Exploring the implementation of Integrated Water Resources Management (IWRM) and Adaptive Management (AM) at a local scale:

A Case study of the uMngeni Catchment, KwaZulu-Natal.

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Abstract

Integrated Water Resources Management (IWRM) and Adaptive Management (AM) are internationally recognised approaches to water resource management. IWRM promotes the application of principles such as integration, participation, inclusion, equity, accountability and efficiency which guide the water sector thus creating an enabling environment for practitioners and decision-makers to be more integrated. AM complements IWRM by embracing uncertainty in water resource management attributed to climate change effects and ineffective governance regimes. AM promotes the institutionalisation of social learning within organisations operating in the water sector by incorporating experimental management practices to inform decision-making. The uMngeni catchment in the province of KwaZulu-Natal, South Africa, faces numerous challenges that threaten the availability and quality of water resources. The aim of the study is to assess the institutional aspects that may or may not facilitate the implementation of IWRM and AM and to provide recommendations for effective management. Therefore, a case study approach was utilised to gain an understanding of the implementation of IWRM and AM at the local scale. There were twenty-one semi-structured interviews which were conducted in the Msunduzi Municipality and eThekwini Metropolitan Municipality. A range of environmental, development and water service governance tools were analysed. Through the collected data, several key findings emerge. Firstly, it is evident that the delay in the establishment of an operational Catchment Management Agency (CMA) and the absence of Water User Associations (WUAs) is hindering the implementation of IWRM and AM. Despite the lack of an authoritative body (CMA) and bridging agents as represented by WUAs, role-players in the catchment are actively attempting to improve integration among water users and to address this void. Secondly, the protection and conservation of water resources is governed by the National Water Resources Strategy (NWRS) at a national level and the draft proto-Catchment Management Strategy (CMS) at a regional level. Even with these tools, participants from non-governmental organisations stated that water resources have been managed (regional and national level) for water service provision rather than resource protection. In addition, the overlap and misunderstanding of catchment management roles and responsibilities between municipal departments and private landowners is negatively affecting the degree of integration as well as learning occurring in the catchment. Lastly, most of the participants' acknowledged the importance of participation and integration, but also indicated that the application of the concept of IWRM is not ideal at the local level particularly in a developing

country. Many participants do not understand AM. The limited practice of social learning in the catchment can be attributed to key strategies i.e., CMS not being official, and information sources (e.g., river health reports) not being updated. There is a recommendation to include previously excluded groups into water resources management through the application of the Corporate Social Responsibility (CSR) model. The model will assist in relationship building and fostering partnerships to improve catchment management and to create a culture of accountability and stress the urgency of this for water resource management.

Declaration

I Akosua Kyerewaa Awuah declare that:

I. The research reported in this thesis, except where otherwise indicated, is my original work.
II. This thesis has not been submitted for any degree or examination at any other university.
III. This thesis does not contain other data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other researchers.
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Acronyms

°C	Degrees Celsius	mm	millimetres
AM	Adaptive Management	MoU	Memorandum of Understanding
AMIS	Conceptual Architecture of the Adaptive Information System	MTSF	Medium Term Strategic Framework
CBD	Central Business District	NBI	Nile Basin Initiative
CEAC	Control and Evaluation Advisory Council	NEMA	National Environmental Management Act
CEO	Chief Executive Officer	NGO	Non-Governmental Organisation
CMA	Catchment Management Agency	NPO	Non-Profit Organisation
CMF	Catchment Management Forum	NRLP	National River Linking Project
CMS	Catchment Management Strategy	NRW	Non-Revenue Water
CSR	Corporate Social Responsibility	NWA	National Water Act 36 of 1998
D'RAP	Durban Research Action Partnership	NWRS	National Water Resource Strategy
DALRD	Department of Agriculture, Land Reform and Rural Development	NWRS-2	National Water Resource Strategy 2nd Edition
DEFF	Department of Environment, Forestry and Fisheries	PMB	Pietermaritzburg
DMR	Department of Mineral Resources	PSIR	Pressure State Impact Responses Framework
DUCT	Duzi Umngeni Conservation Trust	RBC	River Basin Council
DWS	Department of Human Settlement, Water and Sanitation	RQO	Resources Quality Objectives
EDTEA	Department of Economic Development, Tourism and Environmental Affairs	SADC	Southern African Development Community
EI	Ecological Infrastructure	SANBI	South African National Biodiversity Institute
EIA	Environmental Impact Assessment	SDF	Spatial Development Framework

EKZNW	Ezemvelo KZN Wildlife	SEMA	Specific Environmental Management Act
EMF	Environmental Management Framework	SIDA	Swedish International Development Agency
EWS	eThekwini Water and Sanitation Unit	SIP	Strategic Integrated Projects
EWT	Endangered Wildlife Trust	UEIP	Umgeni Ecological Infrastructure Partnership
FET	Further Education and Training	UKZN	University of KwaZulu-Natal
GWP	Global Water Partnership	UN	United Nations
HSSREC	Humanities and Social Sciences Research Ethics Committee	UNCED	United Nations Conference on Environment and Development
IAS	Invasive Alien Species	UNDP	United Nations Development Programme
IDP	Integrated Development Plan	URP	uMngeni Resilience Programme
IMF	International Monetary Fund	WMA	Water Management Area
IWMP	Integrated Waste Management Plan	WRC	Water Research Commission
IWRM	Integrated Water Resources Management	WSA	Water Services Act 108 of 1997
km^2	Kilometres Square	WSDP	Water Services Development Plan
KPI	Key Performance Indicator	WSP	Water Service Providers
KZN	KwaZulu-Natal	WSSD	World Summit on Sustainable Development
LCBC	Lerma Chapala Basin Council	WUA	Water User Association
LCBRM	Lerma Chapala River Basin Regional Management	WUL	Water User Licence
MCPP	Municipal Climate Protection Programme	WWF	World Wide Fund
MDG/SDG	Millennium Development Goals/Sustainable Development Goals		

Chapter One Introduction

1.1 Setting the Scene

Water resource management has become a challenging undertaking because of the uncertainties regarding the state and availability of water, as well as the complexities of decision-making within the broader water sector. This is attributed amongst other things to climate change effects and the approach to water governance which has been sectoral, top-down, centralised and supply based rather than managing the demand. Nowadays it almost seems that the biophysical and climatic setting as a starting point is less relevant yet trying to understand arising challenges and uncertainties is necessary. Those areas that have a constant and reliable availability of water resources are probably still easier to manage than those that are not so fortunate due to predominate arid conditions and rainfall variability (Rijsberman, 2006).

From an environmental perspective, water resources are uncertain due to climate change effects, including extreme weather events such as floods and droughts, which have been prevalent across the world for some time. Flood waters carry sediments which are deposited in water within storage facilities allocated for municipal, recreational or agricultural use, resulting in poor water quality. Droughts cause a decrease in water quantity resulting in a further higher concentration of chemicals or salinity which are not dissolved, reducing water quality possibly to the point of high severity (Kubicz et al., 2021; Pena-Guerrero et al., 2020). Therefore, gaining an understanding of the effects of extreme weather events on water resources, based on historical data, does not sufficiently inform decision-making regarding the management of water resources or the severity of future weather events (Mosley, 2015; Rijsberman, 2006). Firstly, from a governance perspective, the condition of water resources and the decisions made around them are uncertain, due to the complex water systems that exist. The environmental features, associated economic and social dynamics, and political influences within a region make decision-making more complex (de Oliveira Vieira, 2020; Vilakazi, 2013). Secondly, institutional fragmentation exists within the water sector where state departments have a history of implementing plans and policies, or dealing with water issues in isolation, rather than in collaboration. In addition, different water use sectors (e.g., agriculture, energy, mining, industry and manufacturing) make independent decisions regarding water usage (Lubell and Edelenbos, 2013; Mitchell, 2005). Thirdly, there is a mismatch between the way academics, practitioners and water managers understand the human-environment-technology systems in the ideal and the way the system is implemented

on the ground (Agarwal et al, 2000). Fourthly, the increase in demand for water supply is attributed to population and economic growth and decision makers are expected to meet these demands despite the fact that water resources are not replenished at the same rate. In other words, there is a mismatch between supply and demand (Engle and Lemos, 2010; Funke et al., 2007; Hameeteman, 2013). Lastly, water resource management is uncertain due to inconsistent water availability and water stress which may, amongst other factors, be attributed to the lack of built infrastructure (dams) causing a lack of access and unreliable distribution of water (Biswas, 2004; Cox et al., 2008; Pahl-Wostl, 2007; Pahl-Wostl and Sendzimir, 2005; Riddler et al., 2010; Sullivan, 2010; Swatuk, 2005; Thomas and Durham, 2003). The issues described above cannot be solved by water professionals alone and the international community has realised that water issues are increasingly interconnected with other aspects of development. Thus, there is a need to engage and include a variety of disciplines in planning, management and research related to, for instance economics, finance, telecommunications, society, technology, the health sector, food industry and the environmental sector (Cardwell et al., 2006; Mitchell, 2005; Thomas and Durham, 2003).

It is essential to note that the discussion around water governance was embedded or coincided with the discourse regarding development. Initially, the driving force behind global development was economic growth and/or gaining political power (Goldin, 2013b; Engle and Lemons, 2010) with little consideration for the physical environment and the communities reliant on it. In addition, water resources and the associated issues was identified as hampering global development. The re-evaluation of the constructs pertaining to global development sought to promote human well-being, civil rights, political freedom and expression, the conservation and protection of ecosystems, all whilst achieving economic growth (Goldin, 2013b). Therefore, improving the way in which water resources had been managed was a large component toward changing the constructs in global development.

Integrated Water Resources Management (IWRM) has been identified as an approach that embodies principles of transparency, inclusivity, accountability, precaution, legitimacy, efficiency and equity that ensure integration (Brown, 2011; Lubell and Edelenbos, 2013; Mitchell, 2005; Rahaman and Varis, 2005; Thomas and Durham, 2003; USAID, 2002; Wiek and Larson, 2012). It emerged as the dominant water management paradigm internationally in the 1980's in response to the inadequacies of former ad hoc and sectoral approaches to water resource management. The development of IWRM is linked with the transformation of global development from repressive and authoritative practices such as top-down decision-

making into bottom-up and participatory development that promotes human rights, political freedom and social justice (Goldin, 2013b). In 1996, the Global Water Partnership (GWP) was formed in partnership with the United Nations Development Program (UNDP), World Bank and the Swedish International Development Agency (SIDA), to globally advocate for the implementation of IWRM in water sectors. The GWP defines IWRM as the "*process where co-ordinated management and development of water, land and related resources are promoted to maximise economic and social welfare without compromising sustainability*" (Lubell and Edelenbos, 2013; Mitchell, 2005; Rahaman and Varis, 2005). This entails resource protection to ensure good water quality and quantity, managing the demand on water supply in all catchments, including water users in the decision-making process, promoting sustainability and adopting principles that will ensure IWRM and effective water resource governance. Thus, cementing IWRM in the global development discourse. In essence, IWRM promotes stakeholder engagement among water users in the decision-making process and the desired outcome being social *equity*, *economic* viability and *environmental* sustainability known as the core pillars of IWRM and the three E's (Agarwal et al., 2000; Goldin, 2013a; Goldin, 2013b). IWRM is transboundary, manifests at a national and catchment level, and aims to initiate a link between research and decision-making (Lubell and Edelenbos, 2013; Philip et al., 2008; Postel, 2000). This is only possible through participation and a transdisciplinary practice which is where most countries fall short in their way of implementing and thus, practicing IWRM (Brown, 2011).

Prior to 1994, under the apartheid regime, water governance in South Africa was centralized and was not inclusive of different interest groups (Movik et al, 2016). Discriminatory policies were implemented that imposed unfair access to water services, land, employment opportunities and education by the black majority (King, 2007). The first democratic election which took place in 1994, saw the election of a new government headed by the African National Congress (ANC). Consequently, discriminatory policies were removed and replaced with legislative frameworks promoting equality for all South African citizens. In addition, the transformation of water resources management was an integral part of political change (Ashton et al., 2006; Bourblanc, 2012; Dent, 2012). The widespread application of IWRM in developed nations and specifically, Australia and Mexico (Denby et al., 2016), informed the adoption of IWRM principles where government institutions restructured to create a decentralised governance system. This started to promote participatory approaches to water governance (Boakye and Akpor, 2012; Brown, 2011).

In the South African case, the White Paper on National Water Policy and the National Water Act 36 of 1998 (NWA) legitimises IWRM, prescribing ways in which the country could redress the imbalances of the past and how the IWRM paradigm would guide and inform a shift away from a centralised water management system to decentralised governance. For example, the Act frames the institutional backing for IWRM and proposes a move from Irrigation Boards which were predominantly exclusive and 'white' to more inclusive and representative Water User Associations (WUAs). Furthermore, the country is divided into nine management areas each to be governed by a Catchment Management Agency (CMA) for each of the designated Water Management Areas (WMAs). CMAs are or would be responsible for protecting, using, developing, conserving, managing and controlling water resources within hydrological boundaries (Bourblanc, 2012; Karodia and Weston, 2001; Philip et al., 2008). The Act also proposes, as a key element for redress, a role for the private sector and the inclusion of private entities who are expected to provide additional financial resources and technical capacity in the provision of water services. The transition from single issue user groups (irrigation boards) to Water User Associations (WUAs) which are representative of all users in a given jurisdiction. Also, promoting participation through the inclusion of local authorities (municipalities). This assists in integrating land-use activities and service provision with water resource management. Promoting participation is beneficial as local authorities are mandated with services provision, development and spatial planning. Thus, local authorities as water service providers and authorities are better positioned to integrate these functions with water resource management. In addition, local authorities are aware of the issues prevalent on the ground and are better positioned to communicate these to catchment and national levels of management. Evidently, the NWA makes provision for the inclusion of all water users in the water management process. The cornerstone of IWRM is thus the NWA and the Water Services Act 108 of 1997 which together provide for a decentralised water management system. Therefore, the characteristics of IWRM such as river basin management, increased stakeholder participation, and decentralisation, has been a tool towards readdress in South Africa which is evident in the NWA and the Water Services Act.

However, implementing IWRM effectively and successfully toward readdress in South Africa, has not been easy. There is fragmentation in governance structures where for example the Department of Human Settlement, Water and Sanitation (DWS), Department of Agriculture, Land Reform and Rural Development (DALRD), Department of Environment,

Forestry and Fisheries (DEFF) and the Department of Mineral Resources (DMR) act in silos and lack co-ordination (Kidd, 2011). This is attributed to water, land-use and environmental activities, administration and legislation being handled by different departments as listed. Funke et al's (2007) work on WUAs and concerns of transformation and redress, claim that there is a lack of IWRM in the planning stages of development and not all water managers have accepted IWRM or have been trained to implement it (Denby et al., 2016). Stakeholders, especially in rural areas, are not as involved in decision-making as they should be due to a lack of interest to partake in governance issues, a lack of understanding concerning a problem at hand or, some members of the public not having have access to the consultative process and platforms, and being unable to attend meetings due to a lack of funds (Funke et al., 2007; Marzuki, 2015). Goldin (2013b) also identifies the issue of exclusion and inclusion claiming that the voices of some are heard and that many voices are muted at the same time. In addition, Goldin (2013b) pinpoints the issue regarding trust and feelings of shame by certain stakeholder groups, illustrating how important trust is in the transformation process and how some users feel shame and do not participate in decision-making processes due to feelings of inadequacy. This has been attributed to a dominant regime which focusses on technical information and management. It does not take the concerns of society into consideration.

