absent from the CCT's management style. According to Table 25, the CCT does not seem to have the adaptive capacity to understand the different complex situations on the ground, and is also not able to adapt its initiatives to these conditions. A large percentage of residents were not sure about their responsibilities towards water issues versus that of the CCT (CCT, 2016b). There is also evidence of an enforced strategy, or a lack of communication and consultation, when it comes to the installation and implementation of the water management devices (CCT, 2016a). This has resulted in a negative perception of residents towards the initiative, as can be seen in the water management device survey results (CCT, 2016a.

The results of Table 25 also indicated the presence of partial adaptive management conditions in the CCT's water demand management section. The analysis indicated a 40% partial capacity to adapt to initiatives in high income areas though, as the communication delivery systems and language used is better received within these areas. The results of Table 23, which relates to the overall satisfaction with the CCT's communication strategies (CCT, 2016b), indicates the partial effectiveness of communication strategies within the CCT. The Table shows that the communication

with its informal water users is not that effective. This can be an indication of the CCT's lack of capacity to communicate information to the informal residents, or of their lack of providing communication in an accessible or understandable fashion. This can also be explained through the results on the modes of communication channels used. In many instances, the mode of communication used is not accessible to the residents, or cannot be understood due to language challenges (CCT, 2016b).

The results of Table 25 however indicated a 10% adaptive capacity when it comes to the implementation of education and awareness strategies. As per Section 4.4 on mass media communication, a high presence of education and awareness initiatives within the CCT's strategies are indicated. The CCT has launched numerous communication campaigns to assist people in reducing their consumption during the 2015 - 2018 drought period. The newly set level 6B restrictions were largely communicated by means of the media such as air (radio), social media (Twitter and Facebook), online communication (CCT website), printed media (newspapers, flyers, posters, and municipal water account inserts) (see Annexures I and J for an example of a newspaper clipping, media release and municipal water account insert used by the CCT). Some of the other communication and awareness channels that were also used were road campaigns, call centres, and the direct engagement with certain key sectors and water users. On page 120 it is indicated that, within the CCT's updated WC/WDM Strategy of 2015/2016, it is mentioned that one of the core functions of the CCT's Water Demand Management section is behavioural change in the form of education and awareness programmes. More progressive forms of communication such as collaboration and participation however seems to be absent in the CCT.

The results as shown in Table 26 indicated an absence of 71% when it comes to socio-institutional participation and engagement within the CCT. The last paragraph on page 119 indicates that, as per the goals in the WC/WDM Strategy as set out in Table 15, it is clear that the CCT's Water Demand Management section is implementing a policy which is in line with the widely accepted, but tunnel vision view, of the attitude, behaviour and choices (ABC) model, as described by Shove (2010), which is in contrast

with the more progressive view as mentioned in national policy, such as the NWRSII (2013). The second last paragraph on page 117 indicates that the CCT's by-laws are mostly imposed on its residents without much consultation or communication, and the successes achieved with these by-laws are therefore variable (Cardin, 2013).

Table 26 also indicated a partial socio-institutional collaboration of 29%, as per Section 4.5.1, Table 20, which indicated the results of the say of residents on the amount of water delivered by the WMD (CCT, 2016a). The findings indicated that only partial consultation between the CCT and its residents are occurring, with no evidence of participation. Some residents were consulted on the amount of water they would require relating to their household sizes, but this process was however ineffectively done, and on an ad-hock basis only. The collected information seems to have been disregarded in some cases, which nullified the purpose of the attempt made. This finding seems to suggest the need for adequate awareness, consultation and participation before the installation of the devices in this district if the level of acceptance is to be improved. Table 24 indicates the results of the main feedback comments received from respondents during the Customer Satisfaction survey (CCT, 2016b). It can be seen in Table 24 that the CCT's residents feel that the CCT does not consider their needs and expressed a clear desire for better communication and collaboration between the CCT and its residents.

As per the results of Table 27, there seems to be a 70% absence of the implementation of initiatives with the consideration of a complex systems approach. As per the goals in the WC/WDM Strategy, as set out in Table 15, it only partially addresses water demand management issues. It is clear that the CCT's Water Demand Management section is implementing a policy which is in line with the widely accepted, but tunnel vision view, of the attitude, behaviour and choices (ABC) model, as described by Shove (2010), which is in contrast with the more progressive view as mentioned in national policy, such as the NWRSII (2013), in which a wider range of factors that can influence society's water conservation efforts is recognised.

The last paragraph on page 120 indicates that, within the CCT, water savings and losses due to large infrastructural initiatives are largely assessed and reviewed by means of quantitative calculations and projections. Very little consideration is however given to the qualitative, social impacts of water demand management initiatives. Water resource management strategies within the CCT is mostly polarised in nature, with a main focus on large infrastructural projects which can supply all of its residents during periods of water stress (Cardin, 2013). The CCT has not considered the mid-to long term impacts of smaller, decentralised sources of water, as well as the impacts of qualitative, social initiatives on water demand management within the CCT.

Table 27 also revealed the unequal perception and difference in behaviours across the high to low income levels. The results revealed that the water user groups' differences and needs have largely been overlooked by the CCT's current water demand management implementation approaches, with a status quo on the 'one size fits all' approach. Table 27 also indicated an absence in the presence of a flexible system and adaptable procedures. The results of Table 21, relating to the consultation regarding the continuity of the WMD usage (CCT, 2016a), as well as that of Table 2 relating to the perception on whether or not the WMD is a restrictive and punitive mechanism (CCT, 2016a), indicated that there is a very low knowledge capacity or acceptance of the WMD in the Cape Flats area, which can be directly taken as the cause of the severe socio-institutional conflict relating to the WMD experienced within this area at the time. The case study analysis, as indicated in Table 27, indicated an absence in vertical and horizontal integration, and public participation is almost non-existent. The case study analysis indicated that the CCT's water department is largely managing water within a silo approach, which causes inevitable jurisdictional overlaps and inadequate coordination between the interconnected lines of functions. According to the results of Table 27, the CCT does not seem to have the capacity to understand the different complex situations on the ground, and is also not able to adapt its initiatives to these conditions.

Table 27 however also indicated a 30% partial presence of a complex systems approach. The CCT has made an attempt to implement education and awareness, as well as mass media campaign, initiatives within the CCT, but the challenge however is that the Water Services Act does not put emphasis on cooperative and participative governance strategies at local level, and socio-institutional collaboration and participation is therefore absent from the CCT's Water Demand Management section (Toxopeüs, 2019). This is a flaw in the legislation of local governance, as most municipalities are basing their governance regimes according to the principles set out in the legislation that is directly affecting their governance at local level. The second paragraph on page 113 indicates that local governance is mostly working in a silo approach. In the second paragraph on page 115 it states that the South African national policy and legislative development is still following a linear model of policy development (Cardin, 2013).

According to the results of Table 28, there is a 67% partial presence of communication, knowledge and information sharing, but it seems that it is not adapted to the different communities' conditions and needs. The Section 4.4.3 on a printed communication example of municipal water account inserts, indicates the partial inclusion of expert knowledge in the CCT's water resource management initiatives. The results of the collaborative research study by the CCT and the researchers Brick and Visser (2017), indicated that the adaptation of conventional demand-side-management tools to suit specific conditions and parameters can have more effective water demand reduction results, particularly in a time of crisis. Section 4.4 on printed communication, and section 4.2.1 on Wolski's drought severity analysis, serves as some examples of the partial presence of multiple research disciplines and implementation within the CCT's water resources management. The results of Table 23, which relates to the overall satisfaction of residents with the CCT's communication strategies (CCT, 2016b), indicates the partial effectiveness of communication strategies within the CCT. The Table shows that the communication with its informal water users is however not that effective. This can be an indication of the CCT's lack of capacity to communicate information to the informal residents, or of its lack of providing communication in an

accessible or understandable fashion. This can also be explained through the results on the modes of communication channels used. In many instances, the mode of communication used is not accessible to the residents, or cannot be understood due to language challenges (CCT, 2016b).

Table 28 however also indicated an absence of 33% when it comes to communication, knowledge and information sharing in the CCT. The last paragraph on page 120 indicates the lack of new knowledge and information within the CCT's strategies, policy formulation or adjustment. The second paragraph on page 113 indicates that local governance is mostly working in a silo approach. Even if new information becomes available, it is not communicated between government sectors and departments. The paragraph states that within the CCT, water savings and losses due to large infrastructural initiatives are largely assessed and reviewed by means of quantitative calculations and projections. Very little consideration is however given to the qualitative, social impacts of water demand management initiatives. The last paragraph on page 120 indicates that water resource management strategies within the CCT is mostly polarised in nature, with a main focus on large infrastructural projects which can supply all of its residents during periods of water stress (Cardin, 2013). The CCT has not considered the mid-to long term impacts of smaller, decentralised sources of water, as well as the impacts of qualitative, social initiatives on water demand management within the CCT.

Table 13 shows that objective 8 in the National Water Conservation / Water Demand Management Framework ensures the promotion of international co-operation and participation with other South African countries, particularly basin-sharing countries, in developing joint WC/WDM strategies (DWA, 2000). This objective is however absent from the CCT's WC/WDM Strategy, as can be seen in Table 15 on page 118. The survey results, as indicated in Figure 24, which indicated the main customer feedback comments results obtained from the customer satisfaction survey, showed that there was a strong desire of residents for community involvement and participation within the CCT's water initiatives (CCT, 2016b). The survey results revealed that knowledge and

information sharing within the lower income communities in the CCT also appears to be limited, as was seen in the results displayed in Tables 21, 22, 23, and Figure 28 in the two surveys conducted (CCT, 2016a; CCT, 2016b).

Whilst information concerning water restrictions, water conservation measures and the concept of ‘Day Zero’ was proactively and effectively shared with the public, the dissemination of other information, including contents of water policies, by-laws and water demand management initiatives such as the water management device, was rather poor. Respondents in the indigent areas such as Tygerberg/Bellville, Khayelitsha and Klipfontein districts indicated a higher level of negative responses than those within the other districts (CCT, 2016b). Some suburbs and areas within these districts are riddled with social issues such as poverty, illiteracy, unemployment, substance abuse and crime. The results indicated that there is a mismatch in communication between the CCT and the residents within these districts. The survey results showed that communication preferences differed between user groups or sectors, as was indicated in Table 23 and Figure 26 as part of the customer satisfaction and feedback survey results (CCT, 2016b). As indicated in Table 24, showing the results of the main feedback comments received from respondents during the customer satisfaction survey (CCT, 2016b), the survey respondents expressed their desire for the CCT to use various forms of communication channels. The results of the water management device survey revealed that some water demand management initiatives do not always reach all societal groups equally CCT (2016a).

The results of Table 29 indicates a 67% absence of the consideration of socio-institutional adaptive capacity within the policy development and implementation of the CCT. According to the results, as shown in Table 29, there is an absence of legal provisions supporting public participation in the CCT’s policy and legislation. Collaboration between the CCT and its water users have largely been overlooked within its policies, strategies and initiative implementation efforts. The second paragraph on page 113 states that the challenge is that the Water Services Act does not put emphasis on cooperative and participative governance strategies at local level

(Toxopeüs, 2019). This is a flaw in the legislation of local governance, as most municipalities are basing their governance regimes according to the principles set out in the legislation that is directly affecting their governance at local level.

The second last paragraph on page 117 indicates that the CCT's by-laws are mostly imposed on its residents, without much consultation or communication, and the successes achieved with these by-laws are therefore variable (Cardin, 2013). As per the goals in the WC/WDM Strategy, as set out in Table 15, it is clear that the CCT's Water Demand Management section is implementing a policy which is in line with public education and awareness only, and the presence of participation within policy formulation is mostly absent. The second last paragraph on page 117 indicates that the CCT's by-laws are mostly imposed on its residents, without much consultation or communication, and the successes achieved with these by-laws are therefore variable (Cardin, 2013). The last paragraph on page 120 indicates the lack of new knowledge and information within the CCT'S strategies, policy formulation or adjustment. The paragraph states that within the CCT, water savings and losses due to large infrastructural initiatives are largely assessed and reviewed by means of quantitative calculations and projections. Very little consideration is however given to the qualitative, social impacts of water demand management initiatives.

Table 29 indicated a partial presence of 33% when it comes to socio-institutional adaptive capacity within policy development and implementation. As per the goals in the WC/WDM Strategy of 2007, as set out in Table 15, it is clear that the CCT's Water Demand Management section is not integrating climate change within its policy and planning. The recent drought event has however seen the partial incorporation of climate change within its policy updates, such as the CCT's updated WC/WDM Strategy of 2015/2015. Table 24 indicates the results of the main feedback comments received from respondents during the Customer Satisfaction survey (CCT, 2016b). Section 4.5.1, relating to the water management device survey, as well as section 4.5.2 on the customer satisfaction and feedback survey, indicates a partial willingness of the CCT to learn from its residents on whether their initiatives was successful, but the

implementation of improvement strategies is however still limited. Initiatives by water users for solving water demand management challenges is only partially occurring within the CCT, as it is restricted to academic research initiatives only, which in itself is very limited. An example of this is the initiatives by researchers Brick and Visser (2017), as well as Wolski (2018), who participated in research initiatives and/or analysis in order to provide solutions to the water demand management challenges, as described in sections 4.2.1 and 4.4.3.

# 5. Case Study Results Discussion

The discussion of the case study results is structured along the four main objectives of this thesis as listed in Chapter 1.7. It includes a discussion of the thesis results and its relation to each of the objectives for a clearer understanding of how the objectives are informed and answered within the thesis.

– **Objective 1:** *"To conduct a theoretical investigation into adaptation theory and its potential contribution towards an improved understanding of participative water demand management as an adaptive response*".