In the discourse regarding water resources management, IWRM was designed as a long-term approach to developing water resources in a sustainable manner. However, IWRM does not accommodate the potential management changes that are necessary over a short-term. Thus, Adaptive Management (AM) which is a recent approach (Engle et al., 2011) in water resources management might be relevant.

Adaptive Management (AM) has been identified as a complementary approach that embeds uncertainty as a fundamental principle and can be described as increasing the adaptive capacity of a water system so that the water system can cope under the stresses that exist at any given time (Pahl-Wostl, 2007; Pahl-Wostl and Sendzimir, 2005). AM is defined as a process of implementing a management policy in such a way that the managers can learn from that experience and use the knowledge gained in future decision-making (Rouphael, 2020). Therefore, managers would be learning by managing as they would be evaluating the various management alternatives implemented through experimentation or in other words, in a scientific manner. Applying AM consists firstly of identifying a management issue and defining a goal that is to be achieved by a new management policy. Secondly, it means

identifying the various management options that could be implemented to achieve the goal. Thirdly, creating an experimental design of how the management policies will be implemented i.e., where the experimentation of policies will be applied and how the variables will be controlled. Fourthly, based on the experimental design, the policies will be implemented. This is followed by the monitoring of the management interventions which is necessary to identify the responses from the environment to the management policy. Lastly, the management approach is adjusted based on the outcomes from the experimentation (Pahl-Wostl and Sendzimir, 2005; Rouphael, 2020).

This approach strengthens and complements IWRM by bringing the social learning factor into water governance and management, aimed at improving participation and transdisciplinary practices. Social Learning is based on the idea of 'learning to manage by managing to learn' (Pahl-Wostl, 2007; van der Keur et al., 2010) which entails problem solving as a collective or group of individuals from different professional backgrounds. Water managers, community members, practitioners and scientists (stakeholders) combine resources, expertise and knowledge to solve issues in their respective catchment. Each stakeholder recognises the others' concerns before reaching a shared understanding and implementing a solution. Working in integration ensures communication and information flow. Overall, AM and IWRM work together as concepts as IWRM integrates the multiple systems and processes involved in developing water resources at a strategic level and over a longer time frame. AM focusses on short term solutions to management inadequacies through an experimental approach which facilitates learning and provides a more practical, on the ground, learning experience. The practical implementation of IWRM and AM have proven to be highly problematic due to the socio-economic issues in a jurisdiction and the technical skills required. Furthermore, the influence of IWRM on water governance has not been considered as a hindrance in the implementation of AM which is further explored in the Literature Review chapter (Engle et al., 2011).

1.2 Problem Statement

The uMngeni catchment supplies most of its water to the Msunduzi and eThekwini Municipalities, which are two of the most populated municipalities in the catchment area and contribute significantly to South Africa's GDP. According to the *Reconciliation Strategy Studies* for South Africa's metropolitan areas and major river systems by DWS, the Pietermaritzburg-Durban region is at risk of facing water shortages in the not too distant future (Kidd, 2011; KZN Provincial Planning Commission, 2016; Water, 2014). Moreover,

there are challenges faced in managing the water resources. Rainfall received is erratic and the events of floods and droughts are frequent (Hay, 2017). Inadequate designs of water infrastructure and poor maintenance is evident through leakage causing large quantities of water being wasted (GLS Consulting, 2018). Moreover, unbilled and illegal usage of water resources is an issue in the uMngeni catchment, and this is measured as Non-Revenue Water (NRW). In the Msunduzi Municipality, 45% of the water supplied is NRW whereas in the eThekwini Municipality, 40% of the water supplied is NRW (Hay, 2017). Ineffective solid waste management is another major problem to water resource management where approximately 50% of the households in the river basin do not have their refuse collected on a weekly basis. Consequently, waste is being disposed in nearby rivers and streams worsening the water quality. In addition, the Duzi River which feeds the uMngeni is heavily polluted by raw sewerage spills further reducing the water quality and availability (Taylor and Cenerizio, 2018). These issues are partially attributed to ineffective enforcement and compliance to regulations which is linked to the lack of capacity, skills development, financial resources, leadership and political will (Hay, 2017; Taylor and Cenerizio, 2018).

Therefore, with the understanding that IWRM requires the practice of multiple principles to facilitate integration, structural reforms for decentralisation of water resources management and the adoption of experimental techniques to improve management policies; and considering the various issues evident in the uMngeni catchment, the overarching research questions are,

1. To what degree and how is IWRM implemented in the uMngeni catchment as envisaged by the NWA 36 of 1998 (water policy of SA)?

2. Are there any attempts to make use of the AM approach in order to mitigate shortfalls in water resources management? If so, how and to what degree is this approach to be tracked in water resources management?

This research makes an important contribution to debates on IWRM in general and in KwaZulu-Natal (KZN). Therefore, conducting this research is significant as IWRM and AM is mostly understood by scientists with a technical background, often lacking in the ‘softer’ social skills. This often excludes practitioners and local water authorities who battle or do not understand these concepts. IWRM often remains too vague and is not easily unpacked in a way that makes it accessible to the ordinary water user and municipalities, and other actors on the ground. Finally, published literature on water resources management documents the

progression of IWRM and AM at an international and national level (Cervoni et al., 2008), whereas the practice of IWRM and AM at the local scale and specifically in KwaZulu-Natal has rarely been documented. This study is an opportunity to explore IWRM at the local level and link it to AM.

1.3 Aim and Objectives

This study aims to assess the institutional aspects that may or may not facilitate IWRM and AM at a local (municipal) scale generally but more specifically in relation to the broader uMngeni catchment. It will also propose recommendations for effective water resource governance taking IWRM and AM into consideration.

The objectives to achieve the above aim are to:

I. Identify the relevant institutions or organisations and their sphere of influence with regards to their governance roles i.e., level of implementation of IWRM across the catchment;
II. Investigate how IWRM in the broader catchment features in other areas of governance, specifically development planning, environmental management tools and associated tools (WSDP, IWMP, IDP) at the local level, and how this relates to the execution of water service provision functions in the two municipalities;
III. Investigate key decision makers' perceptions and understanding of how IWRM and AM should be implemented and their willingness to change behaviour for the improved management of water resources in the catchment; and
IV. Provide recommendations for effective water resource governance and successful management using the IWRM and AM paradigms.

1.4 Structure of the Thesis

The purpose of this chapter is to introduce IWRM and AM and their relevance in the face of the current water crises globally and in the uMngeni catchment in particular. Factors hindering the implementation of IWRM include climate change impacts, complex water systems, insufficient information available to inform decision-making, institutional fragmentation and issues contributing to poor water quality and availability. Furthermore, these issues make the practice of AM problematic and due to the complexity of these issues, water managers, practitioners, scientists, the private sector, government and civil society groups need to work together to overcome these challenges to yield long-term outcomes. In doing so, experimental designs are employed to improve management regimes over a shorter

term. This chapter further describes the problem statement and states the research aim and objectives.

Chapter two provides an overview of current and past literature on IWRM and AM. The chapter elaborates on the general transition of water governance regimes, the establishment and description of IWRM and scrutinises whether AM complements IWRM and in what ways. The chapter engages further with how IWRM and AM emerged and the associated implementation efforts internationally before focussing on southern Africa and South Africa. Chapter three is the methodology section which details the research design. The study is qualitative employing the case study approach. A document analysis and semi-structured interviews were conducted to obtain data. The chapter provides an explanation behind the selection of the study site and a description of the catchment. Moreover, the data collection, process of analysis, ethical clearance and the limitations and challenges of the study are described. Chapter four constitutes Paper 1 which investigates the extent to which IWRM is implemented in the respective municipalities, with a focus on the existing institutional dynamics and how it facilitates IWRM practices. Chapter five presents Paper 2 of the thesis which investigates the perceptions of the role-players in the uMngeni catchment toward the two management approaches (i.e., IWRM and AM). Papers 1 and 2 are informed by the data collected through the document analysis and 21 semi-structured interviews (see Appendix A). Recommendations are provided for improved water resources management. Chapter six is the overall discussion of the entire thesis which is also informed by the document analysis and data collected through 21 semi-structured interviews (see Appendix A) and analysed in the two papers. Finally, the chapter and the overall thesis is concluded with the final remarks.

Chapter Two Literature Review

2.1 Introduction

This chapter introduces the topic of Integrated Water Resources Management (IWRM) and Adaptive Management (AM) by describing the current global water crisis and the characteristics of management regimes; aimed at ensuring sustainable development and management of water resources. IWRM and AM promote a management style that is inclusive, continuously reviews implemented water policies and enables the decentralisation of water governance (Albareda and Campos, 2018; Benson et al., 2019; Summers et al., 2015). However, it has been contended that in certain contexts IWRM is not well suited to address water management in light of uncertainties (Allen and Garmestami, 2015; Pahl-Wostl, 2007; Varady et al., 2016), such as climate change effects (Medema et al., 2008; Sullivan, 2010), which is why AM may be considered a complementary approach as it emphasises the aspect of reviewing management policies on shorter timescales to more effectively engage with uncertainties (Riddler et al., 2010). The review forms the theoretical basis for the current research.

2.2 Global Water Crises

There is no doubt that improved and more sustainable water management is needed because of the increasing pressure on freshwater resources leading to an overall decrease of water availability and security (UN-Water, 2008). The world population is rapidly growing meanwhile the amount of freshwater available for human consumption is decreasing (Agarwal et al., 2000; Al Radif, 1999; Funke et al., 2007; Kidd, 2011; Pahl-Wostl et al., 2010; Sullivan, 2010). The growth in world economies is further enabling population growth as people can afford a better standard of living. In today's world, a country such as China has an economy that is steadily growing along with its population (Sullivan, 2010). Consequently, there is increased competition for the use of water by people, and for economic activities in the agricultural, industrial and domestic sectors which depletes water resources (Cardwell et al., 2006). Equally so, water quality influences the availability of water (Kidd, 2011). With increased economic activities, water resources become over utilised leaving the river unable to recover. In many instances, there is an increase in water pollution, because water resources are used as sinks for effluent waste. This has a detrimental effect on human health, aquatic life and the effective functioning of ecosystems. Furthermore, economic marginalisation, social inequality and the lack of poverty alleviation strategies has

caused many communities living in poverty to overexploit natural resources like water, soil and forests which are already diminishing; this is especially true for developing countries (Agarwal et al., 2000; Funke et al., 2007; Sullivan, 2010; UN-Water, 2008).

Further pressure on freshwater resources emanates from past and existing water management regimes that do not effectively manage the use of water (Fischhendler, 2008; Funke et al., 2007; Giordano and Shah, 2017; Lenton and Muller, 2009a; Pahl-Wostl et al., 2010; UN-Water, 2008). Unfortunately, climate change is not making the water crises any easier as there is increased variability in rainfall and increased occurrences of floods, droughts and extreme weather conditions that pose further threats to freshwater sources (Agarwal et al., 2000; Al Radif, 1999). Furthermore, increased temperatures result in greater demand for irrigation water due to the increased evaporation rates which poses an additional threat to water security (Ariyani et al., 2020; Surendran et al., 2014). Approximately a third of the world's population is already living in regions where there is high water stress and this figure is expected to rise to two thirds of the population by 2025 (Funke et al., 2007; Mekonnen and Hoekstra, 2016). Thus, most if not all the literature pertaining to water resource management highlights the importance of changing the way we use and manage water resources (e.g., Anderson et al., 2008; Arfan et al., 2020; Benson et al., 2019; Chang, 2020; Goyal et al., 2020; Hameeteman, 2013; Lenton and Muller, 2009a; Shaban, 2020; Thomas and Durham, 2003).

Consequently, IWRM and AM are two management approaches that have been identified in the literature to improve the management of water resources and change the way we do business as usual.

2.3 Integrated Water Resources Management (IWRM)

In 1990 and even earlier, there was a realisation among the international community that existing water management regimes were failing in being effective for water resource governance because they were supply-driven, top-down and sectoral. A new approach to water management was needed. Early in 1992, the International Conference on Water and the Environment was held in Dublin, Ireland, where the four Dublin Principles were developed (ICWE, 1992). The Dublin Principles state firstly that freshwater is a finite and vulnerable resource, essential to sustain life, development and the environment. Secondly, water development and management should be based on a participatory approach, involving users, planners and policy makers at all levels (Funke et al., 2007; Lubell and Edelenbos, 2013).

Thirdly, women play a central part in the provision, management and safeguarding of water. The final principle being water has an economic value in all its competing uses, and should be recognised as an economic good (ICWE, 1992).

Later in the same year, the United Nations Conference on Environment and Development (UNCED), also known as the Earth Summit, held in Rio de Janeiro, Brazil, was where a strategy for sustainable development called Agenda 21 was created, which incorporated the Dublin principles. At these two conferences, international attention was drawn toward the unsustainable use of water and negative effects of droughts, through the Dublin principles and Agenda 21. Mitchell (2005) recognizes the first two of the Dublin principles that form the basis of IWRM whereas Rahaman and Varis (2005) and Van der Keur and Lloyd (2010) recognize that all the principles are the basis of IWRM. Rahaman and Varis (2005) and Anderson et al. (2008) advocate that IWRM was established after the Mar del Plata conference in Argentina, 1977, contradicting Mitchell (2005). Irrespective of this debate, all these events were fundamental in catalysing a shift in the prevailing water governance paradigm to IWRM as a preferred water management approach at the time (Lenton and Muller, 2009a; Mitchell, 2005; Rahaman and Varis, 2005; Wilkinson et al., 2015). Moreover, the World Summit on Sustainable Development (WSSD) held in Johannesburg, South Africa in 2002, was essential in advocating the management approach because it was declared that all countries were to develop an IWRM framework or water efficiency plans before 2005 (Fischhendler, 2008; Lenton and Muller, 2009a; Sally et al., 2011; Wilkinson et al., 2015).

IWRM was recognised as a holistic approach needed for water management because it would link social and economic development with the protection of natural ecosystems. The Swedish International Development Agency (SIDA), the United Nations Development Program (UNDP) and the World Bank established the Global Water Partnership (GWP) in 1996, in response to international calls for a unique organization that would advocate IWRM (Agarwal et al., 2000; Van der Keur and Lloyd, 2010).

2.3.1 Defining IWRM

The GWP has defined IWRM as the process where co-ordinated management of water, land and related resources is promoted so as to maximise economic and social welfare while achieving environmental sustainability (Agarwal et al., 2000). Swatuk (2005) defines IWRM slightly differently stating that IWRM is the equitable use and access to water by stakeholders at a catchment, regional or international level (Al Radif, 1999). In so doing, the integrity of

water resources is maintained due to agreed limits of consumption. Anderson et al. (2008) define IWRM as an approach that leads to better water use while attaining economic and social objectives, and environmental sustainability. The most popularly used definition is that of the GWP with numerous authors opting to cite it such as Lubell and Edelenbos (2013), Medema et al., (2008), Mitchell (2005), Thomas and Durham (2003), and Wilkinson et al. (2015). However, of the cited literature, Cardwell et al. (2006) breaks down the entire concept word for word which leads to a better understanding. Firstly, integrated is defined as bringing different parts together or unity. Secondly, water is defined as a liquid that is important for life on earth and is also a body of water i.e., rivers, streams, oceans and lakes. Thirdly, resources are described as an item or thing of value which could be utilised or can provide support of some kind. Finally, management is defined as an act of arranging, controlling or handling something so as to reach an objective. With that said, IWRM can be understood as a coordinated and goal orientated process that controls the use and development of lakes, streams and rivers among other water resources. The implication is that water is prioritised in the stages of development to ensure the sustainability of the resources for now and the future. To take it a step further, Cardwell et al. (2006) suggest that institutions, time, physical space and objectives are the aspects that need to be coordinated.

Although there is no universally agreed definition of IWRM as detailed above, three aspects are common among all the definitions which are important to highlight. Firstly, IWRM is not about attaining an end state of being sustainable, rather it is a continuous process (Lubell and Edelenbos, 2013). This means IWRM practices should not cease, they should be flexible and adaptive. Secondly, IWRM is goal orientated as all the definitions make mention of either achieving economic development or ecological health. Thirdly, the level of integration in water management will be at varying degrees at any point in time depending on where it is applied and depending on the economic, social and environmental factors influencing the implementation of IWRM. This means the integration of resources may be partial as opposed to being completely integrated (Bourblanc, 2012; Cardwell et al., 2006).

This management approach is therefore based on three pillars: economic efficiency, social equity and environmental sustainability (Badham et al., 2019; Carriger, 2006; Lenton and Muller, 2009a; Wilkinson et al., 2015). With water and financial resources becoming increasingly scarce, efficiency is necessary where the least amount of water is used in developmental activities. Equity is important because it is people's basic human right to have access to safe and sufficient water for well-being and, sustainability is important because

current generations need water for economic and social activities, but in a way that does not jeopardize future generation's ability to do the same. With that being said, the nature of IWRM is the interaction within and between natural and human systems (Medema et al., 2008). The former entails the integration between freshwater and coastal water, upstream-downstream management, groundwater and surface water management, land and water management, blue water and green water. The latter entails the mainstreaming of water resources in policy making, cross-sectoral integration, the integration of stakeholders in the decision-making process and the integration of wastewater management with water management which is described in the following sub-section.

2.3.2 The Natural System

Integrating freshwater management with coastal management is characterised by how freshwater resources and run-off determine the conditions of coastal ecosystems due to land-use activities (Balle-Beganton et al., 2010). With the increased use or extraction of water, there will be a reduction in run-off into coastal areas. Water of poor quality that flows into marine environments is attributed to pollution that emanates from land-use activities (Weideman et al., 2020). Common activities include mining, agriculture and domestic uses. Therefore, freshwater management should take into consideration coastal environments. This is a form of upstream-downstream management or rather a continuum thereof (Agarwal et al., 2000; Nepal et al., 2014). Upstream-downstream management involves activities that occur upstream in a river catchment and how they determine whether activities can be carried out downstream (Nepal et al., 2014). Similarly to freshwater and coastal management, water quality in a river basin is determined by the activities that occur upstream (Al Radif, 1999). Land-use upstream can influence groundwater recharge and river flow. Measures taken upstream to control flooding may result in an increased level of vulnerability of stakeholders and communities downstream who may depend on increased water supply (Somos-Valenzuela et al., 2015).

Integrating groundwater management with surface water management is an extension of upstream-downstream management that occurs on the earth's surface but includes the management of groundwater supply. Groundwater is a large contributor to economic and social development but is vulnerable to pollution from agricultural, mining, domestic and industrial activities (Cox et al., 2008). Considering the technology that is available and the costs to acquire water treatment equipment, reversing the effects of groundwater pollution or contamination within a human time scale is near impossible. Therefore, IWRM needs to

include integrating ground and surface water into planning and decision-making. As mentioned, land-use activities influence the quality of water in rivers and dams (Al Radif, 1999; Luo et al., 2020). However, integrating land and water management highlights the important part that has not been mentioned, which is that the quality and quantity of water flowing in rivers will determine the condition or health of terrestrial and aquatic ecosystems. If ecosystem functioning is not considered in water allocation for the ecological reserve specifically in South Africa, ecosystems will cease to function effectively.

Another important aspect of the natural system is differentiating Green Water from Blue Water. Green Water is described as water that is used for plant growth and water that is transferred through evapotranspiration, whereas Blue Water is described as water that flows in rivers and aquifers. Terrestrial ecosystems can only function with Green Water and aquatic ecosystems require Blue Water. However, there is a dominance in published literature on Blue Water and aquatic functioning while less attention has been placed on terrestrial functioning and soil water management. Green Water management is as important as Blue Water management because it ensures water efficiency in respect to crop yield per water drop and evapotranspiration and protecting ecosystems which is linked to land and water management (Grammatikopoulou et al., 2020; Mekonnen and Hoekstra, 2016; Rijsberman, 2006).

Lastly, the development and management of water includes ensuring sufficient quantities of water is available which is of good quality. The challenge of poor solid waste management reduces the quality of water and ultimately, the water that is available and suitable for human consumption (Kidd, 2011). Therefore, management systems should consider integrating the monitoring of water quality and water quantity in decision-making processes (Agarwal et al., 2000).

2.3.3 The Human System

Mainstreaming of water resources in policy making involves considering the implications of governmental policies and financial planning on the various water resource assets, and the private sector taking into consideration water resources when it comes to production, consumption and the various uses of technology and equipment on water resources (Agarwal et al., 2000; Schoderer et al., 2020). The decisions that state owned entities, trans-national companies and individuals make will have an impact on water availability, water demand, water quality and water-related risks. To effectively integrate water resources into planning

and management, a better understanding of water systems and their vulnerability, capacity and limits is essential (Agarwal et al., 2000; Al Radif, 1999). Relevant information needs to be made available so that decision-makers are aware of the costs of their decisions on water resources. Finally, a platform or mechanism needs to be in place where stakeholders can be included in water resources allocation, planning, conservation, use, decision-making and conflict resolution.

Cross-sectoral integration is another important aspect of the human system where water policies should be aligned with national economic policies and sectoral policies. This is because of the different sectors that directly or indirectly influence water (Javadinejad et al., 2019). An example is the energy sector that uses large quantities of water for electricity generation. Such sectors need to consider their implications on water resources and should be included in water resources management because they influence the quantity and quality of water (Giordano and Shah, 2017). Moreover, any form of development, whether economic or social, needs to consider impacts on water resources. Thus, before development can take place, evaluations need to be carried out concerning water requirements (Agarwal et al., 2000).

The integration of stakeholders in the decision-making process has been identified as key in order to reach a state where water is distributed and used sustainably (Badham et al., 2019). However, the more role-players provide input into a decision-making process the probability increases that different interests and objectives might lead to conflict. Therefore, IWRM needs to have in place conflict resolution tools and approaches where necessary trade-offs or prioritization of interests can be made (Hileman et al., 2016). Moreover, systems need to be in place to include all societal groups into the decision-making process and ensure their access to the consultative process and platforms, building trust among all stakeholders, and interpreting technical information for all stakeholder groups to understand (Funke et al., 2007; Goldin, 2013b; Marzuki, 2015). What is useful is identifying the water management functions at each level of implementation, then identifying and mobilizing the stakeholders who are well positioned to execute the respective functions (Cox et al., 2008).

In addition, there is a need for the integration of wastewater management with water resources management. Water is a reusable resource, but there need to be mechanisms and systems in place to ensure that wastewater is well purified before it is released back into the environment. If adequate mechanisms or processes are not in place, water quality will be

impaired causing the cost of water supply to rise significantly (Zeng et al., 2020). Therefore, to encourage the wise use of water and appropriate disposal of solid waste among communities to reduce the need for additional water purification systems, economic incentives are a positive method of encouraging wise water use. An example includes fee structures such as block tariffs. Block tariffs are characterised as volumetric charges or prices due to water users paying a certain amount based on the volume of water consumed and waste produced. Therefore, households consuming high volumes of water will result in paying higher charges whereas households consuming lower volumes of water will pay lower charges (Narzetti and Marques, 2020; Wilkinson et al., 2015). Block tariffs encourage wise water use as water users can identify the relationship between the amount of water consumed and the price of water.

IWRM as an approach aims to integrate the above factors, just to name a few, when making decisions to ensure the sustainable management of water resources. In doing so, the implementation of IWRM within a country, river basin, or catchment is based, according to the GWP, on three areas of management: the enabling environment, institutional dynamics and management instruments. The GWP has defined these areas collectively as the IWRM Toolbox (de Oliveira Vieira, 2020; Grigg, 2019; Wellens et al., 2019) and this is presented in more detail in the next sub-section.

2.3.4 The IWRM Toolbox

The implementation of IWRM through the Toolbox aims to achieve ecological sustainability, economic efficiency and social equity (Figure 2.1), and the toolbox consists of 12 areas of management (Figure 2.2).

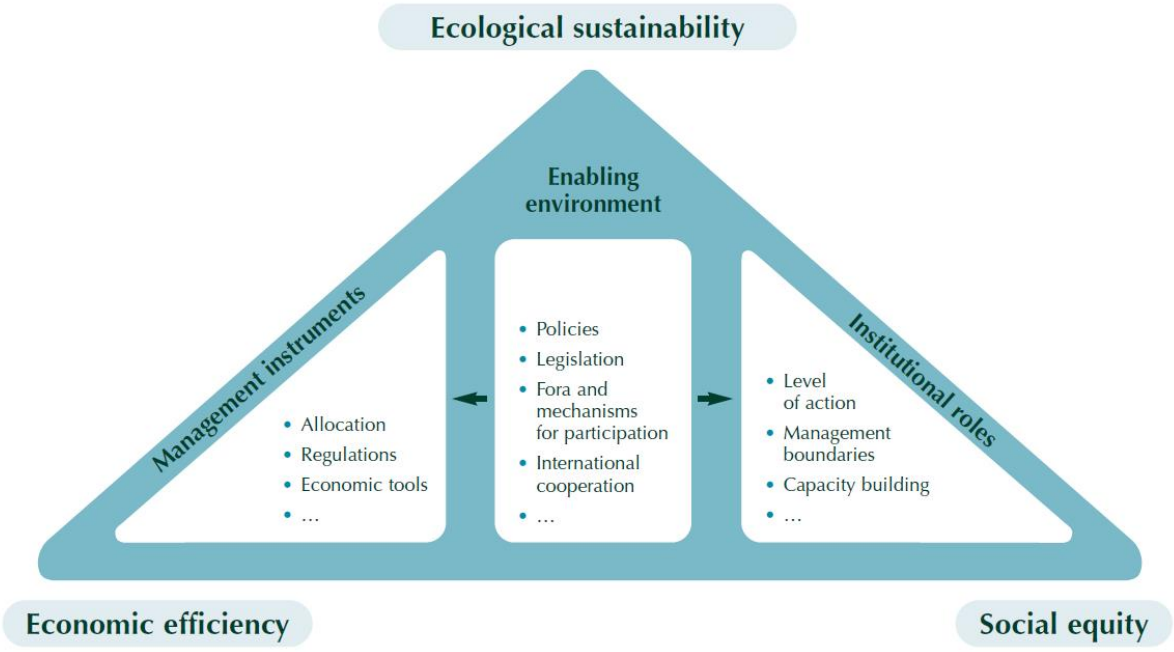

Figure 2.1 The IWRM Toolbox and the three core pillars of the IWRM approach, taken from the Technical Advisory Committee Background Paper no.4 by Agarwal et al (2000).

Enabling environment
1. Policies
2. Legislative framework
3. Financing and incentive structures

Institutional roles
4. Organizational framework
5. Institutional capacity building

Management instruments
6. Water resources assessment
7. Demand management
8. Social change instruments
9. Conflict resolution
10. Regulatory instruments
11. Economic instruments
12. Information management and exchange

Figure 2.2 List of the twelve areas of management categorised in the three groups of the IWRM Toolbox, taken from the Technical Brief (Carriger, 2006).

The enabling environment can be referred to as the 'rules of the game' because it is the prevailing legislation governing a state, the collection of policies implemented by the different tiers of government, and the financial assets that allow stakeholders to fulfil their roles pertaining to water resources management (Agarwal et al., 2000; Vilakazi, 2013; Watson et al., 2019). The enabling environment needs to be well-structured and effective so as to allow the legitimisation and implementation of IWRM policies and plans within the legal frameworks (Lenton and Muller, 2009a).

Water legislation in South Africa, namely the National Water Act (NWA) 36 of 1998 and the Water Services Act (WSA) 108 of 1997, is of utmost importance as it allows for secure and transferable water rights to be established; provides a guideline for the acquisition of water rights by respective users; governs the use of water which is important during times of water scarcity; and explicitly describes the roles and responsibilities of water management agencies, municipalities, authoritative bodies and water and sanitation service providers (Kidd, 2011; Vilakazi, 2013). Moreover, water legislation highlights the importance of water for human needs and thus protects the interests of the general public and future generations. Resource protection and ecosystem functioning is catered for by the inclusion of the Reserve to ensure that the physical environment has sufficient water to function. Characteristically, water legislation cuts across all the water use sectors by establishing the rights and obligations for different stakeholders or water users, promoting sustainable development (Agarwal et al., 2000; Carriger, 2006). Water legislation also needs to make provision for the issuing of fines or penalties as consequences of law infringement. Therefore, without detailed legislation at the national level, designing and implementing IWRM policies can prove to be difficult (Wilkinson et al., 2015). Furthermore, national development strategies and economic policies (e.g., National Development Plan and Medium-Term Strategic Framework) need to consider water policies so that they are aligned and complement each other. Sectoral policies also need to consider potential water resource implications that may arise after decisions have been made (Carriger, 2006).

Furthermore, legislative documents describe the responsibilities of governments, the private sector, municipalities and individual users concerning finances in the water sector (Agarwal et al., 2000). Water resource management issues may be due to the lack of funding or lack of long-term planning and budgeting, resulting in strategies that are not self-sufficient. Financial organizations need to be explicit about who is responsible for resource management and development costs, what the public are responsible for and ensuring that subsidies are

directed to the appropriate people and issues with regards to water (Hamdy et al., 1998). For instance, funds set aside for water service infrastructure maintenance should not be re-directed toward a different function (Collignon, 2002). A well-structured enabling environment is thus crucial in the sharing of water resources in a river system to ensure an upstream-downstream continuum.

When it comes to the enabling environment, implementing IWRM has been difficult because of the varying statutory basis within different countries which legitimise IWRM. A solution is the mainstreaming of IWRM in land-use planning and policies, which will further promote IWRM practices with regards to how management is done, how decisions are derived, which stakeholders are participating, and which stakeholders are not (e.g., water issues like groundwater pollution emanate from land-use, so it is reasonable to link the two) (Mitchell, 2005). Secondly, the design of vague policies that do not have a clear plan of action or description of roles and responsibilities makes it difficult to implement IWRM. Similarly so, IWRM frameworks that are implemented are generic and not site-specific, and do not account the site-specific priority issues and existing capabilities of institutions to deal with them (Watson et al., 2019). Often at times, decision-makers make the mistake of implementing too many changes in a short period of time, instead of at a slower pace (Carriger, 2006). There are states or regions (e.g., Districts in Tanzania and in the Andean region) that do not have an enabling environment that is functioning effectively, which may lead to the inability of institutions to implement IWRM (Chumbula and Massawe, 2018; Cremers et al., 2005). However, institutions do not need to re-establish legislative frameworks but can rather strengthen existing legislative frameworks or systems, and enforce the water plans that have been formulated. This was the case in Egypt where their governance system was strengthened and a strategy was developed to address the challenges in governance at the national level (Carriger, 2006).

The second category of the IWRM Toolbox is the institutional frame which focusses on the organisations at the local, regional, national and international levels; involved in water resources management. Each organisation needs to have well-defined roles and responsibilities, and the capacity to carry out tasks. The ability of water resource organisations to fulfil their mandates rests largely on the institutional capacity.