According to the findings of the literature review, adaptive management is relevant where change is driven by increasing population densities, climate change and unprecedented development within urban settings (Arfanuzzaman and Rahman, 2017; Barnett and Adger, 2007; Mukheibir *et al*., 2015; Sadoff, *et al*., 2017; Wang *et al*., 2014; Wegelin, 2015). This change highlights the need for more inclusive and integrated institutional arrangements that support adaptive decision making. Giacomoni and Berglund (2015) indicated that adaptive water resource management can allow a system to cope more efficiently and sustainably with uncertainty. The theory suggests that adaptive water demand management is essential as the severity of the water scarcity conditions will constantly change (Folke *et al*., 2002). It also indicated that adaptive strategic planning may provide an institution with the ability to facilitate a systematic form for preparing for change in the future (Mayberry, 2015).

Within the literature review, some common challenges that can hinder adaptive management were identified by Allen and Gunderson (2011), such as 1) residents and stakeholders are not substantively included in the planning of new initiatives, 2) failures are disregarded and not embraced as a learning opportunities, 3) decision makers are too risk averse, 4) collaboration is defaulting to status quo formulas when facing uncertain challenges, 5) groups tend to exchange and deliberate rather than maintain action orientated, and 6) planning processes are too time-consuming or results are not

effectively enacted upon. These challenges are common within most municipalities, and should be taken into consideration for the successful and effective incorporation of adaptation within institutional strategies, policies and plans. According to the results of the analysis conducted by Giacomoni, (2012), adaptive demand management strategies can help water systems cope with increasing water stresses caused by challenges and change. The literature referred to the studies conducted by Georgakakos *et al*. (2011) and Westphal *et al.* (2003), which showed that adaptive management outperformed traditional pre-determined management strategies. Giacomoni and Berglund (2015) showed that adaptive demand management strategies can increase a water system's flexibility to cope with increasing stresses of population growth, droughts, and potential decreases in water availability due to climate change. It was also pointed out by the literature that the ability to implement effective water demand management strategies, institutional as well as water user capacity development is required.

There was clear evidence found in the literature that an improved understanding and learning through new knowledge gained, can increase adaptive capacity. The literature indicated that for a society to possess an improved capacity to adapt to water scarcity, there should be a relationship of socio-institutional communication, collaboration and participation. Socio-institutional participation requires the development or improvement of adaptive capacity on both sides (Eppel, 2009; Giacomoni and Berglund, 2015; Ostrom, 2005). In order to achieve this, a water services institution should build on its capacity to adapt its planning, strategies and methodologies to its water users' needs. So in other words, social and institutional adaptive capacity is heavily reliant on each other, and without the one the other cannot be achieved and vice versa. The theory indicated that water demand management policy and decisions are not independent, but are based on, and influenced by, the individual decisions of the water users as well as their capacity to adapt their behaviour to the conservation of water.

It was seen in the example of a large flood that occurred in Bear Creek, Colorado in the United States, the benefits of socio-institutional participation and capacity upliftment was demonstrated. The example showed that the empowerment of actors can provide

an enabling environment for cooperation, trust and learning. The Bear Creek Water Association authorities and stakeholders welcomed the collaboration, which seemed to have impacted on bringing forth a change in discussion focus and enabling alternative options that brought a shift towards improved socio-institutional relationships (Herzog, 2014). Gupta *et al*. (2010) indicated that by increasing the community's capacity to adapt through collaboration and participation, the basis for developing shared visions or objectives and gaining shared commitment to changed agendas can be created. Adaptive management should include collaborative theories where most stakeholders can participate in finding solutions for sustainable water demand management (Herzog, 2014).

The theory highlighted the need for an adaptive policy development design that involves people affected by policies in the policy formulation process (Eppel, 2009). Eppel (2009) indicated that the inclusion of water users and affected stakeholders in the design and implementation of policies and strategies tended to contribute to a higher awareness of the policy implications and outcomes, better policy understanding and improved and informed policy analysis. The literature pointed out that the inclusion of participatory strategies in policy formulation can enable a greater probability of these strategies being respected and enforced, which supports an environment within which institutions can thrive (Ostrom, 1990). As seen in the modification of Arnstein's ladder by Pröpper and Steenbeek's (1998, 1999), which indicates the different degrees of socio-institutional participation. The top of the ladder is defined as a socio-institutional participative relationship recognised by a 'facilitative' role where participation is initiated by the social actors, which is indicated as the most desirable form of participation (Ker Rault, 2008; Pröpper and Steenbeek, 1998, 1999; Van Ast and Boot, 2003). Water demand management, as part of a complex socio-institutional system, therefore calls for a socio-institutional participative approach (Shandas, *et al*., 2008).

As pointed out in the literature review, on the concept of transition management theory, a solution has to be found within a participatory process (Loorbach, 2007). As suggested under transition management theory, participation is not necessarily evenly

distributed, and most water users will have different preferences, and even a small group of water users will fail to identify a common goal that will be accepted by everybody (Loorbach, 2007). The literature suggested that the degree to which the water management institution promotes inclusive and discursive participation processes seems to be associated with its capacity to adapt a governance style to the context and issues at stake within different communities' unique circumstance (Ker Rault, 2008; Ridder *et al*., 2005). Through socio-institutional engagement, all the combined visions of the different water user groups can provide a basis to start from.

The literature pointed out that the good governance of water management addresses water security issues such as water availability, sustainability, human vulnerability, and human needs, through a coordinated and increasingly adaptive governance style (Bakker, 2003; Cook and Bakker, 2012). According to Cook and Bakker (2012) adaptive governance is a promising strategy for water resource management. It was also seen that socio-institutional collaboration can broaden the adaptive capacity of governance systems, which will bring about greater resilience (Pahl-Wostl, 2006). It was suggested by Cook and Bakker (2012), that through the involvement of society in water resource management, new and innovative management and governance ideas that challenge bureaucratic management styles can be created. Ker Rault (2008) argue that social participation in water resources management is more a socio-political issue rather than a technical one.

Good governance ensures the minimisation of corruption, the consideration of minority views, and that "*the voices of the most vulnerable in society are heard in decision-making*" (Cook and Bakker, 2012:98). According to Cook and Bakker (2012), water security is however partly threatened by conflicting political agendas. Allan (2000:184) pointed out that the political environment constrains the water resource management environment so "*that there is a distinct difference between what should be done to manage resources sustainably, and what can be done to manage those resources sustainably*". Political buy-in is therefore extremely important before water resource management policies can become viable. Patch (2010) indicated that there is a need for

strong municipal leadership as well as horizontal and vertical collaboration with other water management organizations for more effective water demand management outcomes. Ker Rault (2008) and Motion (2005) stated that the disillusion in democratic governance and participative approaches can generate conflicts due to socio-institutional manipulation, misunderstanding, and the disregard of alternative opinions. The political component of local government has the power of "*initiating and overseeing the executive actions of officials appointed to act on its behalf in terms of discharging its governmental responsibilities*" (Thornhill, 2014:58), which according to De Visser (2010), undermines the institutional integrity of government.

As part of the literature, the concept of a complex systems approach to socio-institutional adaptive capacity was investigated, as per objective 3 of chapter 1.7 of this thesis:

- **Objective 2:** *"To understand the implications of a complex systems approach to socio-institutional adaptive capacity and its potential to increase and improve adaptive capacity*".

The results of the literature review supports the notion of a socio-institutional complex systems theory and indicated that such an approach would facilitate adaptation. The United Nations Educational, Scientific and Cultural Organization (UNESCO) advocates a systems approach to water security, which involves the protection of vulnerable water systems against water related risks such as floods and droughts, sustainable development and access to safe water services (UNESCO, 2009). Partnerships, collaboration and interactions between society and water institutions are components within a whole system, and a change or impact on one will affect the other as well as all its interlinked components (Pahl-Wostl *et al*., 2013). Saleth and Dinar (2005) viewed weakness in institutional governance systems as the cause of degradation of social trust and cooperation resulting in the failure to ensure long-term water security. The literature suggested that most institutions lack an understanding and knowledge about complex inter-dependencies between social and institutional systems, and solutions to

challenges are therefore reduced to being of a technical nature only (Pahl-Wostl *et al*., 2013).

According to the literature, a socio-institutional approach can be an important tool to raise an understanding of complexity, emergence, and uncertainty. An increased focus on water as a paradigmatic social-institutional system may shift focus on the resilience of such systems and the necessity for adaptive management. Pahl-Wostl *et al*. (2013) stated that such a reframing towards a systemic perspective is essential for adaptive water resources management and to ensure long-term water sustainability. Theory suggests that socio-institutional complexity results in feedback loops, some positive and some negative. There is consequently an intimate linkage between the policy-making environment and the broader socio-economic setting in which it is embedded (Turton, 2002a). Turton (2002a) indicated that the linkage between poverty and second-order resource scarcity is a fundamental one that needs to be taken cognizance of if WDM policies are to be effective.

The analytical paper of Turton (2002a) showed that as a result of the dynamics of complexity, the management of water demand consists of a series of oscillations between first and second-order resource focal points. It was shown that WDM represents yet another layer of management that is superimposed onto an already overburdened set of water management institutions, thereby creating an increased complexity over time. Davis and Sumara (2008:50) states that "*complexity science is argued to compel a different sort of positioning, one that requires accommodation and participation rather than problematised assimilation and application*". The theory suggested that what is required is a model that considers linkages that interconnect with the social and institutional aspects across multiple system levels.

The literature also touched on the panarchy model, which is a good example of a model that describes the theory of complex system dynamics which includes the adaptive cycle (Holling and Gunderson, 2002). The model describes how institutional transformation can be achieved through attributes such as novelty, diversity, human

capital and diversity (level of education, expertise, and occupations), social trust, strengths, variety in institutions, and cross-scale communication, all within the panarchy and between other systems elsewhere. The literature indicated that in order to meet increasing water resource management challenges, there needs to be a paradigm shift towards management strategies that increase urban water system resilience, interventions that considers the entire urban water cycle, re-assess water use and water recycling efficiency strategies, and that involves greater application of natural water purification and recycling systems (Vairavamoorthy *et al*., 2015). It was seen that a paradigm shift firstly involves all the learning processes, which have to start at the level of mental models (Pahl-Wostl *et al*., 2006). A critical reflection on paradigms is therefore needed, as well as their impacts on actors, the problem domain, and current and future uncertainties. A paradigm of new water management approaches should be based on sound and unbiased debates.

According to Turton (2016), technical ingenuity is mostly linked with government, and is therefore distanced from the level of society and the individual. A paradigm shift is needed from large infrastructural projects to a more decentralised approach. The author Hallegate (2009) is of the view that large infrastructural projects are largely irreversible and once constructed an infrastructural “lock-in” occurs. As stated by Pahl-Wostl *et al*., 2006:11), “*a paradigm shift in water management from a prediction and control to a management as learning approach*” is needed. The literature suggested that in order to deal with these challenges, a paradigm shift towards adaptive management and stakeholder participation (Merrey, 2008), social learning (Warner, 2007), and an emphasis on social culture and ethics (Daniels and Endfield, 2009), is needed.

A paradigm shift that considers adaptive water resources management, complex systems analysis as well as a reliance on social participatory processes and stakeholder involvement is necessary in order to manage water resources sustainably over the long term and under increasing unpredictability (Hashemi, 2012). The theory around the transition management model was also discussed in the literature review. It indicated that the model can be used as a strategy for new types of interaction and

cycles of learning. Transition management views the interaction between all relevant actors on different societal levels as a means of social change within the context of a changing societal landscape (Loorbach, 2007). The theory suggested that transition management has the power to steer water demand management towards an improved sustainability path. The goal of transition management is to enable, facilitate, and steer social and technical transformations towards sustainability (Kemp and Loorbach, 2003). Transition management theory considers a societal system as a starting point for analysis (Djalante and Djalante, 2012). It is a model that considers the social dimension as whole systems, as well as the complexity within such systems, and the transition management theory is therefore considered as being better able to address the complex challenges relating to the multiple levels and dimensions present within water resource management in developing countries (Djalante and Djalante, 2012).

As part of the literature, the results of some case study examples were discussed. This speaks to objective 3 of chapter 1.7 of this thesis:

- **Objective 3:** *"To assess the influence of an adaptive approach on the improvement and efficacy of water demand management outcomes through a case study approach*".

It was seen in the case example of adaptive water resource management, where participative water demand management was implemented in the City of Santiago, Chile, that water savings option contracts can be used as a socio-institutional participative water demand management initiative that can be effective (Meza *et al*., 2014). This method considers the distinct and differentiated levels of water security within the city, and then by reallocating water rights among these levels of users. "*Allocation mechanisms can be designed as tools to reallocate water from those who have a lower willingness to pay to those that require higher levels of water security*", which is an effective method of combining the components of both proactive and reactive adaptation measures, and that can therefore be a viable tool for socio-

institutional water demand management adaptation within complex systems (MacAlister and Subramanyam, 2018:253).

Another example which was also discussed within the literature review was the case of socio-institutional participatory water management by the residents of the informal settlement located in Diepsloot, South Africa. The case study results showed that the project has improved the quality of life for the community through a considerable improvement in water quality and runoff at the research sites (Fitchett, 2017). Apart from this, the additional benefits of improved social cohesion, learning and adaptive capacity building were achieved (Fitchett, 2017). The research on the project found that through intensive engagement and participation, the residents portrayed attitudes of high commitment to the project (Fitchett, 2017; Harrison *et al*., 2014). The project is an example of the viability of adaptive initiatives within urban areas (Fitchett, 2017). The case study results proved that a firm relationship with the community can be established through participative engagement, which provides a platform for adaptive capacity building, trust and project success (Fitchett, 2017).

The City of Cape Town's case study section added to an improved understanding of the complex socio-institutional interactions and challenges within a large metropolitan municipality, as per objective 4 of chapter 1.7 of this thesis:

- **Objective 4:** "*To understand the complex interactions and challenges between a public water management institution and society within a large metropolitan city*".