Institutional capacity building is a large component of institutional dynamics and is described as the collective efforts to building, empowering, equipping and enhancing the capabilities

and skills of organisations and the employees, so as to ensure better performance (Hamdy et al., 1998; Partnership, 2009; Wilkinson et al., 2015). It includes improving managerial systems, educating and training employees so they can carry out their responsibilities, conducting networking sessions, workshops or seminars, and having access to necessary resources such as libraries, databases and equipment (Franks, 1999). Capacity building within the water sector is aimed at training individuals to enable them to work in different settings or water-use sectors. Moreover, Hamdy et al. (1998) claim that limitations to water resources development emanate from a lack of capacity. Individuals within the water sector cannot rely on their tertiary education skills to be adequate for their entire career. Rather, they would need to partake in regular training so as to adapt to the changes in their respective work environment. Institutional capacity also includes the aspect of capability, which refers to the size or number of employees within an organisation. The enabling environment as described is essential as it provides a space in which organisations and individuals work (Franks, 1999; Hamdy et al., 1998). An organisation may not be as efficient as it needs to be if their employees are not trained in the new ideas around IWRM or/and if there is a shortage of people to fulfil roles. Institutional capacity and capability can be limited due to a lack of financial resources or human resources which determines whether there will be inter-institutional integration (Agarwal et al., 2000; Horlemann and Dombrowsky, 2012). To ensure institutional development, mechanisms such as staff management and performance monitoring need to be in place (Franks, 1999). Capacity building should not only be about increasing the capacity of organisations but about enhancing the ability of decision-makers to evaluate and address the policies implemented, empower civil society to partake in this process and increasing their resilience in order for them to adjust to changing conditions; all within the boundaries and limits of the environment and their needs (Hamdy et al., 1998). For IWRM to be implemented successfully, capacity building needs to be long-term and continuous. As acknowledged in the early 1990's, human capacity building is an important contributor to water resource management and development.

IWRM requires the decentralization of responsibilities and authority from the national level organisations to provincial and local levels of governance (Carriger, 2006). In South Africa, the custodian of water resources is the Minister of Water Affairs which is at the national level. They are responsible for protecting, developing, managing, using and conserving water resources within their jurisdiction, equitably and sustainably. At the regional level in South Africa, formal water resource management related bodies include service agencies,

consultative committees, catchment management agencies, irrigation boards (and the newly transformed water user associations), catchment management agencies, advisory committees, water tribunals and district municipalities (Agarwal et al., 2000; Meissner et al., 2013). In situations where a catchment management agency has not been established, the water ministry assumes the respective responsibilities. Advisory committees are statutory bodies and theoretically, these bodies play an advisory role to the Minister or Ministry of water, but this may not be the case in reality (National Water Act, 1998). Conservation agencies are also involved in the conservation or allocation of water for effective ecosystem functioning. Regional level organisations that are established according to hydrological boundaries are usually responsible for the allocation of wastewater or water discharge permits, charging or setting of water prices, monitoring and assessing water resources, arbitration of conflicts and land-use planning (Agarwal et al., 2000). River Basin Organizations (RBOs) can be advisory bodies to existing administrative bodies or can become executive bodies with the authority to collect fees and allocate water rights (Agarwal et al., 2000). At the local level, there is a mixture of statutory and non-statutory organisations who are involved in water resources management (Goldin et al., 2008; Malzbender et al., 2005). Water User Associations (WUAs) consist of individual water users who are responsible for certain water activities within a catchment (Ncube, 2018; Wilkinson et al., 2015). WUAs and local municipalities are statutory bodies with the former being required by the NWA 36 of 1998, and the latter being governed by the WSA No 108 of 1997 regarding water service provision (Wilkinson et al., 2015). Community group networks and catchment management forums are non-statutory organisations involved in water resources management (DWAF, 2002). However, due to the participatory approach of government, these organisations play a useful role in information dissemination to the general public. In addition, civil groups are able to communicate their concerns to higher levels of management. NGOs and steering committees that have been formed are also non-statutory and provide support to statutory bodies toward water resources development (DWAF, 2002). The manner in which responsibility is distributed among these organisations will influence the generation of knowledge and dissemination of information, the power dynamics across institutional scales, and the ability of these role-players to fulfil their tasks (Boakye and Akpor, 2012; DWAF, 2002).

The third category of the IWRM Toolbox refers to the management instruments which are the various methods that are used to assist decision-makers to make well-informed decisions. For IWRM to be effective, water managers need to have access to relevant and updated

information pertaining to: ecosystem state or functioning, the hydrological cycle, water quality and quantity, flow dynamics of the surface and groundwater, the relationship between communities' livelihoods and natural resources, socio-economic factors i.e. demography and land-use activities, political influences and perceived development needs (Grigg, 2016). Such information is useful because resource management and making development decisions require a holistic approach. Utilising information that is up to date allows water managers and practitioners to direct their attention to identifying problems or priority areas in relation to water resource issues, recognize where maintenance of water resource infrastructure is needed, and to identify where investments or financial resources are being used (Agarwal et al., 2000; Wilkinson et al., 2015). Constant assessments and monitoring of water resources are important because there are many water-uses for human consumption and economic activities, land-use and the negative effects of climate change, that cause water resources to become depleted. A commonly utilised assessment tool for identifying potential effects of development projects on water resources are Environmental Impact Assessments (EIAs). EIAs are required in terms of environmental legislation in many countries including South Africa and is a proactive approach to prevent ecological degradation (Aucamp, 2012). Other management instruments include communication and information systems, demand management and regulatory instruments which is described in the following sub-sections (Agarwal et al., 2000; Wilkinson et al., 2015).

Communication and Information Systems

For an effective water resource management approach, there needs to be effective communication and access to information pertaining to water supply, use, resource inventory, flow dynamics, water rights and continuous monitoring and regulation (Partnership, 2009; UN-Water, 2008). The important part is communicating such information to different stakeholder groups (Wilkinson et al., 2015). An environment needs to be created where information is disseminated to the public, i.e., through hearings or community meetings. It is essential that there is two-way communication where practitioners or water managers are not dictating or informing, but rather are in a dialogue with stakeholder groups through a co-management approach (Morsing and Schultz, 2006). Attention needs to be placed on the delivery of information so as to minimise confusion. Scientists, practitioners and water managers need to focus on the language, style and format they use to deliver information that will allow non-technical stakeholders to understand. Many make the mistake of using jargon when hosting a meeting which alienates public groups and cause them to lose interest

(Boakye and Akpor, 2012). It is also imperative that through communication, stakeholder expectations are managed. Information management is necessary for decision-making and managing of water resources (Wilkinson et al., 2015).

Demand Management

Although water resource management is characterised by the integration of catchment management activities and stakeholder participation, demand management and supply management are integral to the success of IWRM implementation. Demand management is about ensuring efficient use of water supplies that are already available from a water resource within a basin, to avoid the need to establish new water resources such as building new dams, reservoirs and inter-regional transfer schemes (Butler and Memon, 2005; Wilkinson et al., 2015). The need for demand management has become apparent because of the growing population, competing uses for water, the effects of climate change and the change or improvement in lifestyle which increases water consumption. Demand management goes hand-in-hand with regulatory instruments which are directed at positively influencing the behaviour of water users. It includes the use of water meters, rainwater harvesting, re-use and recycling of greywater, monitoring water leakages and ensuring the conservation of water. Unlike supply management, which has characterised water resource management for too long, water management was centred on meeting the demands of consumers through quantity and quality. Consequently, the use of legislative, financial or technological instruments to reduce water consumption was only welcomed by consumers during times of crises i.e. drought (Jeffrey and Gearey, 2005). Now, new IWRM strategies focus on the wise use of water resources to ensure sustainable development (Al Radif, 1999).

Regulatory Instruments

Regulatory tools provide operational guidance for IWRM to be implemented. The first type of regulatory tool are economic instruments or market-based instruments, which are financial methods of influencing water resource management (Vilakazi, 2013). An example of the influence of economic instruments would be the restrictive use of water to water a residential lawn or, a limit imposed on a company for the quantity of water that can be withdrawn from a given water resource. The polluter pays principle and economic instruments such as tariffs and fee structures are preferred over ‘command and control’ methods which are characterised as government bearing all the costs of water usage and wastage. Command and control require water users to attain permission from government for water usage, abiding by the set

standards and government taking full responsibility for liability or issues. Instead, the application of the polluter pays principle through monitoring and compliance holds water users accountable for the excessive use and abuse of water resources. Moreover, economic instruments can be used as an incentive or to reward water users on desired behaviour or as a punishment for undesirable behaviour (Cantin et al., 2005; Lyon and Maxwell, 2000). Fee structures such as volumetric pricing and block tariffs assist in reducing the quantity of water being used. Volumetric pricing is effective within the agricultural context because it allows volumes of water to be purchased at a discount, provided that farmers pay for water that is for a unit area needed without a surplus generated. Fee structures ensure that high-volume users pay more which may deter excessive use of water. Cross-subsidization is another fiscal instrument where subsidies are redirected from better-off water users to poorer users (Agarwal et al., 2000; Arlosoroff, 1999; Kumar and Singh, 2001; Wilkinson et al., 2015). However, the introduction of new fee structures may require additional monitoring and regulation. There has been little evidence of the effectiveness of the use of economic structures because government attempts to achieve multiple objectives simultaneously, i.e., increasing the water abstraction fee to promote environmental sustainability while deterring excessive water use, and to raise revenues. This makes it difficult to decide which goal the economic instrument has achieved. Therefore, economic instruments need to be used for one objective and public participation is essential for it to be successful. When the public has no knowledge or is against this method, economic instruments do not influence water use behaviour (Cantin et al., 2005).

Direct instruments are largely procedural because it consists of monitoring and compliance of water use, the use of regulations, legislation and guidelines to control excessive water abstraction. Performance indicators need to be determined so as to know when too much water is used, or when IWRM is least effective. Furthermore, benchmark assessments need to be done on a continuous basis to ensure water resource objectives are being achieved (Agarwal et al., 2000). Direct instruments can be extended to self-regulation where water-use sectors and companies apply best practice guidelines within their daily operations, to reduce the quantity of water used.

Finally, regulatory instruments include the use of smart technology, control structures (e.g. flow restricting disks, surge anticipators which detect the pressure in water pumps and pressure reduction valves which are set electronically to control the pressure in water pipes) and technology that accurately measures flow characteristics (Cantin et al., 2005; Kumar and

Singh, 2001). Water saving technology such as drip irrigation can be utilized to reduce water-use in the agricultural context, rainwater harvesting tanks can be used in urban, peri-urban and rural settings to reduce the pressure on water supply and ensure the re-use of rainwater. Technology is beneficial for water purification and aquifer recharge which increases water supply. In addition, the use of pre-paid card systems (which is mostly used in African countries and gaining prominence in the Middle East and Colombia) allows low-income users to purchase the needed quantity of water (Agarwal et al., 2000; Anderson et al., 2008; Kanyoka et al., 2008). However, advanced technology is not always the best solution because it can alienate certain stakeholder groups. Pahl-Wostl et al. (2010) agrees by stating that technological solutions have been used worldwide in various water issues without considering its appropriateness.

2.3.5 IWRM Critiques

Above, IWRM as a water resource management approach has been described as a theoretical concept. However, the nature of the approach in real-life settings has been heavily criticised. The cited literature describes IWRM as an approach but stakeholders and decision-makers have and will continue to understand and apply it differently (Bourblanc, 2012; Fischhendler, 2008; Lubell and Edelenbos, 2013; Rahaman and Varis, 2005), which is why academics in the field characterise IWRM as being difficult to implement (Funke et al., 2007).

Defining IWRM

There has been a great deal of controversy around the definition of IWRM, with Biswas (2004) being the biggest contributor and critic (Lenton and Muller, 2009b). From a Biswarian view influenced by articles prior to 2004, he believes that academics and water managers do not know what IWRM really is and they all hold different ideas on what IWRM entails. Biswas says that when you read the IWRM definition for the first time, it is impressive and very broad, and further states that using lofty phrases within the definition as the GWP have done, does not mean that IWRM will have practical impact now or in the future. Biswas criticises the definition and the GWP for using ‘fashionable’ or ‘politically correct’ words that are not explicit. He further states that IWRM is unusable and cannot guide professionals. The point raised here may be justified because there may have been a lack of documentation concerning the successful implementation of IWRM prior to 2004. In addition, Biswas (2008) maintains the same argument made in Biswas (2004). However, his criticism comes across as subjective because the author makes little reference to other authors or articles. Biswas

(2004) and Biswas (2008) highlights some good critiques pertaining to IWRM which will be explored in subsequent paragraphs but are overshadowed by his excessive use of similes stating that IWRM has become the latest 'gospel', 'the holy grail of water management', 'old wine in a new bottle' and that academics are jumping on the band wagon. Anderson et al. (2008) agrees with Biswas (2008) stating that without a clear definition for IWRM, there is nothing preventing water managers from labelling their current water governance regimes as IWRM, even though what is practiced may be far from the actual characteristics of IWRM, thereby weakening the approach. Legal instruments may embody IWRM concepts and values, however, the implementation of these principles may be restricted due to weak institutional structures and management instruments (Medema et al., 2008). Lubell & Edelenbos (2013) criticize the approach stating that it is vague and abstract, and that water managers and academics run the risk of the concept becoming elastic and losing its meaning.

On the other hand, Funke et al. (2007) acknowledges that while there is no universally accepted definition of IWRM or the definition remains to be controversial, this does not mean that the concept must be dismissed. Instead, a guide to implementing IWRM can only emanate after a debate or discussion putting the approach into the context of a regional, catchment or local context, leading to a relevant and successful implementation, e.g. through the formulation of manuals (Agarwal et al., 2000). Therefore, a hotly debated definition does not mean that IWRM cannot be successful.

IWRM Implementation

Referring back to a point made earlier, there are water management practices that are labelled as IWRM but do not reflect the theoretical nature of IWRM (Medema et al., 2008). For instance, IWRM is about integrating human systems and soft management approaches with hard sciences and engineering (Lubell and Edelenbos, 2013). However, past and current water governance regimes across the world tend to focus on water resources infrastructure development as an approach to manage water resources. This involves the construction of large or centralised waste treatment plants, dams and reservoirs, and financial resources are directed toward protecting and maintaining these structures (Pahl-Wostl, 2009). This is attributed to the reliability and long-term stability the structures offer, in ensuring a continuous water supply especially during periods of droughts or floods (England, 2018; Lenton and Muller, 2009a; Pahl-Wostl, 2009). However, a sole focus on infrastructure development can facilitate excessive use of water and cause a false sense of water availability

and lack of long-term planning, until such a time where people realise that water is becoming scarce (Xiaoliu and Muller, 2009). This then becomes what is termed a Lock-in Situation where decision-makers find it difficult to change their priorities or action plans because they have directed more resources into infrastructural development (Pahl-Wostl, 2010), and are reluctant to change.

Therefore, soft management approaches that focus on decision-making processes are as important (Lenton and Muller, 2009a), coupled with the use of small-scale structures that are spatially located which ensures decentralisation (Pahl-Wostl, 2009). This combination is a better reflection of IWRM. Moreover, IWRM promotes decentralisation and not supplying large-scale infrastructure.

IWRM Implementation in the Global North

A case example is China, where water management shifted from water resources infrastructure development to resource management and preservation. China's Yangtze River is the third longest river in the world and is utilized by the Chinese for transport services and shipping ports. Prior to the 1998 floods, the Water Resources Ministry had depended on the construction of dams, canals, pumps, pipelines, flood control dikes and polders to minimize the negative effects of the frequent floods. The disadvantage of this was the structures were suitable for 1:20 or 1:30 year floods and were no longer suitable for the current flood events due to climate change effects, thus proving the lock-in situation as described by Pahl-Wostl (2010). The maintenance of the structures was proving to be too expensive. In 1999, the then Minister of Water Resources Wang Sucheng identified the need for a water management approach that is focused on water resource management, therefore a change in their management approach to being more adaptive and inclusive of soft approaches (Pittock and Xu, 2010).

Similarly, during the 1960's and 1970's, water management of Japan's largest lake, Lake Biwa, was focused on economic and infrastructural development to accommodate the expanding cities of Osaka and Kobe. Wetlands and lakes were transformed to allow for agricultural activities and, the Seta weir was constructed in the Seta River (which forms part of the basin) to control the negative impacts of floods. This lead to decreased water quality due to increased eutrophication resulting in Red Tides (the discolouring of the lake water due to excessive algal bloom and eutrophication) and the loss of fish diversity in the basin (Kamal, 2009). In a span of approximately thirty years, the Shiga Prefecture Government has

been working on improving their water management through improving their legislative framework, to integrate environmental sustainability and, economic and social development which characterises a soft management approach. Consequently, the lake is functioning as a flood controlled basin during flood events, and as a reservoir during droughts, accommodating different water use (Kamal, 2009).

IWRM Implementation in the Global South

Water management in Chile is no different as it has been centred around agricultural development since before the 1970s (Williams and Carriger, 2006; Pena, 2018), as agriculture has been the primary driver of economic growth. The Water Code 1951 (WC51) was passed to assist in solving water conflicts solely among agricultural water users, demonstrating the importance of the sector (Pena, 2018). Negotiations across different government departments resulted in the Endesa Irrigation Agreement 1947 and the Endesa Irrigation Agreement 1957, which would regulate the development of the Upper Maule River and the Laja River respectively. Consequently, the government departments directed their respective financial resources to fund the construction of the Laguna del Maule Reservoir which was a product of the 1947 agreement (Pena, 2018). In 2005, increasing attention was drawn to the issues of water pollution and poor ecological conservation. This led to the reform of the WC51 addressing the need to combat environmental and water challenges. Despite the reform in legislative tools, the transformation of institutional structures and the implementation of the WC51 has been very slow, and water management continues to lack an element of water resource planning (Pena, 2018).

It is essential to highlight that the implementation of IWRM especially in developing countries, has been steered by the global north specifically the IMF and the World Bank (Agyenim and Gupta, 2012; Manzungu and Derman, 2016). This is apparent in Zimbabwe after gaining independence from British rule in 1980. In achieving reform and economic growth, the Zimbabwean government intended on pursuing the socialism route. However, due to poor economic growth and increasing pressure from international organisations to implement neoliberal policies, the Zimbabwean government reluctantly accepted financial bailout from the IMF and World Bank in the form of Structural Adjustment Programmes (SAPs) (Manzungu and Derman, 2016). In addition, Western donors provided financial resources for water sector reforms on condition that the government implemented IWRM principles. Consequently, the Zimbabwe National Water Authority Act (ZINWA) and the

1998 Water Act were promulgated. The implementation of IWRM and decentralisation of decision-making stalled in the 1990s due to the poor or wrongful implementation of economic and social policies and increased political instability. Moreover, increased human right violations and poor creditworthiness repelled international financial support (Derman and Manzungu, 2016). IWRM gained momentum internationally and reappeared in Zimbabwe in 2009 however, the country continues to struggle in implementing the approach and realise its benefits (Manzungu and Derman, 2016).

Water governance should explore the use of smaller scale infrastructure and smart technology that are appropriate for different regions or water issues, instead of directing large amounts of money toward maintaining few structures. This will encourage efficient water use and finances should be directed at placing water meters or used as financial incentives to decrease water use (Pahl-Wostl, 2007; Pahl-Wostl and Sendzimir, 2005).

Biswas (2004 and 2008) highlights that integration between human and natural systems is not easy to achieve. Evidently, an IWRM framework was applied in the Vaigai River Basin, in South India, where social groups such as women were included in water resource management. The region received administrative and political support from government and external agencies. However, there was no cohesion among the stakeholders due to disputes over the multiple uses of water in the basin. Moreover, there was upstream-downstream conflict and a lack of integration among the governing institutions because of the overlapping functions (Agarwal et al., 2000). Hence, Biswas (2004 and 2008) criticises IWRM because of its shortfalls as evident in South India. This supports the notion that often water managers brand their governance regimes as IWRM, but the visible practices do not resemble the theoretical characteristics of the approach.

Moreover, Funke et al. (2007) and Agarwal et al. (2000) highlight that co-ordination and integration is very important and should exist within and between human and natural systems. Mitchell (2005) provides a third argument around whether integration is the reason for resource depletion or is the solution. The article states that decision-makers always assume that an integrated approach is desired, but the approach has only proven to redirect financial resources and time away from other unnamed functions. Mitchell (2005) states that there are individuals who hold the notion that water resources issues are straight forward and integration is not needed. On the other hand, resource scarcity and degradation is a result of interconnected factors therefore, an integrative approach is required to solve the issues.

Mitchell (2005) contends that water managers and practitioners should attempt to implement IWRM despite its difficulties. In the same fashion, Funke et al. (2007) responded to Biswas (2004) stating that past management regimes across the world failed because there was no integration which led to a change in regime and a new paradigm such as IWRM, to address these problems. It is unreasonable to claim that IWRM cannot be implemented based on the challenges that have been documented by Biswas (2004). Pursuing IWRM may result in short term risk but will yield long-term security (Agarwal et al., 2000; Van der Zaag, 2005), not to mention that the outcomes of effective IWRM implementation can be predicted. However, it is essential that countries or river basin agencies implement an IWRM framework that is site specific (Bourblanc, 2012). There is no set blueprint for the implementation of IWRM because countries or regions differ in terms of resource issues, cultural and natural settings, institutional capacities, levels of infrastructure, laws and regulations, and the opportunities to make the necessary changes (Agarwal et al., 2000; Carriger, 2006; Funke et al., 2007; Lenton and Muller, 2009a; Lubell and Edelenbos, 2013).

Fragmentation

IWRM is also criticised for weak institutional dynamics that cause unsustainable and ineffective water resources management (Hamdy et al., 1998; Mehtonen et al., 2008). Institutional co-ordination or integration is essential for effective functioning. However, achieving institutional integration has proven to be difficult. Mitchell (2005) presents an idea around institutional arrangements and how fragmentation exists. Fragmentation is either vertical where different levels of government i.e. local, provincial and national are not integrated, or horizontal where there is no integration within a level of government i.e. forestry, fisheries, mining, water, agriculture and social development (Horlemann and Dombrowsky, 2012; Mehtonen et al., 2008). Although issues within each department or ministry may be interrelated, there is a lack of co-ordination in solving the issues. Each department or institution may use a policy that is not compatible with the other and, since there are multiple water using sectors, the fragmentation is aggravated (Horlemann and Dombrowsky, 2012; Mitchell, 2005). Irrespective of the type of fragmentation, Mitchell (2005) terms it as the silo effect whereas Horlemann and Dombrowsky (2012) call it '*Problems of Horizontal/Vertical institutional interplay'*. Furthermore, vertical and horizontal fragmentation exist within institutional, functional and social fragmentation. These three aspects are elaborated upon below.

Types of Fragmentation

Institutional fragmentation is described as un-coordinated decision-making between different jurisdictional scales (Lubell and Edelenbos, 2013). Issues of institutional fragmentation are evident between donor institutions and water basin organizations. Donor institutions such as the International Monetary Fund (IMF) or the World Bank have a reputation of using their financial assets to determine or influence whether a programme will be implemented or not, or to decide which interests to pursue within a river basin even if it is not aligned with local organisations (Hirsch et al., 2006; Mehtonen et al., 2008). Likewise, Functional fragmentation exists where organisations or government departments have different responsibilities concerning the same function or resource i.e., water supply needed for irrigation (governed by agricultural ministries) or ecosystem functioning (governed by environmental ministries). Social fragmentation exists when the public are not included in decision-making processes or, water management plans are not communicated to social groups. Some water managers are reluctant to include non-technical experts in decision-making which alienates indigenous knowledge whereas in some areas, there are implicit requirements for information dissemination to the public which is evident in the United States. The same disinterest from the public is evident in Luxembourg and Argentina, with studies identifying public perception being that their input will make no valuable contribution to water resource management (Hamdy et al., 1998; Mitchell, 2005). Technocratic approaches in water management hinders public participation because social groups may not necessarily understand hard engineering. This relates back to the point raised earlier, that water management should focus on both physical sciences and soft management approaches.

Fragmentation in the Global North

In the Netherlands, a certain degree of functional integration exists. The regional governmental departments have integrated governance of agriculture, water safety, housing, recreation, freshwater resources and transport. However, functional fragmentation is evident because the national government is solely responsible for water quality (Lubell and Edelenbos, 2013). Similarly, the Frazer River Estuary in Canada is used for economic and agricultural activities, is home to migratory birds and is utilised for recreational purposes. The growing uses of the estuary have compromised water quality and initiated the loss of habitat for wildlife and fish species. Institutional and Functional fragmentation exists as there are well over 60 institutions that have jurisdiction over the estuary. Water quality agencies,

municipalities, district municipalities, government agencies and transportation agencies have been known to implement sector policies in isolation (lacking integration) which are not compatible with the activities supported by the estuary (Hamdy et al., 1998; Mitchell, 2005). Moreover, the implemented policies are not aligned with each other.

Another example of institutional and functional fragmentation is the Healthy Rivers Commission of New South Wales that manages a catchment situated in Sydney, Australia. Issues within the basin are not resolved, not because there is a lack of political power, but rather there is no set framework which allows a department or institution to take the lead in making important decisions. This is also evident in the Royal Commission on the Future of the Toronto Waterfront who have identified four levels of government and more than 100 agencies who are sharing jurisdiction over the Toronto waterfront. This is an indication that when new regulatory or authoritative bodies are established, there is usually an overlap in institutional functions leading to the weakening of existing other institutional bodies. Consequently, there is miscommunication and it becomes difficult to achieve any of the set goals (Franks, 1999; Hamdy et al., 1998; Mitchell, 2005). It is important that the institutional roles for all tiers of government and external bodies are well-defined so as to avoid overlap and inefficiency (Agarwal et al., 2000).

Fragmentation in the Global South

The evolution of IWRM in various river basins in Ghana have been identified. During pre-colonial times, water management in Ghana was governed by customary laws which prevented water use activities (e.g., farming) along flood plains and prevented excessive abstraction or usage of water (Agyenim and Gupta, 2012). During and post-colonial rule water management became highly sectoral and centralised. IWRM was gaining momentum as an approach to water management and international organisations (e.g., IMF and World Bank) began to promote its application in developing nations, including Ghana. In an attempt to decentralise decision-making, the Water Resources Commission (WRC) was established in 1996, as the national level authority in water management and sub-committees were established across the country. Pilot studies were then commissioned in five river basins (i.e., Ankobra, Densu, Pra, Tano and the White Volta) to assess the sub-committee's ability to promote IWRM at the river basin scale (Agyenim and Gupta, 2012). An outcome of the study was the decision to formulate Basin Management Plans for each river basin which would inform a comprehensive National Water Plan. Despite the institutional progressions made,

IWRM implementation has been faced with several challenges. Water management continues to remain sectoral (institutional and functional fragmentation) due to the lack of financial support to effectively decentralise water management. Local level personnel are required to wait long periods of time after putting in a request to receive funds from national level organisations. In addition, human resources are an issue as there are not enough personnel to perform water resources management functions. A major hindrance in implementing IWRM is the differing beliefs of how water should be perceived. IWRM requires water resources to be perceived as an economic good whereas many Ghanaian citizens perceive water as a social good (Agyenim and Gupta, 2012).

The implementation of IWRM in Chile is evident in the legislative tools such as the Water Code 1981 (WC81) (Williams and Carriger, 2006). Despite river basins being identified as units for water resources management, the establishment of institutions for decentralising decision-making has been very limited. Functional fragmentation is evident in the WC81 as it requires the separate management of surface and groundwater (Pena, 2018). Consequently, water managers cannot adopt policies or plans that integrate ground and surface water. The implication of this is the application for groundwater abstraction is extremely limited as numerous surface water rights have already been issued. Limiting the abstraction of groundwater is to ensure that holders of surface water rights are not negatively affected (Pena, 2018).

Overall, most water governance regimes have been and still are characterized has being highly sectoral and fragmented because organisations do not make decisions in an integrated manner. Governance regimes include an overriding political nature, water policies that are supply-based and lack accountability and transparency (Al Radif, 1999; Fischhendler, 2008). Decision-making may be characterised as being top-down because decisions are made by high ranking officials, they exclude civil society groups and are not translated or evident on the ground (Agarwal et al., 2000; England, 2018; Pahl-Wostl, 2007; Pahl-Wostl and Sendzimir, 2005; USAID, 2002). The information required to inform decision-making is only determined by technical experts who base their data collection largely on quantitative methods. The issue with this is that information sources become minimal, resulting in narrow views on issues like water quality or groundwater. Furthermore, information or knowledge that has been attained is not shared with interested groups or stakeholders namely civil society groups, Non-Governmental Organizations (NGOs) and respective decision-makers. In cases where information is shared, it is usually through case studies with little or no

interaction (Pahl-Wostl, 2007; Pahl-Wostl and Sendzimir, 2005; Wiek and Larson, 2012). Technocratic approaches within the water sector are criticised for not taking into consideration the political, social and economic dimensions of water resources management and continue to yield unsatisfactory results at the expense of society (Funke et al., 2007).

Furthermore, much of the cited literature does not account for future challenges to IWRM as the Rahaman and Varis (2005) paper does. However, six such challenges could be identified and briefly explored in the literature for this dissertation. Firstly, the trend towards privatization (Agarwal et al., 2000) and public-private partnerships has been on an increase. This has the potential to reverse integrative measures in water governance. Moreover, the government is responsible for water uses such as water supply and sanitation services. Therefore, if there is an increase in privatization within the water sector, people who lack purchasing power will have less access to water (Agarwal et al., 2000). This is exacerbated in developing counties, where there is already a lack of infrastructure. Secondly, it is likely that water will be used unsustainably due to viewing the resource as a commodity (Rahaman and Varis, 2005). Thirdly, co-operative watershed management is increasingly becoming normalized, however, water has the capability of bringing together conflicting interests through increased stakeholder and public participation. Agarwal et al. (2000) states that catchment or river basin management is essential in integrating land and water governance and, ensuring the quantity and quality of ecosystems, as well as the upstream-downstream dynamic. Fourthly, in efforts of restoring ecosystem degradation, there is an increase in channelization and dam construction which further jeopardizes water resources. The IWRM principles namely; precautionary, openness or transparency, participation, accountability, coherence, responsiveness, effectiveness, efficiency, equitability, inclusivity and legitimacy (Agarwal et al., 2000; Funke et al., 2007; Pahl-Wostl et al., 2010; Wiek and Larson, 2012) do not focus on how to deal with river restoration which is important in areas that have undergone modifications. Fifthly, current IWRM does not recognize the spiritual and cultural value placed on water resources by communities therefore, sustainable water management will only last a short period of time. Finally, both Rahaman & Varis (2005) and Agarwal et al. (2000) mention that freshwater and coastal management is not co-ordinated. Freshwater resources play a major role in determining the conditions of coastal zones, which is a prime example of an upstream-downstream continuum. With fisheries and aquaculture on the rise to feed the growing population, this is a potential issue to IWRM.

The above challenges or critiques point out that IWRM as a management approach is not flexible and is mechanistic (Pahl-Wostl, 2007) because water dynamics and water usage is predicted and controlled, through implementing strategies and responses. Water management is a complex system and with the increase in climate change effects, water management is riddled with uncertainty. Therefore, IWRM alone is inadequate and needs complementation in order to deal with extensive uncertainties and complexity (Anderson et al., 2008; Thomas and Durham, 2003).