Institutional fragmentation was identified by Biesbroek *et al.* (2011) as one of the seven barriers to adaptive water resource management. Hiagh *et al*. (2010) observed that municipal officials tend to function within their directorates without sufficient cross-directorate interaction. The case study policy and legislation analysis revealed that this is also a barrier in South African legislation and administration, both internally and externally. The South African national policy and legislative development is still following a linear model of policy development (Cardin, 2013). Social and stakeholder challenges

identified according to political and institutional perspectives will usually be addressed by the agenda without consideration and participation from the society that it is impacting on (Cardin, 2013). South African water policy and legislation was therefore developed by water authorities and politicians in response to perceived social issues which in many cases is not the actual social issues experienced, or it may only touch on the social issues experienced (Cardin, 2013).

Apart from a focus on the development of new water supply systems, which has so far dominated the water sector in South Africa, there is however an increasing interest within different water sectors to switch to a water conservation and demand management approach, as is required by the new National Water Act (NWA, 1998). This constitutes a change in the water resources sector in South Africa, from a supply driven sector to an emerging phase of water demand management. The water resources policy changes in South Africa are therefore leading towards an adaptive phase. Water demand management is slowly but surely creeping into South African policy and strategy development, and there is an overall acceptance of the concept and an understanding that the effective implementation of such strategies will be crucial in determining whether or not South Africa will be able to adapt to increasing water scarcity and crisis. This progressive change has however not yet seeped down to the policy and legislation at local government level, including that of the CCT.

The case study results indicated that the conditions for adaptive management are only partially present in the CCT's water demand management section. The case study analysis, as indicated in Table 27, indicated an absence in vertical and horizontal integration, and public participation is almost non-existent. Knowledge and information is shared among the actors, but lacks adaptability towards the unique situations among specific community groups. The results indicated that the policy development does not make provision for the thorough addressing of uncertainties, socio-institutional participation, mechanisms for evaluating policy effectiveness, and the incorporation of feedbacks for future improvement. It can therefore be argued that the prospects for adaptive water management in the CCT are still limited.

The case study analysis indicated that the CCT's water department is largely managing water within a silo approach, which causes inevitable jurisdictional overlaps and inadequate coordination between the interconnected lines of functions. Water management in the CCT is managed through a rather complex web of legislation in a silo dominated management environment. This silo management approach along autonomous line functions leads to fragmented policies. An assessment of the CCT's Water Services Development Plan (WSDP) (2017) revealed that it does not recognise the complex interactions of societal systems. It neglects a deeper understanding between the interactive links of institutional management and the social aspects. There is a lack of understanding on how water management functions translates to social well-being. Within the CCT's strategies, there is little emphasis on the complicated social aspects of water resources management. Awareness initiatives and communication drives in general do not consider the different socio-economic, cultural, and language differences between users. A 'one size fits all' approach has been dominant within its communication strategies. The same messages are sent out to different water user groups, and messages are therefore not adapted to their specific target audiences with the result of ineffective communication and low understanding or interest by water users.

According to Table 25 of the case study analysis section, adaptation within collaborative partnerships and learning seems to be absent from the CCT's management style. The CCT's Water and Sanitation Departments are also only focused on the local legislation directly impacting on Water and Sanitation services, and in the process, other important departmental policy and legislation is excluded. It is for this reason that the principles in essential environmental legislation, which are interlinked with water resource management, are ignored by the CCT's main water policies (NEMA, 1998; Toxopeüs, 2019). As also revealed during the CCT's policy and legislative analysis, it does not put any emphasis on cooperative and participative governance strategies at local level (Toxopeüs, 2019). This is a flaw in the legislation of local governance, as most municipalities are basing their governance regimes according to the principles set out in the legislation that is directly affecting their governance at local level.

According to the results of the case study, it can be deducted that the intensive public awareness campaign on the water restrictions during the 2015 - 2018 drought had a positive impact on the behaviour of the CCT's residents. Although the CCT has also put in place certain by-laws in order to provide regulation of the use of water resources, it was mostly imposed on its residents without much consultation or communication with them, and the successes achieved with these by-laws are therefore variable (Cardin, 2013). The case study results indicated that the strategies implemented mostly consisted of severe water restrictions, increased water tariffs, punitive measure for high water users, and the increase in water management device installations, which restrict water supplies to individual households. As per the goals in the WC/WDM Strategy (2007), as set out in Table 15 in the case study, it is clear that the CCT's Water Demand Management section is implementing a policy which is in line with the widely accepted, but tunnel vision view, of the attitude, behaviour and choices (ABC) model, as described by Shove (2010), which is in contrast with the more progressive view of the NWRSII (2013), in which a wider range of factors that can influence society's water conservation efforts were recognised. The case study policy analysis therefore identified a clear break in the linkage between national and local policy and legislation.

Within the CCT's updated WC/WDM Strategy of 2015/2016, social participation, or the consideration of all the elements that can motivate or serve as barriers to the human component, were not included as part of its list of defensive strategies mentioned in the document (CCT, 2014). It was also mentioned in the Strategy that one of the core functions of the CCT's Water Demand Management section is behavioural change in the form of education and awareness programmes, which is a more bureaucratic management style according to the changing of attitudes, behaviour and choices model, as identified in the literature by Shove (2010) as being a major challenge within water policies. Within the CCT's water demand management implementation processes, this factor has been influential in the failure of some of its initiatives. This relates to its main recognised implementation strategy of education and awareness, or as can be put in other terms, a command and control strategy.

According to the results as shown in Table 29 of the case study analysis, there is an absence in legal provisions supporting public participation in the CCT's policy and legislation. Within the City of Cape Town's Water Services Development Plan (WSDP) of 2017/18, it was seen that no mention was made of any public participation initiatives, except the thirty day required public participation process as part of the development of the Plan, where the public can provide their inputs on the strategy (WSDP, 2017). The main emphasis is once again on a command and control strategy, with a strict implementation of the ABC model. The public is being controlled by reducing their water supply through the installation of water management devices, forcing them to use less water. They are being told that they must change their behaviours, attitude and choices, and education and awareness is the main strategy mentioned within the document in an attempt to achieve this. This indicates a water resource management style that strictly follows the ABC model, with the changing of behaviours, attitudes and choices at the forefront. The citizens are seen as the problem, and if they can be changed the CCT's water conservation challenges can be alleviated. Other social, institutional, economic, and environmental aspects are completely ignored, such as failing infrastructure and governance methodologies, social values, norms and cultures, social traditions, politics, crime, education and employment challenges, as well as economic challenges. According to Shove (2010), relevant societal change is that in which currently acknowledged rules of the game are eroded, in which the status quo is called into question and in which more sustainable governance relating to routines, forms of knowledge, conventions, and expectations takes hold across all domains of daily life. These aspects can have an interlinked and combined impact on water consumption.

The literature showed that within South African water resources policies and strategies, there are overlapping functions and unclear mandates which can potentially lead to a lack of accountability, duplication of service and an ineffective delivery of services. Policy formation should include all aspects of a complex, adaptive and integrated water resource management system. The authors Cook and Bakker (2012) concluded that a broad, integrative framing favours water security as it brings good governance issues to the fore, which is also a central aspect of integrated water resource management. The

Organisation for Economic Co-operation and Development (OECD) recognised that integrated water resource management cannot be properly implemented without considering a broader governance framework (OECD, 2011). This should include measures for governing scientific, educational, and technological issues, as well as communication and participation (Carr *et al.,* 2012; Delli Priscoli, 2004).

The analysis of the CCT's policies and strategies indicated that the CCT strictly regulates its data information to external stakeholders, as well as internally between departments, sub-departments and sections. This causes a fragmented understanding by stakeholders, information gaps and a lack of integration. According to the CCT's WC/WDM Strategy of 2007, as well as its updated WC/WDM Strategy of 2015/16, the available information that drives decision making is mostly consisting of quantifiable variables such as volumes of water saved, number of pipe leakages repaired, water restrictions imposed, amongst others (CCT, 2007; CCT, 2015), instead of a combined qualitative and quantitative approach where indicators such as water user satisfaction, stakeholder inputs and conflict resolution are considered within the system as a whole. As clearly indicated in the CCT's Water Services Development Plan of 2017/18, the water demand management implementation strategies of the CCT are mostly focused on massive, centralised infrastructure, single sources of design and power delivery (WSDP, 2017). Decentralised alternative water resource systems are only promoted, and the direct involvement of the CCT with such initiatives are therefore limited.

The case study results showed that the CCT was able to effectively reduce its water consumption, thereby delaying the expected 'Day Zero' to 2019/20 (CCT, 2018b). This achievement seemed to have resulted from water demand management strategies that included heavy water restrictions, increased water tariffs, as well as heavy news media coverage, amongst others. These solutions were therefore heavily based on an enforcement, punitive and restrictive strategy, together with a communication approach that has set the stage for social alarm and anxiety. Although effective in the short term to avert crisis, these strategies are not a long-term solution to the problem.

The mass communication which raised the social alarm caused heavy negative socio-economic impacts for the CCT. There was a huge economic loss of revenue generated from tourism due to the avoidance by local and international tourists of the area. Many large income generating industries that were relying on water as part of their production operations, closed down or moved their industry locations to other areas within South Africa. An example of this was the Coca Cola Canners' operations which closed down due to the heavy water restrictions and high water tariffs, as well as the media communication of the imminent 'Day Zero', and the consequences for a company relying on water as part of the main ingredient of their products.

Another strategy implemented by the CCT was to publicly display the water consumption details of large water users, as was seen in Figure 22 showing the CCT's Water Map, which was effective to a certain degree in reducing water consumption during the critical drought period. This strategy consisted of the CCT publicly releasing the addresses of the top one hundred highest water users as part of a naming and shaming strategy to curtail water consumption. This strategy is however not ideal, as it could have also adversely affected the socio-institutional trust relationship, and could have damaged the long-term perceptions and attitudes of residents towards the CCT. This type of enforced strategy can therefore not be considered as being a sustainable solution over the long-term, as it can lead to increased future conflicts between the residents and the municipality, thereby impacting negatively on initiative acceptance and ultimate success rates. According to the literature, trust within communities of interests are the pre-conditions for collective system management and a greater system resilience (Campbell and Sacchetti, 2017).

The survey results revealed that the CCT's socio-institutional dimension consists out of complex relationships that are mixed, and that causes different forms of interaction and transition. This was also evident in the literature that spoke about the concept of transition management theory, which advocates the involvement of a wide selection of participants within processes (Djalante and Djalante, 2012); Foxon *et al*., 2008; Meadowcroft, 2009; Rotmans, *et al,* 2001). The survey results, as indicated in Figure

24, which indicated the results of the main customer feedback comments obtained from the customer satisfaction survey, showed that there was a strong desire amongst residents for community involvement and participation within the CCT's water initiatives (CCT, 2016b). Respondents requested more open meetings that included the residents within a community, and not just the community leaders and representatives. The customer satisfaction and feedback survey results also revealed that the CCT's water conservation awareness and communication strategies are mostly linear in nature, with similar awareness initiatives and communication messages conducted across the different user categories (CCT, 2016b), irrespective of income category, cultures, politics, livelihoods, occupancy numbers, or geographic location This uni-lateral communication strategy is problematic as, although similar messages might be translated into different languages, the message and delivery methods may not be received where the communication channel is not available, or where the message is not understood or ill received due to social challenges such as illiteracy, crime or poverty.

The survey results revealed that knowledge and information sharing within the lower income communities in the CCT also appears to be limited, as was seen in the results displayed in Tables 21, 22, 23, and Figure 28 in the two surveys conducted (CCT, 2016a; CCT, 2016b). Also, the outreach of project-specific public disclosures seems to be limited. Whilst information concerning water restrictions, water conservation measures and the concept of 'Day Zero' was proactively and effectively shared with the public, the dissemination of other information, including contents of water policies, by-laws and water demand management initiatives such as the water management device, was rather poor. Respondents in the indigent areas such as Tygerberg/Bellville, Khayelitsha and Klipfontein districts indicated a higher level of negative responses than those within the other districts (CCT, 2016b). Some suburbs and areas within these districts are riddled with social issues such as poverty, illiteracy, unemployment, substance abuse and crime. The results indicated that there is a mismatch in communication between the CCT and the residents within these districts. This might be an indication of the CCT's messages not being constructed and delivered with its

audience in mind, the lack of the CCT to communicate, contact or providing water conservation messages within these areas, or it may indicate a lack of social capacity within these districts. The CCT should therefore closely investigate the reason for this and adapt its communication strategies accordingly.

Across all sectors, there was a high level of frustration with information communicated by the CCT. A large percentage of residents were not sure about their responsibilities regarding water issues versus that of the CCT (CCT, 2016b). There is also evidence of an enforced strategy, or a lack of communication and consultation, when it comes to the installation and implementation of the water management devices (CCT, 2016a). This has resulted in a negative perception of residents towards the initiative, as can be seen in the water management device survey results (CCT, 2016a. This scenario can only create a socio-institutional conflict situation, and a resultant failure of this water savings initiative.

The survey results showed that communication preferences differed between user groups or sectors, as was indicated in Table 23 and Figure 26 as part of the customer satisfaction and feedback survey results (CCT, 2016b). The CCT therefore needs to understand the need for ‘multi-channel hopping’ to meet the differing requirements between different water user groups, and the need to adapt communication channel usage to these groups or communities. As indicated in Table 24, indicating the results of the main feedback comments received from respondents during the customer satisfaction survey (CCT, 2016b), the survey respondents expressed the desire for the CCT to use various forms of communication channels. By ignoring these differences the different water user groups cannot effectively receive the messages, and can therefore not understand or ‘learn’ about water conservation, and will therefore lack the capacity to accept water conservation or other demand management initiatives within their areas.

Table 25 of the case study analysis section indicated an absence in the ease and accessibility of information and knowledge within certain areas of the CCT. Within the survey analysis, it became clear that the same messages are sent out to different water

user groups (CCT, 2016a), and the messages are therefore not adapted to their specific target audiences with the result of ineffective communication and low understanding or interest by water users. According to the literature review, the process of collaborative partnership should include effective social communication principles, such as messages developed with the targeted water user groups in mind (Brown, 2011). Socio-institutional collaboration and learning is required in order to adapt conservation awareness and communication messages to different water use groups or categories. According to Pahl-Wostl (2006), increasing socio-institutional collaboration can broaden the adaptive capacity of governance systems which will bring about greater resilience. (Rec. 2) By involving social participation in water management, new and innovative management and governance ideas that challenge bureaucratic management styles can be created (Cook and Bakker, 2012; Ison and Watson, 2007; Mostert *et al*., 2007; Pahl-Wostl *et al*., 2007).

The results of the water management device survey revealed that some water demand management initiatives do not always reach all groups in society equally (CCT, 2016a). With the water management device initiative, the main focus is to mechanically limit or restrict certain chosen residents' access to water supply CCT (2016a), whereas other members of society have access to unlimited water supplies. The CCT's water demand management initiatives largely involves the enforcement of restrictive water demand practices on the poorer communities which are struggling to financially keep up with steep water prices. This can directly affect the socio-institutional system which, as a result, becomes subjected to socio-institutional conflict, communication breakdown, community despondency, and a lack of trust and acceptance of water demand initiatives, amongst others. Water demand management processes can therefore directly affect the socio-institutional processes necessary to ensure successful water security.

According to Table 25 in the case study analysis section, the CCT does not seem to have the capacity to understand the different complex situations on the ground, and is also not able to adapt its initiatives to these conditions. As indicated in the literature,

transitions toward sustainability do not depend on policy makers merely persuading the public to make sacrifices or educating them on how to achieve this, but rather on the recognition of a holistic and integrated social view. Given that the ABC model is the dominant paradigm in the CCT's water policies, the scope of relevant social science is typically restricted to that which is theoretically consistent with it.

According to Shove (2010) social science would be that which engages with problems, like those of understanding the details of path-dependence, the temporal and spatial and configuration of innovation junctions, or the potential for modulating and aligning the elements of social practice (De Wit, Rip 2006; Shove, 2010; Van den Ende *et al*., 2002). Efforts to draw generic behavioural conclusions would be largely immaterial, as they fail to capture the vital processes of social change (Shove, 2010). Within the CCT, water savings and losses due to large infrastructural initiatives are largely assessed and reviewed by means of quantitative calculations and projections. Very little consideration is however given to the qualitative, social impacts of water demand management initiatives. Water resource management strategies within the CCT is mostly polarised in nature with a main focus on large infrastructural projects which can supply all of its residents during periods of water stress (Cardin, 2013).

## 6. Conclusions

The literature is proposing adaptive management as a tool to ensure sustainable water resource management within a changing and uncertain future. It is suggested that ‘business as usual’ will be unsustainable when considering current change relating to population increases and climatic changes, amongst others, and new, innovative solutions, that are adapted to these changing conditions, will be necessary in order to mitigate future water related disasters and conflicts. The literature indicates that, when applied to water demand management, adaptive management can build on effectiveness and efficiency with increased benefits, such as increased water provision and demand sustainability, as well as an improved social acceptability and service delivery. The literature indicates that growing water demand and threats derived from variability and change will make it increasingly important for water institutions to develop the required skills to manage conflicts over decreasing water resources. They need to adapt their strategies to consider society and institutions as whole systems with different interacting components. By disseminating the information obtained in the literature, it is clear that a change is needed towards adaptive water demand management initiatives that considers whole systems thinking, variability, societal impacts and sustainability.

Central to adaptive water demand management is the improvement of knowledge generation strategies. This will stimulate the development of sustainable and effective water demand management policies and encourage the cascading and adaptation of these policies to different social settings. The literature suggests that in developing adaptive capacities, the wide involvement of water users, stakeholders and institutions is critical. The theory suggested that social perceptions can lead to interpretations that may give rise to the acceptance, or rejection, of water demand management strategies and initiatives. The literature indicated that experience has shown that new adaptive approaches such as participative water demand management can be used in order to achieve an increased social adaptive capacity through changed perceptions and behaviour in adapting to change. Through an adaptive strategy such as participation, a platform can be created whereby a water management institution and its water users

can share information and new knowledge that can facilitate a positive change in perceptions, thereby achieving an improved understanding between both actors.

Socio-institutional participation within water demand management initiatives and decision making can contribute to building trust, thereby improving a shared understanding of the management issues at stake and an increased socio-institutional adaptive capacity (Fitchett, 2017). The theory suggested that participation is an effective way to extend networks of socio-institutional trust (Campbell and Sacchetti, 2017). Cooperation, coordination and trust within the water sector, as well as beyond, is crucial when prioritising options for adaptation (Stuart-Hill, 2015). An adaptive water demand management strategy which includes participation may therefore contribute to improved acceptance, success, effectiveness and sustainability of initiatives and an enhanced quality of decision-making. For water institutions to respond to change they will however have to deal with obstacles through building adaptive capacity. The results obtained during this thesis demonstrated the importance of adaptive strategies, such as participative water demand management, in the face of major challenges relating to the high inter-connectedness and complexity of water demand management systems, as well as external complexity and change.

The theory indicated that an inadequate participatory water demand management approach can affect the legitimacy of water demand management initiatives and reduce the societal acceptance of these interventions. Water demand management occurs within a socio-institutional network in which all actors feel the changes to management decisions. It was seen that adaptive strategic planning should build on the knowledge obtained from a complex socio-institutional systems approach. It should establish the basis for collaborative actions, long-term vision, socio-economic challenges and impacts, and the identification of critical challenges, all within a socio-institutional systems approach. Adaptation within this network includes the fostering of collaboration, communication, partnership and shared knowledge, thereby increasing the systems' ability to cope with water scarcity, change and variability. This would create flexible

water demand management initiatives that are integrated and multi-dimensional, capable of meeting the water demands of the future.

The literature review reflected critically on the positive and negative outcomes of current institutional governance approaches, and how challenges to water security reflect the expanding complexity of challenges and increasing uncertainty within water demand management. The literature identified some complex challenges within water demand management that can limit socio-institutional adaptive capacity, such as a dominant focus on technical water demand management solutions, a silo approach, a lack of effective policy implementation, minimal social participation, political influences, ineffective communication strategies, and a lack of horizontal and vertical integration, amongst others. Adapting to change and uncertainty will require the strengthening of socio-institutional learning capacity. To be able to adapt, socio-institutional actors need to build on their capacity to recognise that they should remain open and responsive to change. The theory suggested that the systems approach must be properly understood if adaptive capacities within water demand management are to be improved. A systems approach to water demand management can help the different actors to understand aspects such as feedback loops, complex interactions and linkages that can create long-term impacts.

The complexity of water resource systems was well described in the theory by highlighting the management challenges and complex links with other problems and uncertainty that may not be quantifiable. It suggested that there is a need for a management style that involves the consideration of socio-institutional systems, and to recognise its complexity that includes multiple stakeholders and water use actors and their divergent perceptions, attitudes and behaviours, as well as the impact of these elements on the effectiveness and sustainability of water demand management. The literature reiterated the wide acceptance of a systems approach and its complexity linked to socio-institutional processes. There was a general agreement by authors that the incorporation of the concept of complex systems into institutional policies and strategies is a requirement for adaptation capacity.

An approach of “sense and respond” rather than “command and control” is needed within water demand management. Large scale projects, policies and decisions should be reduced to smaller initiatives that consider a socio-institutional systems approach. This can assist in the successful navigation of a changing and only partly predictable system (Roux and Biggs, 2010). Water demand management plays out within a complex socio-institutional system which involves the inclusion of principles such as the interaction and collaboration between an institution and its water users or stakeholders, a decentralised approach, social networking, continuous improvement, water user and stakeholder participation in initiative implementation and consensus building, amongst others (Turton and Meissner, 2002). The social costs and consequences of traditional approaches to water demand management are profound (Xiao, 2017). It is when the social pressures for change are clearly felt that the ineffectual strategies and initiatives of traditional approaches applied by water institutions are revealed, and that the need for a new adaptive, socio-institutional renewal becomes evident (Turton and Meissner, 2002).

From the analysis of the various literature concepts and theories, as well as the CCT case study, it became evident that there are strategic areas within the CCT’s Water Demand Management section where improvement is needed. One of these areas is the recognition of the social diversity of consumers and stakeholders. A water institution must make provision for different communication and approach strategies within different settings. As seen in the literature discussion on complex systems theory, water demand management occurs within a system with different interconnecting components, yet with a different setting of each of these components. Water demand management strategies and initiatives which work in one setting may not work in another setting. Water demand management strategies and initiatives should therefore be adapted to speak to the complexity of these different system components for it to be effective. The complexity of social and institutional aspects need to be understood, and the best way to do this is to view it as a whole system of interconnecting parts (Turton, 2002a).

As indicated in Table 27 in the case study analysis, consensus resolution to social conflicts is mostly absent within the CCT's water demand management section. The positive findings of the case study examples indicated that the management of water conflicts within water demand management should be based on a coordinated and shared decision-making process. It will require the acceptance of certain levels of decentralised decision-making and the recognition of a range of views about water demand management. Within the literature, Kanta and Zechman (2014) pointed out that water use is ultimately driven by the decentralised decisions of water users. Government departments in South Africa are constitutionally mandated to work collectively and to avoid duplication, but this seldom happens as there are still too many lines drawn between different departments and within departments.

The case study analysis revealed the unequal perception and difference in behaviours across the high to low income levels. The two surveys' results revealed that the water user groups' differences and needs have been largely overlooked by the CCT's current water demand management implementation approaches, with a status quo on the 'one size fits all' approach. Water conservation awareness messages have been focused on a one water user society, providing the same communication messages and through the same type of media and instruments to the water users of Cape Town as if one social group as a whole, ignoring the social differences, circumstances, different water requirements, climatic differences across geographic locations, different cultures, political influences, and economic differences that is a reality within the CCT. For water demand management measures to be effective, implementation approaches should be relevant to the specific water user groups that will be affected by the implementation, otherwise it will not be successful.

The case study results outlined the dynamic interactions between water users and the CCT. From the analysis of the case study it is evident that there are strategic areas within the CCT's water demand management programme where improvement are needed. One of these areas is the recognition of the social diversity and complexity of water users and stakeholders. A water institution must make provision for different

communication and approach strategies within different settings. The case study analysis results indicated that the integration of the complex interrelationships between water user groups, the physical area where they reside and the water institution is lacking within their strategies, policies and legislation. The lack of the CCT to consider the complex social barriers such as linguistics, cultures, preferences and social circumstances within different homogenous water user and stakeholder groups when planning and implementing water demand management initiatives and strategies may create a socio-institutional environment of mistrust and conflicting priorities. Although water is essential for sustainable livelihoods, many water services institutions fail to address different water needs and typically do not include the impacts of water demand management on societal livelihoods (Smits, 2005). Water demand management practices which considers livelihoods can enhance communities (Moriarty and Butterworth, 2003).

According to the literature, getting people to respond to water conservation is not just as simple as getting them to change their behaviours, attitudes and choices (Shove, 2010). As represented in the United Kingdoms "Framework for pro-environmental behaviours" produced by their Department for Environment, Food and Rural Affairs (DEFRA, 2008), the extent to which people adopt pro-water conservation behaviours depends upon a mixture of positive "motivators" and negative "barriers". Society is generally motivated by "*the feel good factor, social norm, individual benefits (e.g. health, financial outlay), ease, being part of something*", and can often also be compromised by equally common barriers, such as "*external constraints (infrastructure, cost, working patterns, demands on time), habit, skepticism, disempowerment*", amongst others (DEFRA, 2008:07). Stern (2000:418) listed a number of contextual factors that can influence society's motivation to conserve water, which goes far beyond the generally accepted ABC model, such as "*interpersonal influences, community expectations, advertising, government regulations, legal and institutional factors, monetary incentives and costs, the physical difficulty of specific actions, the capabilities and constraints provided by technology and the built environment, the availability of public policies to support behavior, and various features of the broad social, economic, and political context"*, amongst others. The consideration

of society's motivators and barriers will have an impact on the level and quality of socio-institutional participation within the CCT's water resource management. It is therefore considered relevant to also investigate the progressiveness of the South African water policy framework to move beyond the commonly implemented ABC model.

The survey results revealed that collaboration between the CCT and its water users have largely been overlooked within its policies, strategies and initiative implementation efforts. Low income water users may feel insecure and vulnerable with, in some cases, high financial debts, which has an impact on their willingness to use water more sparingly and to accept water use restrictions. The literature pointed out that institutional change has been dramatic and progressive but have failed to completely tackle increasingly complex water challenges (Merry *et al*., 2007). Most of South Africa's water sector institutions have not yet reached equilibrium in considering the integration of complex and overlapping dimensions, dealing with the dynamism of the system, measuring sustainability, dealing with internal integration, as well as creating the mechanisms for gaining social participation and collaborative consensus. According to the City of Cape Town's main water resources policy and legislation, it can be concluded that the sector is predominantly managed according to a mechanistic systems approach rather than a complex systems approach. Its administrative systems is mostly centralised and hierarchical with narrow water user and stakeholder participation.

Although the CCT has made some headway in the investigation of diverse sources of design and alternative water resource options, these efforts almost always end at the investigation stage and seldom reaches the implementation stages. It seems that the CCT's water demand decision makers have not yet fully considered a planning approach that incorporates the complex, interlinked aspects of a socio-institutional system. If an institution is regulating in a fair, equitable and reasonable manner, collaborating with its water users and stakeholders, then water demand management initiatives should be fairly well received and accepted by society.

By including water users, stakeholders and special interest groups within policy development and planning processes, the institution may gain legitimacy and experience success in the implementation of its water demand management programme.