2.3.6 Summary of the key IWRM aspects

Overall, IWRM is a broad management approach encompassing various aspects. Three core themes have been identified within the reviewed literature and these three themes will be used as indicators in the study so as to determine whether IWRM as an approach is practiced in the respective study sites. The themes are the enabling environment, institutional dynamics and management instruments. More specifically, the study shall focus on whether legislation and finances are creating an environment for IWRM implementation, whether there is integration and co-ordination among institutions and departments, the capacity of stakeholders to engage with the management approach and monitoring and compliance.

2.4 Adaptive Management

As alluded to above, the implementation of IWRM has proven to be difficult because it still relies to a great extent on a 'predict and control' system. This is not conducive to an environment with a plethora of uncertainties around water resources on the one hand and the management environment on the other. For example: competing uses of water resources and allocation for agricultural, domestic, industrial and environmental functioning, population growth, the numerous institutions involved in water governance and the lack of knowledge acquired to inform decision-making (Dent, 2012). Moreover, uncertainty in water governance arises when water managers lack an understanding and fail to come to an agreement regarding the factors that drive the socio-hydrological system (Allen and Garmestani, 2015; Summers et al., 2015). Climate change is a known uncertainty in the water sector, as the quantity of water is rapidly decreasing due to extreme weather conditions (Albareda and Campos, 2018; Medema et al., 2008; Riddler et al., 2010; Sullivan, 2010). IWRM as described is not well designed to compensate for such uncertainties or is known to be missing a key element that will account for uncertainties (Pahl-Wostl, 2007; Varady et al., 2016). Therefore, water governance regimes need to shift from 'predict and control approaches' to

‘management as learning’ approaches that will account for this shortfall (Albareda and Campos, 2018; Pahl-Wostl, 2007).

Adaptive Management (AM) is described as an approach to resource management which has been applied to various environmental contexts i.e. in Australia to improve the management strategies implemented in the Great Barrier Reef and for river flow management, in South Africa for the management of the Kruger National Park and in New Zealand to re-introduce species (Allen and Garmestani, 2015; Summers et al., 2015), just to name a few. In this context, adaptive management is explored in regard to water resource management. AM is an iterative process where through improved knowledge generation and understanding, uncertainties become better understood and are pro-actively managed. The approach entails identifying management objectives of policies or strategies that are implemented in a river system. Secondly, constructing a hypothesis or multiple hypotheses based on the policies or strategies that have been implemented. Thirdly, alternative management systems are implemented in a river system so as to assess and evaluate the outcomes of these systems, which could replace or improve existing policies in place. The decision to change a management system is determined on whether the experimentation yields positive or negative outcomes (Allen and Garmestani, 2015; Pahl-Wostl, 2007; Summers et al., 2015; Varady et al., 2016). Through the AM process, implemented policies or strategies will increase a river system’s ability to be resilient to the constant changes and pressures acting upon it on one hand, and better inform decision-makers on the other. This is represented through the Pressure State Impact Response (PSIR) framework illustrated in Figure 2.3.

Pressures acting on a river system include climate change, human use and human demands (e.g., increased production and agricultural activities to meet the growing populations’ demands). The state of the river system becomes degraded due to the pressures and is evident in the poor water quality (e.g., increased run-off from agricultural lands and industrial waste disposed in river systems). The impacts are considered as the consequences of the pressures acting on the river system (e.g., loss in fish populations, decrease in water quality and the lack of water available for domestic activities and subsistence farming). Consequently, the welfare of communities who rely on rivers for their livelihood is compromised. This extends to biodiversity loss as a result of poor ecological conditions in the river system (Cooper, 2013). An AM approach increases the system’s ability to respond to these pressures rather than react to the pressures which is counterproductive (Pahl-Wostl, 2007).

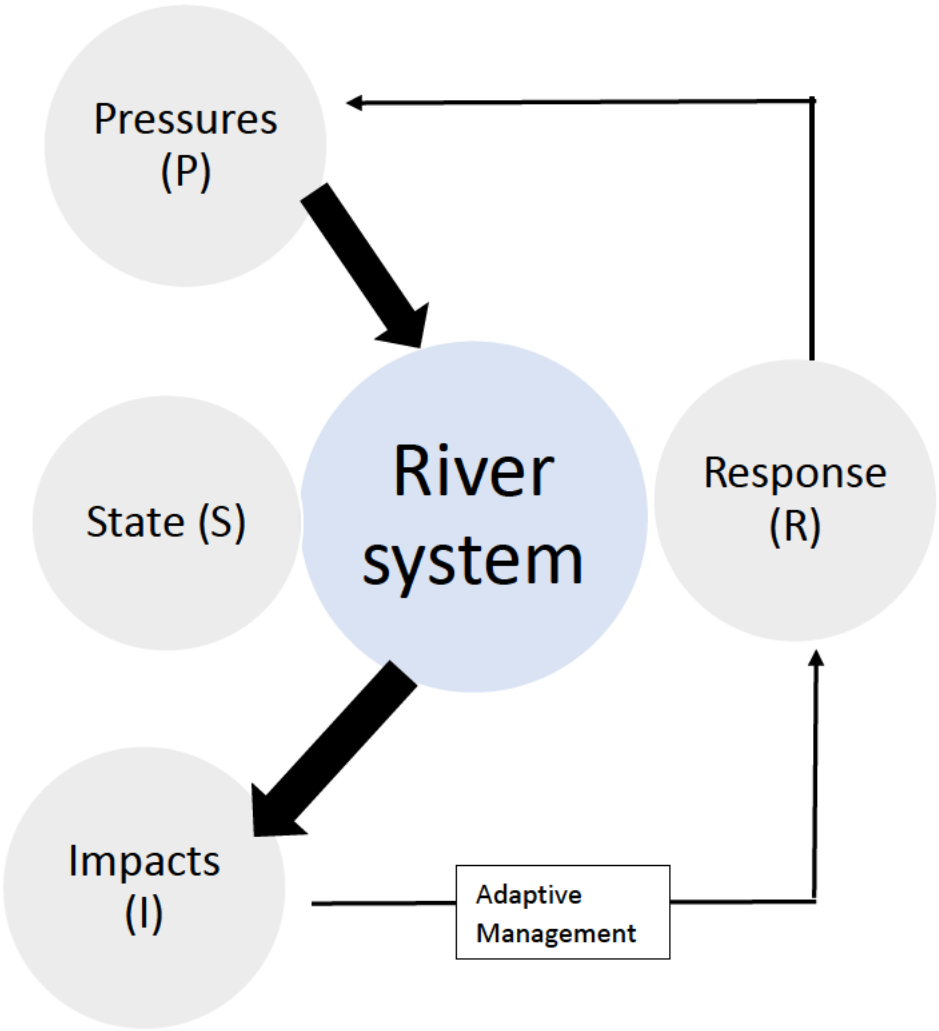

Figure 2.3 Pressure-State-Impact-Response Framework illustrating Adaptive Management (AM) increases a system's ability to respond to the various pressures acting on it.

The management approach was initially presented as a management regime in the 1970's and was developed by the International Institute for Applied Systems Analysis in Vienna (Medema et al., 2008). It is becoming prominent in water resources literature because it is designed to deal with uncertainties through flexibility and learning (Pahl-Wostl and Sendzimir, 2005; Riddler et al., 2010; Varady et al., 2016). However, AM can only be successful if management systems and decision-makers institutionalise learning and establish programmes that will monitor and assess existing and implemented policies and strategies.

2.4.1 The Learning Component

A management system that institutionalises learning involves decision-makers actively creating hypotheses based on the policies that exist in a catchment (for water management) after time has lapsed. The management objectives of the existing policy are also identified to determine whether the policy is achieving what it has set out to achieve. In cases where existing policies need to be replaced or updated, alternative policies are tested out in the catchment based on the created hypotheses and the outcomes are evaluated (Albareda and Campos, 2018; Allen and Garmestani, 2015; Summers et al., 2015; Varady et al., 2016) as depicted in Figure 2.4.

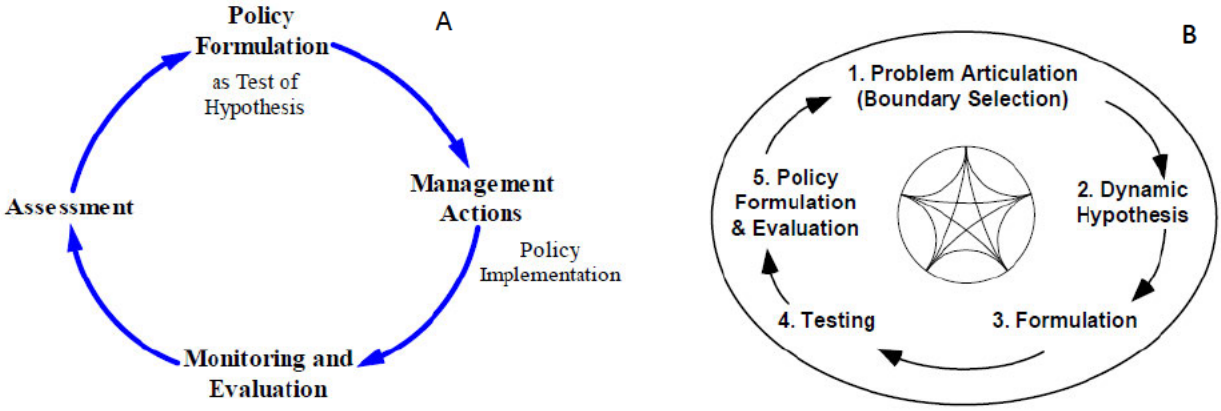

Figure 2.4 Coupled loop illustrating the nature of the Adaptive Management (AM) process. Loop A feeds into Loop B (taken from Pahl-Wostl and Sendzimir, 2005)

Loop A is initiated at the assessment stage where a catchment is assessed based on the conditions at the time of assessment. A new policy is formulated so as to test a hypothesis based on the prevailing conditions and desired state of the catchment. After the experimentation, the new policy is implemented which will require ongoing monitoring and evaluation. This feeds into loop B which is a similar process but features adaptive management. The cycle begins where a problem in management or the policy implemented is identified. A hypothesis is formulated and tested again based on the outcomes of the existing policy through the experimentation of an alternative policy. Based on the testing, a new policy is implemented, or the existing policy is updated which will once again require monitoring.

A large part of the learning process includes stakeholders handling common water issues as a collective i.e. water managers, social and physical scientists, decision-makers, civil society groups, private entities, water companies, farmers associations, NGOs and environmental authorities (Riddler et al., 2010; Varady et al., 2016). Pahl-Wostl (2007) terms this as Social Learning as it incorporates interdisciplinarity and makes use of formal and informal knowledge, thus improving and extending the knowledge base. The group consists of people with a set of skills and practical experience pertaining to the water sector, directly or indirectly, people who can contribute to decision-making and implementation. Thus, increasing stakeholder participation and the knowledge base (Boakye and Akpor, 2012; Carriger, 2006; Riddler et al., 2010). Each member of the social group uses their expertise to recognize the other members' concerns around water resource management. Ideally, all the members then reach a shared understanding on the priority water issues before coming up with a solution and pulling resources (i.e., time, knowledge and finances) together to deal with the issue at hand. While this may be the aim of AM, in reality the different backgrounds, perspectives and priorities of the various actors usually results in conflict in the decision-making process. While some conflict can be productive, it can also be a hindrance (Riddler et al., 2010). With the different stakeholders collaborating, this promotes integration as described in the IWRM section. However, conflict resolution tools as describe in the IWRM management instrument sub-section will be necessary as people will have different ideas in the decision-making process. Furthermore, a solution in one area may result in a problem in another area. Therefore, self-organisation, relationships and leadership is key. Decisions are made based on relevant information acquired by each member i.e., inventory on water resources and the quality of water. In all cases, capacity building and training is needed for practitioners to effectively implement AM and disseminate new information to user communities (Riddler et al., 2010).

Ultimately, stakeholders themselves need to be able to characterise what makes a water management regime adaptive and what conditions will enable the regime to produce positive outcomes (Pahl-Wostl and Sendzimir, 2005). This is a highly contextual exercise. It is essential to understand that the effectiveness of management regimes and strategies are constantly changing due to the pressures acting on a system, new experiences and insights (Vilakazi, 2013). Decision-makers should not be implementing a fixed policy for a long period of time, even if the policy yields positive results in the initial stages. Instead, small changes should be made to ensure the policy is adapting to the environment at hand.

Therefore, in theory, both IWRM and AM promote a management style that continuously reviews implemented policies. However, when analysing the elements of IWRM, the review of policies is not as emphasised, whereas AM over emphasises the aspect of reviewing management policies. Furthermore, the elements of IWRM are designed to achieve long-term goals, and AM focusses on shorter time-scales thereby complementing IWRM. The danger with IWRM is that the idea of a policy review process gets lost in its complexity (Riddler et al., 2010). While IWRM and AM each have challenges, the approaches can complement each other in the water governance space.

For IWRM and AM to be evident in a catchment, stakeholders need to consciously and constantly create indicators relevant to the implemented policy that speak to i.e., ecological functioning and hydrological flow for monitoring and evaluation purposes. Secondly, stakeholders need to be able to analyse the information and reach accurate conclusions. This is best achieved if all stakeholders are involved to avoid a narrow perspective on an issue. Thirdly, management regimes should reflect newly acquired information and should be understood by all involved (Pahl-Wostl and Sendzimir, 2005).

2.4.2 The Different Types of Adaptive Management

AM is not based on experimentation that is characterised by trial and error, and randomisation (Varady et al., 2016). Rather, experimentation involves identifying management objectives for a catchment or basin and identifying a theory of management activities or actions that can be implemented to achieve the objectives (Allen and Curtis, 2005). These actions are implemented in a catchment or basin and the environmental responses are identified and monitored. This process can be done through Passive Adaptive Management or Active Adaptive Management.

Passive Adaptive Management

Passive AM is defined as a process of implementing a policy that is historically informed by best practice, then reviewing the implemented policy (Allen and Curtis, 2005). It is essential to note that Passive AM only has a single objective which is to identify the resource's response to the implemented policy (Williams, 2011). A singular water management system or policy is applied in a catchment (Figure 2.5) based on decision-makers pre-determined understanding of the environment. A single approach is applied because decision-makers believe the approach is best suited for the catchment (Williams, 2011). Advantages of this is that less funding is needed to implement the management system or policy, and a short

amount of time is needed to assess the outcomes. However, there are increased chances that the experimentation will fail because the management system applied is based on a pre-determined understanding of an environment, it does not provide reliable information to make decisions, and it may be seen as undermining the premise of AM which is based on dealing with uncertainty (Allen and Curtis, 2005). Therefore, predictions or a pre-determined understanding does not suffice (Pahl-Wostl and Sendzimir, 2005). Such an approach does not consider the dynamic nature of the physical environment (Summers et al., 2015). Passive AM can also be described as non-experimental because it involves designing models or systems that predict the environments' responses to the management system

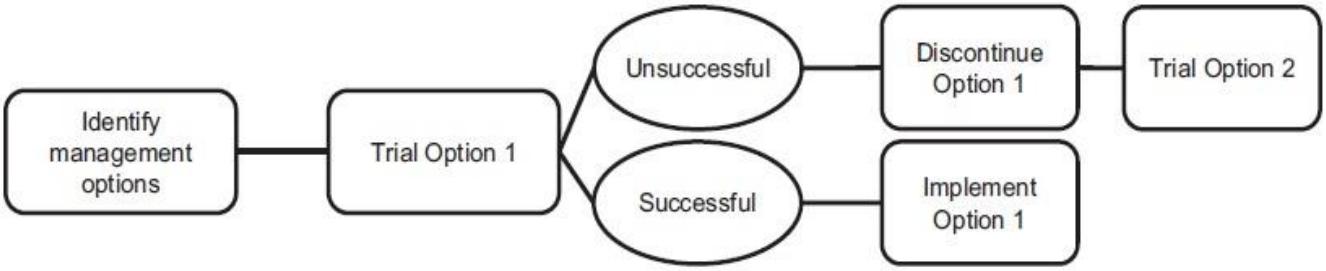

Figure 2.5 Passive management approach (taken from Summers et al., 2015).