The CCT municipality is generally making use of a suite of water demand management strategies with the aim of reducing water demand within the city. Table 27 of the CCT case study analysis however indicated an absence in the presence of a flexible system and adaptable procedures. The emphasis of good governance should be on combining shared decision-making, and of more flexible polycentric water governance structures (Susskind, 2013). The case study results however indicated a dominant silo approach with a lack of systems management strategies. It also showed that many lingering bureaucratic management approaches are still evident in the CCT, which continues to hamper socio-institutional adaptive capacity. Water demand managers increasingly have to act in the interest of society, as it is the actions of society that are impacting on water use and availability.

The case study demonstrated that, although all the necessary determinants of adaptive capacity may be present within the CCT, its ability to adapt are affected by its limitations in socio-institutional capacities, communication challenges, human attitudes and behaviours toward water demand management. As indicated in the literature review, for an institution to function under changing conditions it needs to incorporate aspects of social wellbeing and capacity development, knowledge capacity development, organisational capacity development, as well as good governance and conflict resolution mechanisms within its policies and legislation (Hashemi, 2012). As was the case during the recent period of extreme drought, the CCT and its residents adapted to the situation through responses such as severe water restrictions, increased tariffs, mass media communication campaigns, amongst others. These adaptive responses are however not sustainable as they were based on an enforced and restrictive strategy, as was seen in the results of the water management device survey which required respondents to indicate the extent to which they agree or disagree with the statement “*I*

*regard the WMD as a mechanism of restriction and punishment of households with water account arrears*". The findings illustrated that some of the respondents felt that the WMD was specifically installed in their households simply because they had unpaid water accounts. This related once again to the CCT's lack of capacity to effectively communicate with residents and to involve them within the decision making process. This is also a huge factor when it comes to socio-institutional conflict with regards to the WMD as the residents consider it an unequal process between the affluent and the indigent communities.

One of the major mistakes made by the CCT with regards to stakeholder collaboration was that it mostly focused on conflict control, instead of adapting its strategies towards innovative solutions to prevent or reduce these conflicts in the first place. A water demand management strategy based on adaptive solutions can be greatly effective, such as was seen in the case examples in Chapter 2, where communities worked side by side with the water services institutions to find, and implement, suitable solutions to water resource management issues. This realisation of the recent drought crisis should instead have been averted through more adaptive strategies focusing on long-term sustainability. Strategies such as those focusing on communication that are adapted to the users' capacity, or to increase their capacities, as well as the inclusion of social collaboration and participation in water demand management initiative decisions and implementation, will be more sustainable in the long-term.

Within the CCT's water demand management processes, certain factors have been influential in the failure of some of its initiatives. This relates to its mainly demand and control strategy. The CCT's lack of knowledge and understanding of water users' needs, perceptions, challenges and water use patterns, causes social constraints such as a low level of payment for water and sanitation services, high levels of water wastage and high levels of distrust and resistance regarding WC/WDM initiatives. Since the WC/WDM strategy implementation in 2007 some challenges were identified, such as the lack of knowledge and understanding of water users' needs and water usage patterns which may limit the ability to reduce water user demand. In part this is due to

the lack of adequate management information systems, adequate water user interaction, and lack of research. The conclusion of the survey results might therefore be drawn that the CCT's 'one approach fits all' is not working and it therefore needs to adapt its awareness messages and delivery methods to differing categories and geographic locations. The study also revealed that the social capacity to adapt to awareness issues is variable, and aspects that are affecting this should be further investigated. Because of a lack of knowledge and understanding, demand management is often viewed as negative, punitive and as restrictive measures by some water user groups.

According to a finding within the National Water Conservation and Demand Management Strategy, constraints identified within the CCT's Water and Sanitation Department were predominantly driven by a lack of coordination and partnerships with the water users and stakeholders (DWA, 2000). Water resources management is predominantly challenged by inadequate clarity on institutional arrangements, roles and responsibilities and a main focus on supply-side management and large infrastructural development. The lack of trust by water users is one of these factors, especially relating to the water management device initiative.

The case study analysis revealed that although adaptive management is motivated within some of South Africa's key legislation, it seems to be lacking when it comes to the implementation aspect. Within the case study, water demand management initiatives are viewed as a programme with a start and an end date. Initiatives are often forced and/or not explained properly to water users and are commonly only perceived as drought relief mechanisms. Water users are often confused and do not know what water conservation measures are in place and why it is in place. Conflicting messages within water strategies and by-laws contributes to further social confusion and conflict. There seems to be a mismatch of communication messages and delivery methods to the different focus communities.

The survey results indicated that the social adaptive capacities; especially within the low income areas; are at the low end of the scale, indicating a lack of socio-institutional communication, collaboration and participation within these areas. This correlates with the CCT's lack of incorporating socio-institutional adaptive capacity within its policy development and implementation. According to the results, the CCT is partially effective in communicating and sharing information, but there seems to be a general lack of effectively communicating and collaborating with the low income residents.

A main empirical finding of the CCT case study is that adaptive measures such as water user and stakeholder participation is of paramount importance to the long-term sustainability of water demand management within the CCT, but are mostly lacking within its current management system. A new adaptive response is therefore required that includes participation methods that are specifically designed to adapt to the unique needs and specific situation of the diverse communities within the CCT.

As the literature suggested, an improved adaptive water demand management strategy, such as participation, could secure a more long-term impact outside periods of drought, thereby playing a role in preventing, or delaying, the adverse impacts of these extreme periods of droughts from occurring (England, 2012). This was illustrated by the feedback obtained from water users during the customer satisfaction and feedback survey as per the results indicated in Table 24 of the case study (CCT, 2016b). Trust goes both ways, and by not responding to the water users' complaints, not following processes and a lack of providing information, may cause mistrust by water users which can take years to rectify. The results showed that adaptive water demand management measures that fosters a two way trust system among the CCT and its residents is mostly lacking, but is a necessity for long-term water security within the City of Cape Town.

# 7. Recommendations

The recommendations section was structured by including a list of the main recommendations as deducted from this thesis' results, which will be followed by a discussion on each of these recommendations. The main recommendations of this thesis are:

- The need for institutional and social integration of adaptive water demand management with consideration of community livelihoods;
- The consideration of social and institutional aspects as one system that is comprised of complex, interlinked elements;
- The requirement for robust and flexible strategy development;
- The inclusion of new knowledge and learning in policy, legislation and implementation strategies for improved water demand management;
- The improvement of communication and information flow with a targeted approach;
- Including community participation strategies in water demand management policy and legislation, implementation and communication strategies;
- The improved attention to the most vulnerable, their livelihoods and conflict resolution within water demand management policy and strategies, and;
- Recommendations for further research.

**The need for institutional and social integration of adaptive water demand management with consideration of community livelihoods:**

The institutional and social adaptation of water demand management needs to be integrated in policy, legislation and implementation strategies. An increased adaptive capacity can achieve socio-institutional system resilience. A shift away from a silo approach towards a multi-strategy and implementation approach that are adaptable and flexible is required. If adaptive water demand management is to be included in

implementation strategies, it would make sense to adapt these strategies to the unique livelihoods and circumstances within specific communities as is evidenced by the survey results. Drought can impact on peoples' livelihoods and these impacts, and water users' responses to it, should be considered within the CCT's communication strategies and awareness initiatives.

This could be achieved by adapting communication to target the unique circumstances and livelihoods of specific communities, considering socio-institutional participation within water demand management strategies and decision making, the application of a systems approach within planning and implementation strategies, and a decentralised water demand management initiative approach, amongst others. Processes are needed that can developed the social capacities within certain communities through participative engagement, sustained dialogue and transparent strategies which could build community trust.

Water demand management managers within the CCT should acquire the necessary adaptive capacity to be able to engage with specific communities more effectively. This could lead to an increase in community trust and initiative acceptance, thereby improving water demand management success and outcomes for both the institution as well as the specific communities. As evidenced by the literature review and case study results, the CCT's decision makers should acquire the necessary capacity to distinguish between the short and long-term impacts of initiative impacts and to effectively adapt their planning towards a longer time-frame. This will secure an increased level of water security and sustainability.

**The consideration of social and institutional aspects as one system that is comprised of complex, interlinked elements:**

As evident in the case study survey results, there are socio-institutional communication and relationship challenges that consist of variable complexity. This was especially

apparent in the negative perceptions held by communities regarding the water management device. As pointed out by the case study survey results, improved knowledge is required on the different socio-institutional system components, the variability between them, and their interconnectedness in order to establish strategies and initiatives that will address the variance and linkages.

This can be achieved through the development of systems models which could enable users to understand and predict the behaviour of complex socio-institutional systems that can be characterised by non-linearities, time delays, and feedbacks. This could lead to an improved understanding of social complexities and its role in adaptive communication and participation strategies. Decision and negotiation tools should also be developed to inform the implementation of a systems approach. A shift towards the development of real world models could revolutionise institutional adaptive capacity to manage water demand under constant social change and increasing complexity. This could lead to improved water demand management strategies characterised by robustness and adaptability across all sectors and scales of socio-institutional systems.

**The requirement for robust and flexible strategy development:**

Water institutions should develop robust water demand management strategies to bring about changes in socio-institutional capacities, attitudes and behaviours. This will enable the capacity to handle complex and unexpected challenges experienced within socio-institutional systems. As evident in the literature review and case study, water demand management decision makers are prone to implementing approaches in silos, with a one size fits all approach when it comes to engaging with different communities.

The increased robustness and improvability of water demand management policy and strategies could lead to the creation of a proper foundation towards the establishment of adaptive water demand management strategies that can address the different community needs and challenges more effectively. As indicated within the literature review, new knowledge and learning can achieve greater system robustness and

flexibility due to it being able to increase socio-institutional adaptive capacities and responses.

**The inclusion of new knowledge and learning in policy, legislation and implementation strategies for improved water demand management:**

As was made evident in the literature review, adaptation is not just about adjusting our systems to changing conditions but it is also about finding new ways to operate in an ever changing environment. A shift towards ingenuity and finding solutions that are innovative and focused on local conditions and capacities is necessary. This could be achieved by incorporating new knowledge, technology and research findings that will have the ability to provide adaptive solutions to change within water demand management. The CCT could ensure more effective water demand management implementation by taking cognisance of the latest site- and situation-specific data and information.

The literature pointed out that adaptive strategies should be developed through a ‘trial and error’ approach which can facilitate learning and improvement. By investigating different alternative options in water demand management strategies, data can be produced that is replicable and repeatable. The CCT should therefore consider various scenarios that can provide the opportunity to experiment with different alternatives that they might otherwise not have considered. The CCT would also do well if they could start comparing policy and strategic outcomes, and evaluate alternatives that could ensure the most effective adaptive water demand management outcomes.

The CCT’s policy and legislation should be guided by new knowledge and learning. There is a need for improved information and data on the complex socio-institutional interactions and its impact on water demand management, and vice versa. This would lead to a reduced vulnerability and risk within its water demand management programme. Water demand management decision makers need knowledgeable

management systems that are capable of leading them in a direction that will ensure long-term water demand sustainability.

**The improvement of communication and information flow with a targeted approach:**

As evident in the literature, the construction of communication messages and channels should consider the social circumstances within a target area. An understanding of social issues can be most effective when water user collaboration and interaction occurs. The theory suggested that it is imperative for institutions to consider a compendium of communication channels and strategies that can target specific communities with their own unique social issues and circumstances.

As indicated by the case study survey results, there is a lack of specific community targeted and adapted communication within the CCT. The CCT therefore needs to ensure that it uses a number of different mechanisms and communication channels, adapted to reach its specific target audiences most effectively. This can be achieved by improving information flow between the CCT and its water users. Key performance indicators (KPI's) need to be set for each communication channel to monitor performance and ensure that a channel optimisation process can be strategically managed. Channel migration and optimisation requires that non-efficient channels be scrapped, balanced against the need to ensure that all water user groups are able to get the most effective and equitable level of service. KPI's can be used to evaluate trends and make knowledge driven decisions to increase efficiency, adaptability, communication and water user satisfaction.

A shift is needed within the CCT towards a communication strategy where new communication channels are introduced and measured against best practices. Communication should be reinforced and consistently executed, water user expectations should be met, and it should be efficient and effective. A formal change management approach could lead to an improved socio-institutional understanding, an

increase in adaptive capacities and ensure adaptation, adoption and reinforcement among the key actors.

**Including community participation strategies in water demand management policy and legislation, implementation and communication strategies:**

The theory highlighted that participation is necessary for adaptation to occur. It was made clear that a socio-institutional participative strategy and related planning processes could build on social and institutional adaptive capacity. Institutions should therefore investigate the feasibility of adopting water user focused strategies that includes collaboration, partnership and involvement in decision making. By deliberately involving society within its water strategies, institutions can create initiatives that will engender a certain level of trust and an improved level of acceptance with its water users. This can be achieved by the development of innovative communication and participation strategies that are guided by the different communities' specific knowledge to assist in finding new solutions to complex water demand management challenges. The networks and relationships of people within a specific community should guide and inform the way in which critical water resources are managed, consumed and protected.

According to the case study results, socio-institutional participation is largely lacking within the CCT's governance system. It is therefore recommended that the CCT's governance creates a basis for socio-institutional participatory involvement. This can be achieved through policy and legislative decisions that are based on a participatory process where all residents are given a voice in policy development without prejudice or discrimination. The literature suggested that social collaborative and participatory strategies can provide legitimacy to policies and legislation. The CCT's relevant policies and legislation should therefore be reviewed to strengthen governance and to facilitate change and adaptation. This can be achieved through a participative water demand management approach which can lead to the creation of community specific knowledge and thereby building on adaptive capacity.

**The improved attention to the most vulnerable, their livelihoods and conflict resolution within water demand management policy and strategies:**

It is important to assess people's access to resources to enable them to cope with, and adapt to the shock of droughts. Knowledge of the specific socio-economic challenges within different communities should therefore guide policy and strategy development in order to support the most vulnerable. According to the case study results, the CCT is using a restrictive and enforced approach in an effort to reduce water consumption within the city. This can have a negative impact, especially in the most vulnerable communities. According to the literature, high priority should be placed on meeting the needs and water demands of the most vulnerable. Water demand management strategies need to be designed to take into account the need to reduce the risks to the vulnerable sections of society. This can be achieved through a livelihoods approach, where the challenges experienced are viewed through the eyes of the target community.

The CCT survey results revealed that the indigent communities view the implementation of the water management device as an enforced, restrictive and discriminatory method. This can clearly be seen in the negative views and feedbacks received from the survey results. This has led to a lack of trust and consequent socio-institutional conflict within the most vulnerable communities of the CCT. The CCT should therefore place high priority on an improved communication and participation strategy within these communities. Special attention must be placed on managing existing and emerging water conflicts. This can be achieved by acknowledging and building on adaptive capacity to find solutions acceptable to all actors.

**Recommended further research:**

Further research studies that empirically assess adaptation are critical for building a more comprehensive theory of adaptation in order for water demand management policy and strategies to be designed to fit the specific needs and circumstances of communities, as well as the settings in which adaptation processes can occur within these communities. The literature suggested that adaptive communication strategies can assist in gaining the trust of water users and improve their knowledge. An improved understanding is therefore required on the specific social circumstances within different communities and the communication strategies and challenges that can best reach these communities in an understandable way.

Further research is required on communities' areas of vulnerability as well as an understanding of social, economic and ecological challenges that can facilitate conflict. More information is necessary on the causes of socio-institutional conflict and how to deal with it. An improved understanding is therefore required between the societal and water institution's inter-relationships and conflict situations. There is a need for assessments based on the impact of participative water demand management in creating this understanding and its role in conflict mitigation and building adaptive capacity.

Further investigation into community perceptions, and how it impacts on their water savings behaviour, is required. Improved information is needed on the social aspect of water demand management, as well as the adaptive capacity of society to reduce their water use. More data that provides information on the social conditions of water users and how it can impact on their adaptive capacity and water use is necessary.

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# ANNEXURE A: The Survey Sampling Matrix

| South Peninsula | | Household Type | Actual Surveys Received | | |
|---|---|---|---|---|---|
| **Suburb** | No Surveys | | **Suburb** | No Surveys | Variance |
| Ocean View (Fish Hoek) | 60 | Low Income | Ocean View (Fish Hoek) | 64 | 4 |
| Retreat | 10 | Middle Income | Retreat | 63 | 53 |
| San Michel | 38 | High Income | San Michel | 36 | -2 |
| SUB TOTAL | 108 | | SUB TOTAL | 163 | |
| | | | | | |
| **Tygerberg/Bellville** | | **Household Type** | **Actual Surveys Received** | | |
| **Suburb** | No Surveys | | **Suburb** | No Surveys | Variance |
| Wallacedene (Kraaifontein) | 60 | Low Income | Wallacedene (Kraaifontein) | 60 | 0 |
| MarindaHeights | 47 | Middle Income | MarindaHeights | 45 | -2 |
| Eden Park | 36 | High Income | Eden Park | 34 | -2 |
| SUB TOTAL | 143 | | SUB TOTAL | 139 | |
| | | | | | |
| **Khayelitsha** | | **Household Type** | **Actual Surveys Received** | | |
| **Suburb** | No Surveys | | **Suburb** | No Surveys | Variance |
| Graceland (Khayelitsha) | 57 | Low Income | Graceland (Khayelitsha) | 55 | -2 |
| Bongweni | 60 | Middle Income | Bongweni | 60 | 0 |
| | | High Income | | | |
| SUB TOTAL | 117 | | SUB TOTAL | 115 | |
| | | | | | |
| | | | | | |
| **Helderberg/Kuilsrivier** | | **Household Type** | **Actual Surveys Received** | | |
| **Suburb** | No Surveys | | **Suburb** | No Surveys | Variance |
| Eindhoven (Delft) | 60 | Low Income | Eindhoven (Delft) | 59 | -1 |
| Rosedale | 47 | Middle Income | Rosedale | 47 | 0 |
| Elim | 53 | High Income | Elim | 54 | 1 |
| SUB TOTAL | 160 | | SUB TOTAL | 160 | |
| | | | | | |
| **Mitchels Plain** | | **Household Type** | **Actual Surveys Received** | | |
| **Suburb** | No Surveys | | **Suburb** | No Surveys | Variance |
| Woodlands (Mitchells Plain) | 60 | Low Income | Woodlands (Mitchells Plain) | 62 | 2 |
| Colorado (Mitchells Plain) | 47 | Middle Income | Colorado (Mitchells Plain) | 51 | 4 |
| Strandfontein | 47 | High Income | Strandfontein | 46 | -1 |
| SUB TOTAL | 154 | | SUB TOTAL | 159 | |
| | | | | | |
| **Kraaifontein/Blouberg** | | **Household Type** | **Actual Surveys Received** | | |
| **Suburb** | No Surveys | | **Suburb** | No Surveys | Variance |
| Saxonsea (Atlantis) | 60 | Low Income | Saxonsea (Atlantis) | 59 | -1 |
| Richwood | 57 | Middle Income | Richwood | 56 | -1 |
| Milnerton Ridge | 56 | High Income | Milnerton Ridge | 53 | -3 |
| SUB TOTAL | 173 | | SUB TOTAL | 168 | |
| | | | | | |
| **Central (Cape Town Area)** | | **Household Type** | **Actual Surveys Received** | | |

| **Suburb** | No Surveys | | **Suburb** | No Surveys | Variance |
|---|---|---|---|---|---|
| Bishop Lavis | 60 | Low Income | Bishop Lavis | 60 | 0 |
| Montana | 60 | Middle Income | Montana/Charlesville | 70 | 10 |
| Thornton | 60 | High Income | Thornton | 62 | 2 |
| SUB TOTAL | 180 | | SUB TOTAL | 192 | |
| | | | | | |
| **Klipfontein** | | **Household Type** | **Actual Surveys Received** | | |
| **Suburb** | No Surveys | | **Suburb** | No Surveys | Variance |
| New Rest (Gugulethu) | 60 | Low Income | New Rest (Gugulethu) | 60 | 0 |
| Belgravia (Athlone) | 60 | Middle Income | Belgravia (Athlone) | 60 | 0 |
| Surrey | 60 | High Income | Surrey | 71 | 11 |
| SUB TOTAL | 180 | | SUB TOTAL | 191 | |
| **TOTAL** | **1215** | | **TOTAL** | **1287** | **72** |

## ANNEXURE B: Example of Business Customer Notification Letter

**WATER AND SANITATION**

CITY OF CAPE TOWN
ISIXEKO SASEKAPA
STAD KAAPSTAD

**Zolile Basholo**
Manager: Water Demand Management and Planning

**T**: +27 21 590 1479 **F:** +27 21 590 1504
**E**: zolile.basholo@capetown.gov.za

### Dear Water Consumer: Business and Commercial Industry

**NOTICE: ANNUAL WATER AND SANITATION CUSTOMER SATISFACTION SURVEY**

The CCT would like to inform water consumers within the business and commercial industry that our Annual Water and Sanitation Customer Satisfaction survey will be conducted at your place of business on the (date) _____at (time) ____ :____ .

Business and commercial water consumers should therefore be aware of the intended visit from a survey representative. The surveyors will be employees of the CCT.

The survey's main aims are to gain insight regarding customer requirements and gauge customer satisfaction in terms of what is expected by the customer service charter. The assessment results will assist in forward planning in that they will:

- Ascertain an acceptable level of service satisfaction which needs to be achieved and/or maintained,
- Identify any areas needing improvement,
- Uncover any needs not currently being addressed, especially in informal and in business areas,
- Interrogate and evaluate effectiveness of marketing campaigns, and inform communication strategies.

Surveyors will be wearing white shirts and black pants, and will carry a CCT identification card. CCTwould like to remind residents that it is in their interest to participate as these results will help inform future spending. The survey will consist of approximately 25 questions and should take about 10 minutes to complete. All information provided to the surveyors will be kept highly confidential.

If in doubt about any person claiming to be from or working on behalf of the CCT, consumers can contact the CCT's project representative to confirm the person's identity.

- CCT Project Representative: Nina Viljoen, Tel: 021 444 3398, Email: nina.viljoen@capetown.gov.za

Yours sincerely

_____ _____

**ZOLILE BASHOLO** **Date**
Manager: Water Demand Management
and Planning

## ANNEXURE C: An Example of an EPWP Project Registration Form

| CCT | |
|---|---|
| **EPWP PROJECT REGISTRATION TEMPLATE VER 2.0** | |
| EPWP Project Registration Number | |
| Project Profile ID | |
| Directorate | Utilities |
| Line Department | Water & Sanitation |
| Financial Year | 2015/2016 |
| Project Type | Mainstream |
| Contract or Works Project Name | Water and Sanitation Customer Satisfaction Survey |
| Contract or Works Project Number | Tender 465C |
| Project Description | Community Survey |
| Asset to be Delivered | Survey Questionnaires to be Completed |
| Cost Centre Number | |
| WBS Number | |
| Capital or Operating Budget | |
| Planned Number of Work Opportunities | |
| Labour Type (Direct / Indirect) | Indirect |
| % Target Labour Intensity | |
| Planned Start Date (YYYY/MM/DD) | |
| Planned End Date (YYYY/MM/DD) | |
| Wage Budget | |
| Sub-Council | 19, 20, 02, 07, 21, 10, 09, 05, 23, 18, 01, 04, 15, 17, 11 |
| Ward | 69, 61, 68, 110, 72, 71, 58, 06, 111, 106, 08, 102, 94, 18, 103, 17, 20, 11, 75, 88, 66, 67, 43, 04, 29, 105, 28, 30, 48, 53, 24, 44, 49, 46 |
| Location | CCT - Various Suburbs |
| Project Manager Name | Nina Viljoen |
| Project Manager Work Telephone # | 021 444 3398 |
| Project Manager Mobile # | |
| Project Manager eMail Address | nina.viljoen@capetown.gov.za |
| EPWP Departmental Coordinator Name | |
| EPWP Departmental Coordinator Work Telephone # | |
| EPWP Departmental Coordinator Mobile # | |
| EPWP Departmental Coordinator eMail Address | |

| | |
|---|---|
| **Declared by Project Manager to be True and Correct** | (name)……<br><br>(signature)…… |
| **Date:** | …… |

## ANNEXURE D: An EPWP Research Assistant Training Certificate

EXPANDED PUBLIC WORKS PROGRAMME

CITY OF CAPE TOWN
ISIXEKO SASEKAPA
STAD KAAPSTAD

# CERTIFICATE OF SERVICE

I, Nina Viljoen - Research Officer

Certify that

**RUSCHANA A""""""" B"""""""""**

**I.D. NUMBER: 6"""""""""""""**

was in the employment of the City of Cape Town, 12 Hertzog Boulevard, Foreshore Cape Town

from: 14 April 2014 until: 31 July 2014

as

**COMMUNITY LIAISON OFFICER - RESEARCH**

On the City of Cape Town's Expanded Public Works Programme with the appropriate onsite training being provided on:

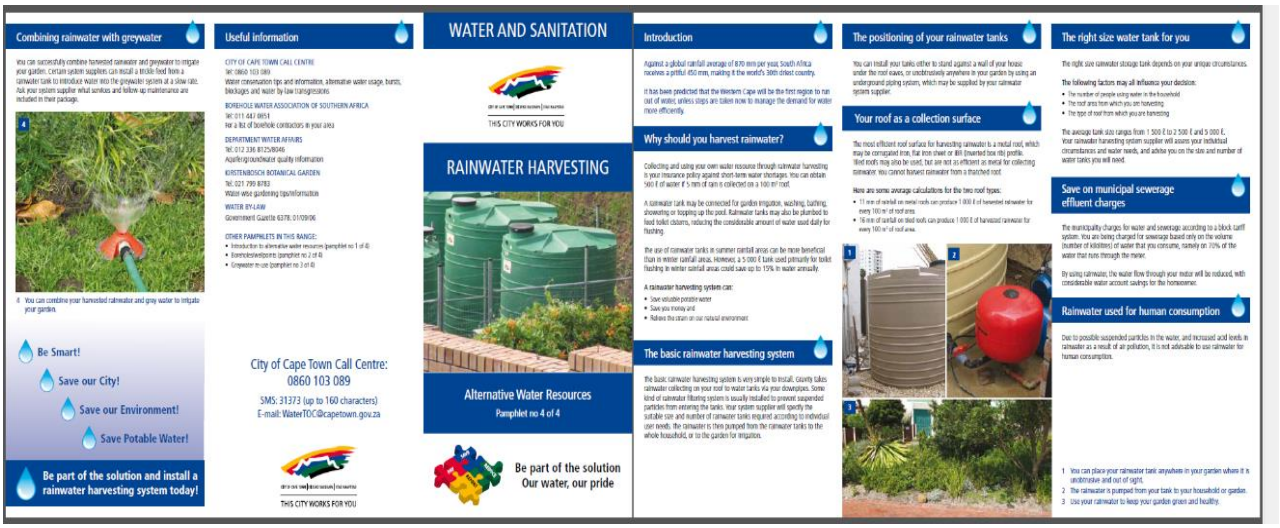
Survey Research Methodology
Research Data Capturing Methods
Conceptualisation of Survey Research
Basic Research Data Analysis
Administrative Functions

_____ _____

Employer's signature Date

**ANNEXURE E: Examples of Education and Awareness Material Distributed to Participants.**



## ANNEXURE F: Example of Survey Participant Information and Confidentiality Clause

Dear Consumer

The CCT, Water and Sanitation Department would like your assistance with our “Water Consumption Trend Analysis” research survey which will only take a few minutes of your time. This survey will be assessing the water consumption behaviour of consumers across different geographic areas within the CCT. Your input would be highly valuable to us and will provide us with information regarding highest water usage categories, water usage differences relating to climatic variation as well as linking consumption figures to water conservation measures and impact. With this information CCTwill be able to assess benchmarking figures for different consumer categories and will enable us to assess our water conservation and demand management programmes which will be instrumental in effective Water Demand Management initiatives within your area.