Active Adaptive Management

Active AM is defined as a process of implementing a policy that is designed to test hypotheses (Allen and Curtis, 2005). Unlike Passive AM, Active AM has multiple objectives i.e., the resource's response to the implemented policy or system and for learning to occur (Williams, 2011). Active AM is preferred because experimentation includes implementing multiple management systems in a catchment or basin, and each system is monitored and compared. The management systems that yield favourable outcomes are the desired approaches (Figure 2.6) (Summers et al., 2015). Therefore, Active AM integrated with policy formulation will increase a river systems' adaptive capacity (ability of a system to cope under existing stress i.e. climate change without compromising ecological and social processes) (Pahl-Wostl, 2007) because management concepts are designed then piloted within a real-life setting, and evaluated then modified accordingly so as to yield desired outcomes (Medema et al., 2008, Varady et al., 2016).

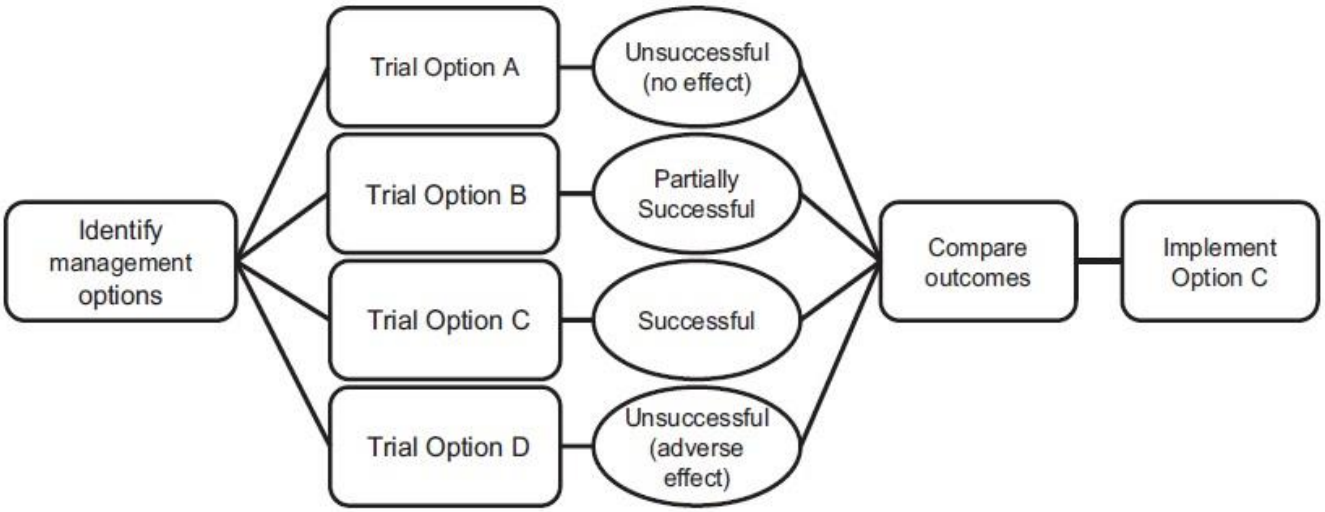

Figure 2.6 Active management approach (taken from Summers et al., 2015).

Passive and Active AM are distinguished by the way uncertainty is recognised and treated (Williams, 2011). Passive AM solely focusses on the resource's response to the implemented policy or system. If learning occurred, it is a welcomed outcome but is not the intention of the approach. Therefore, little to no attention is placed on the uncertainty factor. On the other hand, Active AM focusses on identifying the resource's response to the implemented policy and reducing the uncertainty factor by implementing multiple policies in different units. At the same time, applying Active AM is with the intention of learning something new. Consequently, applying Active AM will require time, patience, financial resources and the ability to explore the unknown (Allen and Curtis, 2005; Williams, 2011).

2.4.3 The Monitoring Process and the Use of Indicators

AM requires the implementation of multiple policies in a system to identify which policy is most appropriate in reducing uncertainty (Summers et al., 2015). To achieve this, a Monitoring and Evaluation (M&E) process needs to be in place. M&E is a tool used to identify favourable and least effective practices of a policy (Lamhauge et al., 2013). Moreover, it is an iterative process which allows information to be gathered and inform decision-making. M&E begins with the identification of an issue and methods that will address the issue. Secondly, objectives that are to be achieved by a policy are designed and will be measured in the form of indicators which can be qualitative or quantitative (Izurieta et al., 2011; Lamhauge et al., 2013). Indicators summarize large amounts of information into a single value and measure the performance or response of a resource to an implemented policy in a defined environment (Stem et al., 2005). Therefore, indicators demonstrate whether a

policy is achieving the desired results or not. In cases where indicators are reflecting undesired results, the implemented policy will require reworking and adjustments in management actions (Sullivan et al., 2010).

It is imperative that monitoring systems are affordable because economic efficiency is one of the three pillars of IWRM and therefore, this should apply to AM too. In addition, indicators should be easy to collect and analyse (Franceschini et al., 2007). Having a high-cost monitoring process would defeat the overall purpose of making well-informed decisions as the cost would make the gathering of data restrictive and could result in limited or no data. A way to ensure that monitoring processes are cost effective is ensuring that data is collected continuously, is reliable and will actually be used in decision-making (Reed et al., 2006). Gathering information that does not contribute to decision-making will mean that monitoring is actually not needed and thus, wasteful expenditure (Franceschini et al., 2007). Secondly, a plan or monitoring design allows for effective monitoring to take place because it is known what indicators need to be identified (Sullivan et al., 2010). Edelenbos and Lubell (2013) also highlight that constant monitoring of biophysical systems will result in effective water management because policies will reflect and be based on new knowledge. The information or indicators needed are identified along with a monitoring strategy. Information that is not necessary to the decision-making process would not be included. Data is then collected based on what is set out in the design stage (Reed et al., 2006). Collected data would then be interpreted through data analysis and the creation of models (Izurieta et al., 2011). The information that is analysed should complement the identified indicators. (Sullivan et al., 2010).

2.4.4 Adaptive Management Critiques

AM is about recognizing the importance of the human dimension in water use, the importance of stakeholder engagement in finding solutions around water issues, and combining learning with policy formulation to ensure water security (Pahl-Wostl and Sendzimir, 2005; Sullivan, 2010). This way, AM complements IWRM which as both are based on a participatory approach (Pahl-Wostl and Sendzimir, 2005; Van der Keur and Lloyd, 2010). Clear benefits of AM include an improved decision-making process due to stakeholder engagement, and a well-structured organizational framework. However, implementing social learning as part of AM means that stakeholders will have to learn to resolve conflicts when different ideas have been raised. Although learning includes creating models and conducting experiments to see which would yield positive outcomes (Medema et

al., 2008; van der Keur et al., 2010), there is a possibility that scientists or practitioners may spend too much time on creating models rather than their actual implementation, including field testing them. Moreover, a great deal of the time the experiments are on a large scale (e.g., multiple catchments). Other disadvantages of learning include the increased cost of gathering information and for monitoring and evaluation to take place, increased transparency within the decision-making process which may not sit well with some water managers, some practitioners shy away from the learning process which deals only with uncertainties out of the fear of failing or possibly undermining their credibility, and difficulty in acquiring sufficient funding (Medema et al., 2008; van der Keur et al., 2010).

The Issue with Implementing IWRM and AM

In previous sections AM is described as an approach that complements IWRM in water resources management (Anderson et al., 2008; Thomas and Durham, 2003). In implementing both approaches, four objectives are identified which are integration (Lubell and Edelenbos, 2013), decentralisation of decision-making (Agarwal et al., 2000; Van der Zaag, 2005), experimentation and social learning (Albareda and Campos, 2018; Summers et al., 2015). Decentralisation is achieved through increased participation from various stakeholders whereas experimentation is achieved through flexibility and adaptability of management actions and those who implement them. In addition, social learning is applied when different forms of knowledge feed into the decision-making process. However, implementing AM and IWRM simultaneously has its challenges (Engle et al., 2011).

Firstly, there are trade-offs when implementing IWRM and AM in a defined environment (Engle et al., 2011; Wang et al., 2019). Water managers may achieve two of the four objectives and fall short with the remaining two objectives. This is demonstrated in Brazil which comprises of 26 administrative states. Each state adopted its own approach to implementing IWRM and AM (Engle et al., 2011). Some states have prioritised integration and decentralisation of water resources management by promoting participation of civil society groups. Consequently, the management regime is not as flexible and resilient as required by AM. Similarly, other states have a centralised water resource management approach with heavy reliance on water resource consultants and technocrats. Although these states are compromising on decentralisation and integration, the water resources management approach allows for experimentation and social learning (Engle et al., 2011). Secondly, IWRM may hinder the implementation of AM. As demonstrated in Brazil, the influence of

IWRM (i.e., decentralisation and increased participation) often at times is not considered when implementing AM (Medema et al, 2008). With more stakeholders participating in the decision-making process, the ability to successfully practice social learning and experimentation is greatly reduced. Finally, with AM becoming prominent (Pahl-Wostl and Sendzimir, 2005; Varady et al., 2016), IWRM practices and principles are characterised as an old approach with AM being recognised as a new approach to water resources management.

2.5 The Global Experiences of IWRM and AM in Practice

2.5.1 The case study of the Lerma-Chapala River Basin in Mexico

The Lerma River flows from the Chignahuapan Lagoon in Western Sierra Madre, in the State of Mexico, covering 708 km^2 into the Chapala Lake in the Jalisco State. The lake is the largest in Mexico and the third largest in South America (Hidalgo and Pena, 2009).

The River Basin is under immense pressure from population growth and water supply. The Basin supplies water to a total of six cities, four within the basin boundary and two outside. In 2000, the Basin was supporting 11 million people and is projected to support 13.2 million by 2030. Agricultural irrigation consumed large quantities of water as agricultural activities took up 3 million ha of land in the basin which is more than half of the total area. Industrial activities were on the rise with the development of corridors. However, industrial activities resulted in the increase of pollutants entering the river system thereby decreasing water quality and availability. Moreover, environmental impacts include soil and land degradation as a result of land-use change and extensive economic activities. All this occurred between 1940 and 1980, where the Federal Water Authority had to accommodate rapid economic growth based on a lack of information concerning the water resources within the river basin. As a result, there was the over-allocation of water rights which caused increased competition and conflicts among water users.

A National Water Plan was presented in 1970 and approved in 1975 with the establishment of the National Water Plan Commission. Six regional water resources offices were established within each state in an effort to decentralise the water administration and, the Lerma-Chapala River Basin Regional Management (LCBRM) was formed (Hidalgo and Pena, 2009). Firstly, the LCBRM began to study the river basin and signed a coordination agreement with the other five states and Federal government, with the aim to change water allocation, improve water quality and ecosystem integrity. Secondly, the Control and Evaluation Advisory Council (CEAC) was established to oversee implementation. Thirdly, the Water Treatment

Programme was initiated involving 106 treatment plants to improve the water quality within the river basin. Fourthly, the Federal Water Law was changed in 1992 into 'The 1992 National Water Law' (Hidalgo and Pena, 2009), to allow for the establishment of advisory bodies who can enforce plans or programmes to improve water management. CEAC became the Lerma-Chapala Basin Council (LCBC) which initiated stakeholder engagement and public participation. The council also initiated clean-up programmes and promoted efficient water-use. Finally, 'The 1992 National Water Law' was revised in 2004 to incorporate IWRM concepts and change areas so as to continuously improve water management (Hidalgo and Pena, 2009). This case study demonstrates the importance of assessing the incorporation IWRM principles in water laws (the national level) and the decentralisation process in water governance which informed the research objectives of the study. Water governance reform in Mexico mirrors a similar transition in South Africa, which is explored in subsequent sections of the literature review.

A review by Hidalgo and Pena (2009) showed that stakeholders became more aware of the problems experienced in the river basin and were willing to partake in solutions, there were less conflicts, and the LCBC played a huge role as a facilitator between the different water-use sectors to ensure cooperation. The universities in the area contributed tremendously to information generation and dissemination, which allowed for informed decision-making. The Chapala Lakes' natural capacity level has recovered and water treatment is ongoing. The water quality has improved and the allocation of water for agricultural activities during a drought has increased from 30% to 50%, due to improved river functioning and water availability. Overall, the Lerma-Chapala River Basin was a good experiment and social learning case study for all of Mexico. Future challenges will be the provision of financial resources as the State Councils rely on Federal funds to ensure water management and the implementation of IWRM and AM (Hidalgo and Pena, 2009).

2.5.2 The case study of the Dharan and Dhulikhel cities in Nepal

Research was conducted in Dharan (sub-metropolitan city) and Dhulikhel (large urban area). The two cities experience heavy rainfall between June and September annually and the Himalayan Mountain icecaps were melting due to the rise in air temperatures caused by climate change. Moreover, the country is known for its rapidly growing urban areas, population growth and improved middle-class lifestyle. However, there is a lack of water retention or storage due to the lack of appropriate water resources infrastructure (Pandey and Bajracharya, 2017). The objective of the research conducted was to analyse the water

management systems within the two cities to identify existing water conflicts, challenges and management problems.

The findings of the research revealed that both cities had no local government which was the main reason for the poor water management regime. As a result, the researchers established a City Water Forum within both cities in order for scientists and civil society groups to collectively produce and share information regarding water resources management (Pandey and Bajracharya, 2017). The forums have managed to initiate rainwater harvesting systems in individual homes, practice groundwater extraction and recharge as alternate water resources, and reduce upstream-downstream conflict among water users. While Pandey and Bajracharya (2017) contributes in this regard to IWRM and AM literature, the work highlights the importance of having well-functioning institutions that will facilitate integrated and adaptive water resources management. This is relevant to the researcher, as the institutional landscape and sphere of influence in the South African context is explored at the municipal level. Pandey and Bajracharya (2017) identified the relevant stakeholders in regard to water management in the two cities by organizing a meeting inviting professionals from the water sector. This is particularly useful to the researcher and the research being conducted; as key stakeholders in the water sector of the uMngeni can be identified by attending the bi-annual uMngeni Ecological Infrastructure Partnership (UEIP) meetings. In addition, the methods employed by Pandey and Bajracharya (2017) include key informant interviews and an analysis of policies in the two cities. This informs the current research method as semi-structured interviews is the appropriate tool to engage with the key stakeholders, and the analysis of water policies assists in understanding the enabling environment for IWRM and AM in the uMngeni catchment. Unlike the cited literature within this review, Pandey and Bajracharya (2017) analyse IWRM and AM at a local level informing the research method adopted for the current study.