The attached survey questionnaire will by no means infringe on your privacy and contains a confidentiality clause. This means that your identity will be treated with high confidentiality and that any information provided will be confidential and will be discarded after completion of this study. Your participation is voluntary and you are free to indicate your acceptance or to decline participation in this research study.

If you choose to participate please sign below to confirm that you gave permission to continue with this survey.

_____
Consumer Signature

_____
Date

Your participation would be sincerely appreciated and are valued by the CCT.

Kind Regards

**Nina Viljoen**
Research Officer

Water Demand Management and Operational Implementation
Water and Sanitation
Goodwood Municipal Office
261 Voortrekker Road
Goodwood

**Tel:** 021 590 1518
**Email:** nina.viljoen@capetown.gov.za

CITY OF CAPE TOWN
ISIXEKO SASEKAPA
STAD KAAPSTAD

Making progress possible. Together.

## ANNEXURE G: Signed CCT Research Data Request and Confidentiality Agreement

| RESEARCH STUDY OR DATA/INFORMATION PERMISSION REQUEST & CONFIDENTIALITY AGREEMENT | | | CITY OF CAPE TOWN ISIXEKO SASEKAPA STAD KAAPSTAD | |
|---|---|---|---|---|
| W&S/R002 | 05/08/2015 | WATER AND SANITATION DEPARTMENT | Version: 1 | Page 1 of 8 |
| COMPILED: N. VILJOEN | | | APPROVED: C MUBADIRO | |

### WATER AND SANITATION – RESEARCH

### EXTERNAL RESEARCH ASSISTANCE OR INFORMATION/DATA REQUEST & CONFIDENTIALITY AGREEMENT

- All applicants must please answer each category in detail.
- Applications do not necessarily guarantee commitment by the Research Section to consider or provide the requested research assistance or information/data.
- The research section reserves the right to decline such application based on specialised research requirements and availability of resources/data.
- This document should be signed and attached to the research approval report for final approval signatures.
- All research requests to be approved by the Office of the Executive Director: Utility Services

| Section 1: Requesting Institution/Organisation Details | |
|---|---|
| Institution/Organisation Name: | University of Cape Town (UCT) and City of Cape Town (CCT) |
| Department/Section Name: | Department of Environmental and Geographical Sciences (UCT) and Department of Water and Sanitation (CCT) |
| Institution/Organisation Address: | (UCT: Rondebosch, 7700) and (CCT: 12 Hertzog Street, Cape Town, 8001) |
| **Section 2: Requesters Details** | |
| Requesters Name: | Nina Viljoen |
| Student Number or Designation: | Student Number: VLJNIN001 and Designation: Research and Development Officer |
| Contact Details of Requester: | Tel: 021 444 3398 |
| | Cell: 083 344 4883 |
| | Email: nina.viljoen@capetown.gov.za |
| | Fax: - |
| Person Accepting Responsibility for Provided Information | Nina Viljoen |
| **Section 3: Requested Research Assistance or Information** | |
| Please provide a detailed description of the research assistance or information/data you require | (a) Water Demand Management initiative and programme data such as residential water consumption survey results, water demand management initiative data as obtained from |

| RESEARCH STUDY OR DATA/INFORMATION PERMISSION REQUEST & CONFIDENTIALITY AGREEMENT | | | CITY OF CAPE TOWN ISIXEKO SASEKAPA STAD KAAPSTAD Making progress possible. Together. | |
|---|---|---|---|---|
| W&S/R002 | 05/08/2015 | WATER AND SANITATION DEPARTMENT | Version: 1 | Page 2 of 8 |
| COMPILED: N. VILJOEN | | | APPROVED: C MUBADIRO | |

| | | |
|---|---|---|
| | the updated WMD strategy, etc. Please note that only data approved and released for my usage by project managers and Branch managers will be used.<br>(b) Research collaboration as part of this research thesis between City of Cape Town Water and Sanitation Department and UCT Environmental and Geographical Sciences Department.<br>(c) A draft CCT/UCT Research Collaboration Memorandum of Understanding (MOA) document is attached. This document is in the final stages of vetting by the City's Legal Department from where it will go for approval signatures.<br>(d) Please note: Student is City of Cape Town employee also. This collaboration means that research will be conducted by both institutions and research publications and conference exposure will be awarded to both research organisations. | |
| **What is the purpose/objective of the required research assistance or information/data, i.e. for completion of tertiary study, etc.** | For completion of PhD studies. | |
| **Please name the project/initiative for which this research assistance or information/data will be needed** | PhD Research Thesis: An Analysis of the Socio-Institutional Impacts of Water Demand Management Initiatives wiithin the City of Cape Town, South Africa. | |
| **Category of Service (please tick applicable option/s):** | **Research Assistance, i.e. Analysis, etc.** | **Is deductions, conclusions and recommendations also needed?** |
| | **Research Information/data, i.e. water consumption figures, inclusion in study, etc.** √ | **Expert Advice from City Water Engineering Professional** √ |
| | **Other:** | |
| **If you require research information/data, what will the information/data be used for?** | PhD Thesis, Journal Articles and Conference Presentations | |
| **Where will this research information/data be stored?** | On students laptop. | |
| **Will this information/data be discarded after use? If no, please explain** | Raw data will be discarded, summarised data will be included within results section of thesis. | |
| **Will this information/data be shared with other institutions, organisations or individuals? If yes, please explain** | Yes, research collaboration with UCT. | |

| RESEARCH STUDY OR DATA/INFORMATION PERMISSION REQUEST & CONFIDENTIALITY AGREEMENT | | | CITY OF CAPE TOWN<br>ISIXEKO SASEKAPA<br>STAD KAAPSTAD | |
|---|---|---|---|---|
| W&S/R002 | 05/08/2015 | WATER AND SANITATION DEPARTMENT | Version: 1 | Page 3 of 8 |
| COMPILED: N. VILJOEN | | | APPROVED: C MUBADIRO | |

| | |
|---|---|
| By when do you require this research assistance or information/data? | As soon as possible. |
| Please tick whether specialised software programme analysis will be required,if applicable. | SWIFT<br>IMQS<br>WADISO<br>SAP<br>Other:_____ |
| Please provide any additional preferences and specifications regarding your request: | |
| | |
| | |
| | |
| | |

## Section 4: Declaration of Research Information/Data Confidentiality and Use of Intellectual Property

### 1. Definitions

**(1) Trade Marks:** mean all marks, designs, service marks, logos, brand names, slogans and designs (whether registered or not) to which the City of Cape Town has any rights at the Signature Date or at any time during the currency of this Agreement;

**(2) Intellectual Property:** means any patents, inventions, designs, applications for the aforegoing, Trade Marks, copyright, trade secrets and service marks and other intellectual property rights residing in any process belonging to the City of Cape Town and rights to claim something as its confidential information, including in other jurisdictions, that grant similar rights as the aforegoing, including those subsisting in inventions, drawings, software, business names, goodwill and the style of presentation of goods or services and in applications for the protection thereof;

**(3) Know-How:** means all Confidential Information of whatever nature relating to the Intellectual Property and its exploitation as well as any other confidential information generally relating to the manufacture, use and sale of the Products, including technical information, manufacturing techniques, design specifications, formulae, systems, processes, information concerning materials and business information generally;

**(4) Permitted Recipients:** means employees, directors, officers, professional advisors, agents, financiers and consultants of Recipient;

**(5) Confidential Information:** means any information of whatever nature, which has been, or may be obtained directly or indirectly received by the Recipient from the City of Cape Town, whether in writing or in electronic format, or pursuant to discussions held between the Parties, or which can be obtained by examination, testing, visual inspection or analyses, including, without limitation, the City of Cape Town's Know-How and Intellectual Property and all information relating to the City of Cape Town's past, present and future research and development or its business activities, products, services, clients, or to its technical knowledge, including, without limitation, the City of Cape Town's trade secrets, as well as the terms and conditions of this Agreement, instruction books, technical pamphlets, catalogues, advertising material, specifications and other materials and documents made available to the Recipient by the City of Cape Town relating to the Products, any information identified as confidential, and any other material which contains or otherwise reflects, or is generated or derived from any such information as is specified in this definition; and

**(6) Recipient:** means the Institution/Organisation described in clause 1 herein.

## 2. Clauses

5.1 Rights in Confidential Information & Intellectual Property

(1) the City of Cape Town's Confidential Information & Intellectual Property are assets in which it has proprietary or other rights or interests, the unauthorised disclosure or use of which may cause harm to the City of Cape Town.

(2) the Recipient will not acquire any rights in respect of the Confidential Information or Intellectual Property save as stated in this Agreement.

5.2 Disclosure and use of Confidential Information & Intellectual Property

(1) the Recipient will not disclose Confidential Information to any third party or use the Confidential Information or Intellectual Property without the written consent of the City of Cape Town, save in accordance with this Agreement.

(2) the Recipient may disclose the Confidential Information or Intellectual Property to its Permitted Recipients, provided that:

(a) the Recipient will take such steps as are necessary to ensure that its Permitted Recipients to which Confidential Information or Intellectual Property are disclosed adhere to this Agreement;

(b) any disclosure by a Permitted Recipient of the Confidential Information or Intellectual Property contrary to this Agreement will constitute an unauthorised disclosure by the Recipient.

(3) The City of Cape Town may authorise the Recipient to disclose its Confidential Information or Intellectual Property to a third party other than a Permitted Recipient provided that such permission shall be valid:

(a) only if given in writing;

(b) for disclosure only to the third party identified in the written authorisation; and for that specific instance of disclosure only,

(c) and clause 5.2(2) shall apply as if the third party were a Permitted Recipient.

(4) The Recipient may only disclose the Confidential Information or Intellectual Property if:

(a) it is found in the City of Cape Town brochures, website, pamphlets or any such advertising information which is already in the public domain;

(b) it is required to disclose by law, any court of competent jurisdiction, any government agency or regulatory body lawfully requesting the same or by the regulations of any recognised stock exchange provided that the Recipient promptly notifies the City of Cape Town and consults with the City of Cape Town in advance in relation to the timing and content of such disclosure;

(c) was lawfully known to the Recipient prior to its disclosure to the Recipient by or on behalf of the City of Cape Town provided that the source of such information was not subject to a confidentiality Agreement with the City of Cape Town in respect thereof or fiduciary or

other similar duties of confidentiality in respect thereof; or

(c) it was independently developed by the Recipient without reference to or use of any Confidential Information or Intellectual Property.

(5) In the circumstances listed in clause 5.2(4), the Recipient shall:

(a) limit the disclosure only to that which is necessary to comply with the law;

(b) advise the City of Cape Town in writing as soon as reasonably possible of the disclosure or intended disclosure specifying:

(i) the Confidential Information or Intellectual Property subject to disclosure;

(ii) the reasons for the disclosure;

(iii) the law under the direction of which the disclosure is or will be made; and

(iv) where applicable, the identity of any third party requiring disclosure; and

(v) provide the City of Cape Town with all reasonable cooperation to limit or prevent the disclosure.

5.3 Use of Confidential Information & Intellectual Property

(1) The Parties will not use the Confidential Information or Intellectual Property for any purpose other than:

(a) that for which it is disclosed in connection with this transaction;

(b) as otherwise permitted by the City of Cape Town in writing; or

(c) in accordance with this Agreement.

(2) The Recipient and/or any of its directors, employees and/or representatives will not:

(a) copy, reproduced or duplicated in whole or in part if the Confidential Information or Intellectual Property for any purpose other than a purpose envisaged in terms of this Agreement ,or after having received the written consent of the City of Cape Town; and

(b) use the Confidential Information or Intellectual Property for its own benefit or the benefit of any other person (other than the City of Cape Town) except as provided for in this Agreement.

5.4 Standard of Care

(1) The Recipient will receive and use the Confidential Information or Intellectual Property in such a way as to prevent any unauthorised access to it.

(2) In the event that the Recipient becomes aware that the Confidential Information or Intellectual Property have been disclosed by it or it's Permitted Recipients contrary to the terms of this Agreement, the Receiving Party will:

(a) inform the City of Cape Town in writing specifying what Confidential Information or Intellectual Property have been disclosed, how and to whom it has or may have been

disclosed, when the unauthorised disclosure took place and what steps will be taken to retrieve the Confidential Information or Intellectual Property and prevent future unauthorised disclosures;

(b) take such steps as are necessary or as the City of Cape Town directs to retrieve the Confidential Information or Intellectual Property from unauthorised persons and to prevent further unauthorised disclosure of the Confidential Information or Intellectual Property; and

(c) co-operate with the City of Cape Town in taking any steps taken by it to retrieve the Confidential Information or Intellectual Property from unauthorised persons and to prevent further disclosure of the Confidential Information or Intellectual Property.

(3) Clause 5.2(4) is without prejudice to any rights of the City of Cape Town arising from the unauthorised disclosure of its Confidential Information or Intellectual Property.

5.5 No Warranties regarding Confidential Information & Intellectual Property

The City of Cape Town does not warrant that the Confidential Information or Intellectual Property it discloses are accurate or complete and the City of Cape Town will not be liable for any losses, damages, costs or penalties suffered by, or claims made against, the Recipient as a result of any inaccuracies in, or incompleteness of, the Confidential Information or Intellectual Property disclosed.

5.6 Return of Confidential Information & Intellectual Property

(1) Upon the request of the City of Cape Town, the Recipient will return, destroy or expunge from any storage device all Confidential Information other than documents prepared by the Recipient provided that if required by law or for purposes of this Agreement, the Recipient may retain one copy of the Confidential Information for the period so required.

(2) Where the City of Cape Town has required destruction of the media containing Confidential the Recipient will, on request, confirm in writing that it has destroyed all Confidential Information and made reasonable efforts to expunge Confidential Information stored electronically from any storage device on which it was held.

(3) All requests in terms of this clause 5.6 will be complied with within five (5) Business Days.

## 3. Indemnities

The Recipient hereby indemnifies the City of Cape Town and holds it harmless against all loss or damage which the City of Cape Town may sustain, and against any claim which may be made against the City of Cape Town by any other person, as a result of or arising out of:

(1) a breach by the Recipient of any of its obligations in terms of this Agreement;

(2) any wilful or negligent act or omission, or unauthorised or unlawful conduct by the Recipient or any of its employees, agents, directors or representatives; and

(3) the disclosure or unauthorised use of Confidential Information or Intellectual Property, contrary to this Agreement, by the Recipient, the Permitted Recipients or third parties in respect of whom the Recipient has been authorised to make disclosure.

| RESEARCH STUDY OR DATA/INFORMATION PERMISSION REQUEST & CONFIDENTIALITY AGREEMENT | | | CITY OF CAPE TOWN ISIXEKO SASEKAPA STAD KAAPSTAD Making progress possible. Together. | |
|---|---|---|---|---|
| W&S/R002 | 05/08/2015 | WATER AND SANITATION DEPARTMENT | Version: 1 | Page 8 of 8 |
| COMPILED: N. VILJOEN | | | APPROVED: C MUBADIRO | |

Signature of **Recipient**: .....

Signed at ...**Goodwood**..... on .....**29 March 2016**.....

Signature of **authorised City Official**:.....

Designation of authorised City Official HOD

Signed at Goodwood on 30/3/2016

# ANNEXURE H: Excerpt from Code of Conduct for Municipal Employees

**CODE OF CONDUCT FOR MUNICIPAL STAFF MEMBERS**
(As published in schedule 2 of the Municipal Systems Act 32 of 2000)

**Definitions**
1. In this Schedule "partner" means a person who permanently lives with another person in a manner as if married.
**General conduct**
2. A staff member of a municipality must at all times—
(a) loyally execute the lawful policies of the municipal council;
(b) perform the functions of office in good faith, diligently, honestly and in a transparent manner;
(c) act in such a way that the spirit, purport and objects of section 50 are promoted;
(d) act in the best interest of the municipality and in such a way that the credibility and integrity of the municipality are not compromised; and
(e) act impartially and treat all people, including other staff members, equally without favour or prejudice.
**Commitment to serving the public interest**
3. A staff member of a municipality is a public servant in a developmental local system, and must accordingly—
(a) implement the provisions of section 50(2);
(b) foster a culture of commitment to serving the public and a collective sense of responsibility for performance in terms of standards and targets;
(c) promote and seek to implement the basic values and principles of public administration described in section 195 ( 1 ) of the Constitution;
(d) obtain copies of or information about the municipality's integrated development plan, and as far as possible within the ambit of the staff member's job description, seek to implement the objectives set out in the integrated development plan, and achieve the performance targets set for each performance indicator;
(e) participate in the overall performance management system for the municipality, as well as the staff member's individual performance appraisal and reward system, if such exists, in order to maximise the ability of the municipality as a whole to achieve its objectives and improve the quality of life of its residents.
**Personal gain**
4. (1) A staff member of a municipality may not—
(a) use the position or privileges of a staff member, or confidential information obtained as a staff member, for private gain or to improperly benefit another person; or
(b) take a decision on behalf of the municipality concerning a matter in which that staff member or that staff member's spouse, partner or business associate, has a direct or indirect personal or private business interest.
(2) Except with the prior consent of the council of a municipality a staff member of the municipality may not—
(a) be a party to a contract for—
(i) the provision of goods or services to the municipality; or
(ii) the performance of any work for the municipality otherwise than as a staff member;
(b) obtain a financial interest in any business of the municipality; or
(c) be engaged in any business, trade or profession other than the work of the municipality.
**Disclosure of benefits**
5. (1) A staff member of a municipality who, or whose spouse, partner, business associate or close family member, acquired or stands to acquire any direct benefit from a contract concluded with the municipality, must disclose in writing full particulars of the benefit to the council.
(2) This item does not apply to a benefit which a staff member, or a spouse, partner, business associate or close family member, has or acquires in common with all other residents of the municipality.
**Unauthorised disclosure of information**
6. (1) A staff member of a municipality may not without permission disclose any privileged or confidential information obtained as a staff member of the municipality to an unauthorised person.
(2) For the purpose of this item "privileged or confidential information" includes any information—
(a) determined by the municipal council or any structure or functionary of the municipality to be privileged or confidential;
(b) discussed in closed session by the council or a committee of the council;
(c) disclosure of which would violate a person's right to privacy; or
(d) declared to be privileged, confidential or secret In terms of any law.
(3) This item does not derogate from a person's right of access to information in terms of national legislation.

# ANNEXURE I: Newspaper Article on CCT Level 2 Water Restrictions

**Newspaper Article: Cape Argus 08 March 2016**

## Water restriction level to stay

Lindsay Dentlinger

ALTHOUGH dam levels in the province continue to drop, the city has said it won't be increasing the current level two water restrictions it imposed on January 1.

"We are achieving what we have aimed for, a 10 percent reduction in demand," the city's director for water and sanitation, Peter Flower, said yesterday.

But the council's portfolio committee on utility services said while the city was coping with existing supply, it was seriously concerned about the plight of neighbouring municipalities.

The council said it had to do whatever it could to assist.

Mayoral committee member for utility services Ernest Sonnenberg said while the city had the capabilities to redirect water from other sources, other municipalities were not in the same position. "It's about being neighbourly. We have to see how we can assist other municipalities."

The DA's Clive Justus agreed.

"While we have a responsibility towards our own consumers, those in rural areas face serious problems."

Yesterday, the weekly average for the six dams that supply Cape Town, stood at 37.4 percent, down from 38.7 percent the previous week. Flower said the Voëlvlei Dam was at the critically low level of around 22 percent.

Whereas municipalities would usually draw around 200 megalitres from the dam a day, extraction had been reduced to only around 30 megalitres.

Cape Town was not using water from this dam at all, relying instead on Theewaterskloof and Wemmershoek dams. The levels of both these dams have also dropped over the past week, to 39.8 percent and 51.9 percent, respectively.

The Freedom Front Plus's André Fourie said he hoped the city was not being complacent about the current water situation, given its ever-growing population. "I think the situation is more serious than we think. We can't just hope for rain."

# ANNEXURE J: CCT Media Release: 10 December 2015

CITY OF CAPE TOWN
ISIXEKO SASEKAPA
STAD KAAPSTAD
Making progress possible. Together.

**CITY OF CAPE TOWN**

**10 DECEMBER 2015**

**MEDIA RELEASE**

**City's Council amends and approves proposed water restrictions**

***The implementation of Level 2 water restrictions was today approved by the City's Council after an amendment to the report that allows for relaxed rules in certain instances. In addition to getting residents to tighten up on their water usage, this will have implications for their water accounts. In addition, the City would like to inform residents that they may experience a slight change in the taste and colour of their water going into summer due to lower dam levels. Read more below:***

The implementation of Level 2 water restrictions was today approved at the City of Cape Town's final Council meeting of the year. The committee approved the step up to Level 2 water restrictions in Cape Town, after an amendment was made to cases pertaining to alternative water source users.

The amendment states that when watering gardens, parks and open spaces with alternative water sources (rain-water harvesting, grey water reuse, treated effluent water, wellpoints and boreholes) residents are encouraged to do so only before 09:00 or after 18:00 on Tuesdays, Thursdays and Saturdays, and to display the appropriate signage which must be clearly visible from a public thoroughfare. Users must be registered with the City in order to do so. This was in response to customers who expressed dissatisfaction with the stringent measures being applied to those who have already taken steps to use alternative water sources in the interests of reducing their consumption.

As we are situated in a water-scarce region, the City imposes Level 1 restrictions (10% water savings) at all times. Because the City's dam levels are lower than the norm for this time of year, it was proposed that the City implement Level 2 restrictions (20% savings) to preserve the long-term sustainability of the resource.

Furthermore, if passed by Council, residents will have to abide by the following, more stringent regulations:

- No watering (e.g. using buckets) of a garden, sports field, or other grassed area using potable water between 09:00 and 18:00
- No watering (e.g. using buckets) will be permitted within 24 hours of rainfall that provides adequate saturation. Facilities/customers making use of boreholes or other alternative sources are not exempt
- Irrigation (e.g. hose pipe/sprinklers) is only to take place on Tuesdays, Thursdays and Saturdays during approved hours, and for no longer than an hour in total. Facilities/customers making use of boreholes or other alternative sources are not exempt
- If alternative water sources are utilised, customers should ensure that they display signage to this effect clearly visible from a public thoroughfare
- Where a hosepipe is used for irrigation, it must have a controlling device attached at the end
- No washing or hosing down of hard-surfaced or paved areas with potable (drinking water from tap) water
- A hosepipe used for washing vehicles must be fitted with an automatic self-closing device
- Automatic top-up systems for swimming pools and garden ponds are not allowed. Furthermore, the use of a pool cover is recommended
- Commercial car-wash industries must comply with industry best practice norms. Informal car washes must use buckets rather than hosepipes
- Wash basins in public facilities must be fitted with demand-type taps
- Showers provided at public facilities must be fitted with demand-type valves
- Potable water may not be used to dampen sand or other building material to prevent these materials from being blown away
- Standpipe draw-off taps must be of a height of at least 450 mm, measured above ground level
- The maximum flow rate from any tap installed at a hand basin may not exceed 6 litres per minute
- The maximum flow rate of any showerhead may not exceed 10 litres per minute
- Water closet cisterns may not exceed 9,5 litres in capacity
- Automatic flushing cisterns or tipping tanks shall not be used for flushing a urinal
- All automatic flushing cisterns fitted to urinals must be replaced with manually operated systems, or non-manual apparatus that only flushes after each use
- Terminal water fittings (taps and outlets) installed outside any buildings, other than residential buildings, must incorporate a self-closing device; or have a removable handle for operating purposes; or be capable of being locked to prevent unauthorised use; or be of a demand type that limits water use for each operation
- Water audits must be undertaken annually by major water users (more than 10 000 kl a month), but excluding where these are multiple dwelling units
- No person may allow water, used as a heat-exchange medium in any equipment or plant and supplied from a water installation, to run continuously to waste except for maintaining a prescribed level of total dissolved solids in a recirculating plant
- Ornamental water features may only be operated if the water is recycled

Residents who wish to apply for an exemption can apply to the City's Director: Water Services by contacting Water.Restrictions@capetown.gov.za

In addition, the City would like to inform residents that changes to the bulk water distribution system could intermittently impact on water pressure, clarity or taste within some areas of the northern and central suburbs of the city. These changes became necessary due to the low level of the Voëlvlei Dam.

Resultant flow changes in some of the water pipelines may temporarily cause cloudiness or a slight discolouration in the water. Residents with sensitive palates may also notice a slight change in the taste of their water as it will now be coming from a different mix of sources.

Water consumers in several parts of the city may have also experienced an earthy taste and odour to their drinking water caused by low levels of Geosmin in dam waters. We would like to reassure residents that this is a naturally occurring compound and is neither toxic nor harmful to health. Water quality is monitored continuously and all water supplied will be entirely safe for human consumption.

Residents and visitors are assured that the City is working proactively to manage available water resources and reduce the effects of geosmin in the source waters – concentrations of which are anticipated to increase with lower dam levels and hot, windy conditions.

The City would like to remind residents that these are not punitive measures, but rather the City taking the necessary steps to protect our water supplies and guard against finding ourselves in full-blown crisis, as has been the case in other municipalities.

The City thanks residents for their cooperation and understanding.

**End**

**Issued by: Media Office, City of Cape Town**

**Media enquiries: Councillor Ernest Sonnenberg, Mayoral Committee Member for Utility Services, City of Cape Town**

# ANNEXURE K: Municipal Account Insert

CITY OF CAPE TOWN
ISIXEKO SASEKAPA
STAD KAAPSTAD

WATER AND SANITATION DEPARTMENT

**EXCESSIVE WATER CONSUMPTION WARNING**

Dear Consumer/resident

The City of Cape Town has implemented Level 3b Water Restrictions as dam levels are low due to the regional drought following two successive years of extremely low winter rainfall.

The City has thus been appealing to all users to reduce their water consumption significantly. As at 13 February 2017, with the last 10% of a dam`s water being unusable, City-supply dam levels could be seen as effectively around 26%.

According to our records your January 2017 consumption was higher than 50 kilolitres. It should be well below this level.

Your consumption is viewed as excessive and unacceptable given the drought and resultant water restrictions imposed by the City.

Cape Town is a water scarce region and we are making every effort to manage the water crisis.

Out of the almost one million customers we supply with water, most households are using an average of approximately 20 kilolitres per month. There are 20 000 households using significantly more than this and your household is one of them.

The City values the effort and co-operation of many consumers who have reduced their consumption considerably. You must do the same. To ensure efficient water usage, we encourage you to follow the attached Level 3b water restriction measures and to visit the City`s website for further water saving tips.

You are hereby warned to reduce your consumption immediately failing which the City will consider the installation of a water restricting device.

**If you are found to be contravening restrictions you will be fined.**

**If you have any queries or require technical support from the Water Inspectorate, please do not hesitate to contact Water.Restrictions@capetown.gov.za for assistance and advice on reducing your water consumption.**

**To contact our 24-hour Call Centre, phone 0860 103 089 or send an SMS to 31373.**

**Yours faithfully,**

P. de Lille

**PATRICIA DE LILLE**

**EXECUTIVE MAYOR**

CIVIC CENTRE IZIKO LEENKONZO ZOLUNTU BURGERSENTRUM
12 HERTZOG BOULEVARD CAPE TOWN 8001 PO BOX 298 CAPE TOWN 8000
www.capetown.gov.za

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