2.6 Integrated and Adaptive Water Management in Southern Africa

While reform in water governance began during the 1980's for the international community (Al Radif, 1999), reform in water governance within the SADC region only came into fruition in the beginning of the 1990's due to increased pressure from droughts and access to debates and experiences of IWRM in global water forums (Swatuk, 2005; Wilkinson et al., 2015). Moreover, population growth, unequal access to water, poor quality and quantity of water, declining infrastructure, increased occurrences of floods and lack of service delivery exacerbated the water crises (Swatuk, 2005). Due to this, it became evident that a new

approach was needed to address the growing concerns about water resources management. IWRM implementation in the SADC region is mostly evident at the transboundary scale as 12 countries share 15 international river basins. Numerous technical water commissions or River Basin Organisations (RBOs) have been established across these river basins to ensure the equitable development and use of water resources and promote joint planning among neighbouring states (Heyns, 2003). Actions toward establishing transboundary organisations or RBOs is guided by an international tool namely the United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses. As a result, the SADC Protocol on Shared Watercourse Systems was ratified in 1995 to guide Southern African states in the management of transboundary water resources (Bruch, 2003; Heyns, 2003). A product of this protocol is the modification of the 1987 Action Plan for the Common Zambezi River System (ZACPLAN) which aims to promote water resource development and recognise the importance of public participation, public awareness and transparency which mirror the principles of IWRM, in the Zambezi river basin (Bruch, 2003; Nakayama 2003). Signatories to this agreement include Namibia, Botswana, Zimbabwe, Mozambique, Angola, Tanzania and Malawi. The ZACPLAN is just one example of the agreements that exists among Southern African states that recognise IWRM (Heyns, 2003).

Much of the accomplishment toward implementing IWRM at the national scale is evident firstly through the promulgation of new water laws and secondly, through institutional reform (Derman and Prabhakaran, 2016). Countries such as Zimbabwe, Mozambique, Botswana and Zambia have each established their respective water laws that incorporates the principles of IWRM and have established water resource management institutions at the catchment scale (Bruch, 2003; Kujinga et al., 2020; Manzungu and Derman, 2016; Nakayama, 2003). Although reforms in the water sector for each respective country can be identified, the degree of implementation has been limited due to various challenges (Derman and Prabhakaran, 2016).

Institutional Challenges

The premise of IWRM is that water resources should be managed at the scale of a catchment or watershed as water resources flow across political or administrative boundaries. Thus, managing water should be within hydrological boundaries. Consequently, a great deal of cooperation among institutions is required to ensure sustainable development and use of water resources. As mentioned, 12 countries share 15 river basins therefore, the upstream-

downstream linkage in management regimes is necessary (Heyns, 2003). However, one of the biggest challenges in implementing IWRM in the SADC region is the institutional landscape (Van der Zaag, 2005). Political reforms in the SADC region involves the establishment of new institutions that serve all water users instead of the white minority. Thus, new institutions are established but parallel the purpose of existing institutions (Kluge et al., 2008). Furthermore, multiple institutions are identified to be performing the same functions which is redundant (Heyns, 2005). In Botswana, the Department of Water Affairs (DWA) and the North West District Council (NWDC) both had mandates for ensuring water supply (Kujinga et al., 2020). Another complication is evident where water functions are divided among multiple institutions instead of being headed by a single institution. In Zimbabwe, water functions are divided between the Zimbabwe National Water Authority (ZINWA) and the Environmental Management Agency (EMA). The former is responsible for overseeing water quantity whereas the latter is responsible for water quality (Manzungu and Derman, 2016) which does not ensure the integration of water quality and quantity as required by IWRM (Agarwal et al., 2000; Kidd, 2011). SADC countries have also faced difficulty with integrating planning among multiple water-use sectors, at the national and regional levels (Boroto, 2004; Kluge et al., 2008). Lastly, in a country such as Namibia where a large number of the population is located in rural areas, water management is rooted in traditional or customary norms; where communities have indigenous management systems to access water (Meissner, 2003). This is considering the lack of municipal water supply and the slow establishment of formal water resources management institutions in peripheral areas (Malzbender et al., 2005).

Financial Restrictions

The lack of human and financial resources is a hindrance to the implementation of IWRM (Swatuk, 2005), especially in Southern African states which have weaker economies compared to the developed countries (Dirwai et al., 2020). Therefore, water resource management activities cannot be carried out effectively i.e., ensuring compliance to water licence conditions, monitoring water-use activities, conducting surveys, information gathering and data collection, producing reports for information dissemination, maintenance of water resource infrastructure and hosting meetings for public participation purposes (Brown et al., 2020; Bruch, 2003; Manzungu and Derman, 2016). Although most of the SADC nations have national, regional and local level management institutions, the financial resources or budgets are largely centralized and controlled by national government.

Consequently, low level institutions are not able to respond when an urgent issue arises (Boroto, 2004; Kujinga et al., 2020).

External Influence

As SADC countries gained independence from colonial rulers, institutional reforms and transformation in governance practices followed. However, struggling economies and the lack of economic growth suggested that some SADC countries (e.g., Zimbabwe, Zambia, Mozambique, Malawi and Lesotho) had to accept Structural Adjustment Programs (SAPs); and comply with the terms and conditions associated with the funding received (Abalu et al., 1996; Hope and Kayira, 1997; Sassa, 1996). With the implementation of IWRM already taking place in developed countries, academics from external institutions and donor agencies such as the IMF and the World Bank were promoting the adoption of IWRM in the SADC region (Manzungu and Derman, 2016; Movik et al., 2016). One of the conditions of accepting the SAPs was the restructuring of institutions and adopting IWRM in the water sector (Hope and Kanyira, 1997). Issues prevalent in Zimbabwe, Malawi and Zambia included unequal distribution of water resources and the lack of access to these water resources as a large proportion of the population continues to travel long distances to collect water. However, with the need to accept SAPs, SADC states could no longer pursue their plans of water resource infrastructure development to improve access to water resources. Rather, the focus on 'soft' water resource management became a priority. The main challenge with external influence is that the terms and conditions associated with the funding received does not consider the issues that already exist in SADC states which may not necessarily be for the good of the region (Swatuk, 2005). Policy reform and the establishment of institutions has occurred at the national level whereas at the household level, people still cannot access water apart from travelling long distances (Movik et al., 2016). In addition, SADC states rely on bilateral agreements with neighbouring countries to fund water resource infrastructure development projects as donor funding is allocated for institutional and policy reforms (Movik et al., 2016).

Poor Guidelines and other influencing factors

Poor policy design in the water sector and water-use sectors is another challenge that limits the implementation of IWRM in Southern Africa (Brown et al., 2020; Dirwai et al., 2020). In many of the SADC states, policies and plans have been drafted however (Movik et al., 2016), many of these plans are criticised for lacking clarity regarding procedures (Manzungu and

Derman, 2016). In a country such as Botswana which gained independence in 1966 and reform in water governance only taking place in 2009, much of this reform is taking place in a policy vacuum (Kijinga et al., 2020). Other challenges faced in SADC countries that have negatively affected IWRM implementation includes social issues such as HIV/AIDS (Boroto, 2004; Bruch, 2003) and political instability which has been limited to a couple of countries. Between 2000 and 2009, Zimbabwe saw a series of political changes among the ruling party, the Zimbabwe African National Union- Patriotic Front (ZANU-PF) which saw the abandonment of water resource reform and the adoption of land reform and land distribution without compensation (Manzungu and Derman, 2016). Similarly, the Angolan civil war which began in 1975 with sporadic episodes up until 2002 limited the adoption and implementation of IWRM (Meissner, 2003).

2.7 Water Resource Management in South Africa

South Africa is a semi-arid, water stressed country, with variable climate and unevenly distributed water resources (Bourblanc, 2012; Dent, 2012; Kidd, 2011; Vilakazi, 2013). Moreover, the country receives low average rainfall, rising temperatures, increased frequency and intensity of floods and droughts (Partnership, 2009).

The transformation in water governance was part of a larger process of political change at the end of the Apartheid regime in 1994 (Ashton et al., 2006; Bourblanc, 2012; Dent, 2012). The advantage of this was, it was not necessary to persuade, incentivise or encourage stakeholders, the general public or decision-makers to change the way water was being managed. The reason being South African citizens were not happy with the prevailing governance regime and change was initiated in all the economic and social sectors within the country (Muller, 2009) by abolishing all apartheid laws with a specific focus on discriminatory and segregating elements. The White Paper on the National Water Policy legislates for inclusion and stakeholder participation in water resources management. At first, decision-makers were faced with the challenge that the public were not interested in water resource protection and transboundary cooperation which was necessary because the two major river systems that South Africa rely on is shared with neighbouring countries (Orange-Senqu and Limpopo Rivers) (Dent, 2012). The publics' disinterest in water resource protection stemmed from approximately 21 million people not having access to sanitation services or clean potable water and felt strongly about addressing this above any other issues. The transformation of the legal framework began with the restructuring of the South African Constitution. An important section relating to the environment is Section 24 which states

"*everyone has the right to an environment that is not harmful to their health or well-being"* and *"to have an environment protected…prevent pollution and ecological degradation"*. This was followed by the development of the National Environmental Management Act No 107 of 1998 (NEMA). NEMA is a framework of environmental law that embodies sustainability principles and governs environmental management. This then led to the establishment of the White Paper on the National Water Policy which was approved in 1997 by cabinet. This enabled the promulgation of the National Water Act (NWA) No 36 of 1998 and the Water Services Act (WSA) No 108 of 1997 which are described later in this sub-section. South Africa's environmental legislation is known to be one of the best worldwide (Karodia and Weston, 2001; Kidd, 2011; Partnership, 2009; Wilkinson et al., 2015).

Similar to the Mexico case study, South Africa is a good example of IWRM being incorporated into water legislation. Water resources management is enabled by the NWA No 36 of 1998 which states that the then Department of Water Affairs and Forestry (DWAF), now Department of Human Settlements, Water and Sanitation (DWS), is the custodian of the water resources within the country and needs to make provision for water-use by ensuring bulk water supply (Muller, 2009). The department has the responsibility to enforce water legislation, regulations and guideline tools, develop and implement an IWRM policy, water services policy and a National Water Resource Strategy (NWRS), determine a pricing strategy, and authorising and allocating water rights and water-use licenses for strategic purposes which extends to inter-water management areas. The DWS is also responsible for monitoring water resources, establishing reserves, managing dams, maintaining water resource infrastructure such as reservoirs and boreholes, implementing tariffs, and determining water resource classes and Resource Quality Objectives (RQOs) (Makaya et al., 2020; Momberg et al., 2020).

The WSA No 108 of 1997 states that the responsibility of managing water services falls on the Water Service Authorities and Water Service Providers (WSPs) (Maphela and Cloete, 2020). Water Service Authorities are usually district and local municipalities while WSPs are organizations who have obtained a contract with the Water Service Authorities to sell water and accept wastewater in order for treatment to occur (Momberg et al., 2020; Wilkinson et al., 2015). Although, many local municipalities in South Africa have a dual responsibility of being a water service authority and a WSP (Weaver et al., 2017). For the past two decades, municipalities across the country have been branded as dysfunctional due to the inability to supply reliable water supply and fulfil the functions as water service authorities. This is

evident as many municipalities lack water services and sanitation master plans, demonstrating the lack of long-term planning (Yako, 2015). Consequently, water resource infrastructure and the reticulation systems are not maintained and become degraded (Weaver et al., 2017). Major factors contributing to the issue include severe economic challenges and the lack of human resources. Many residents in predominantly peri-urban settlements are unable to pay for water services due to the household socio-economic status. Other residents refuse to pay for services due to their perception that water is a social good rather than an economic good. Either way, municipalities struggle to collect revenue which should be obtained from water-users. Moreover, many municipalities have an inaccurate billing system and poor management or records of indigent households. Thus, inadequate financial resources to perform water service provision (McKenzie et al., 2012; Yako, 2015). On the other hand, human resource challenges within municipalities include high staff turnover and the loss of institutional knowledge, the lack of capacity by personnel to perform duties and the mismanagement of funds resulting in unpaid salaries and wages (Weaver et al., 2017; Wegelin and Jacobs, 2013). Funke et al. (2007) state that the integration between human and environmental dimensions as described in the previous sub-sections are well reflected in South Africa's water legislation. However, more than 20 years have passed and the country is still battling to implement these two Water Acts due to the factors described (Maphela and Cloete, 2020; Muller, 2009; Sally et al., 2011). This is evident as numerous institutions have not been formed, newly formed institutions are still weak, small-holder farmers find it difficult to access water whereas commercial farmers and mines maintain an uninterrupted water supply because revenue and development in the sector is prioritized. We therefore can identify that water resources management is still entrenched with historical biases and transformation has been limited in this regard (Sally et al., 2011).

On a provincial level, IWRM is reflected by the gradual formation of Catchment Management Agencies (CMAs) which are responsible for water resources management at a catchment or regional scale, in accordance with national policies (Wilkinson et al., 2015). A CMA is an institution guided by an appointed governing body to perform water resource management activities, coordinate the mandates of water resource institutions at regional and local levels, and promote public participation in the management of water resources in a Water Management Area (WMA). A CMA is considered an established institution when a submitted CMA proposal is accepted and published in the government gazette by national government. Water resource management activities is a collective term which refers to

conserving, protecting and monitoring the water resources in the WMA; implementing the Catchment Management Strategy (CMS) designed for a respective WMA; establishing the rules to ensure water-use regulation; creating management and information systems; administering modifications to waterworks; controlling, limiting and prohibiting water usage in a catchment during water shortages; and managing and providing support to water resource institutions within a WMA. Currently, there are two out of the proposed nine CMAs that are functioning namely the Inkomathi-Usuthu CMA and the Breede-Gouritz CMA (Bourblanc, 2012; Dent, 2012; Khorommbi, 2019). Therefore, the functions these CMA perform include investigating and advising on the development, protection, conservation, use and control of water resources, implementing cooperative governance procedures with district and local level municipalities and developing a CMS and financial or business plan for operation. Each CMA is responsible for developing a CMS aligned with the National Water Resource Strategy (NWRS), which is South Africa's national IWRM plan (Sadiki and Ncube, 2020). Other functions include coordinating water-use activities by water resource institutions and water-users; coordinating the implementation of the CMS with water services development plans by water service authorities; ensuring the implementation of IWRM and involving communities in water resource management activities (Munnik, 2020). If a CMA for a respective Water Management Area (WMA) (Figure 2.7) is non-existent, the regional offices of the DWS take on the responsibilities as described (Funke et al., 2007), and are then identified as Proto-CMAs (Meissner et al., 2017). Therefore, there are seven Proto-CMAs.

Furthermore, the Minister of DWS can entrust additional powers and duties to a CMA which is dependent on the capacity of the CMA and is then referred to as a 'responsible authority' which is a fully functioning CMA (Munnik, 2020). Additional mandates include issuing water-use licenses and general authorisations based on conditions; extending water-use licenses; reviewing and amending water-use licenses and renewing them; permitting water-use without a license provided it is required by another law; requiring the verification of existing water-use licenses; suspending water-use and enforcing license conditions. The Inkomati-Usuthu CMA was the first CMA to be established in South Africa and thus does not have a model to learn directly from (Roux et al., 2010). Consequently, the CMA has embarked on developing a learning strategy framework which will enable the institution to mainstream a learning culture in water resources management in the respective WMA. The CMA recognises that the WMA comprises of complex socio-ecological systems and thus the framework suggests concepts and actions to incorporate in their management plans

(Edokpayi et al., 2020; Roux et al., 2010). Moreover, the Inkomati-Usuthu CMA has committed to being an effective learning institution by generating knowledge through scientific, traditional, local and practical sources; validating and legitimising such knowledge; acquiring knowledge from external sources; disseminating knowledge to staff, stakeholders and interested parties in the WMA; and adapting its water resource management regime which is informed by sound new knowledge while achieving its learning objectives (Roux et al., 2010). Although the Inkomati-Usuthu CMA strives to implement IWRM and demonstrates AM in the catchment, difficulties in implementing the two management approaches are still evident.

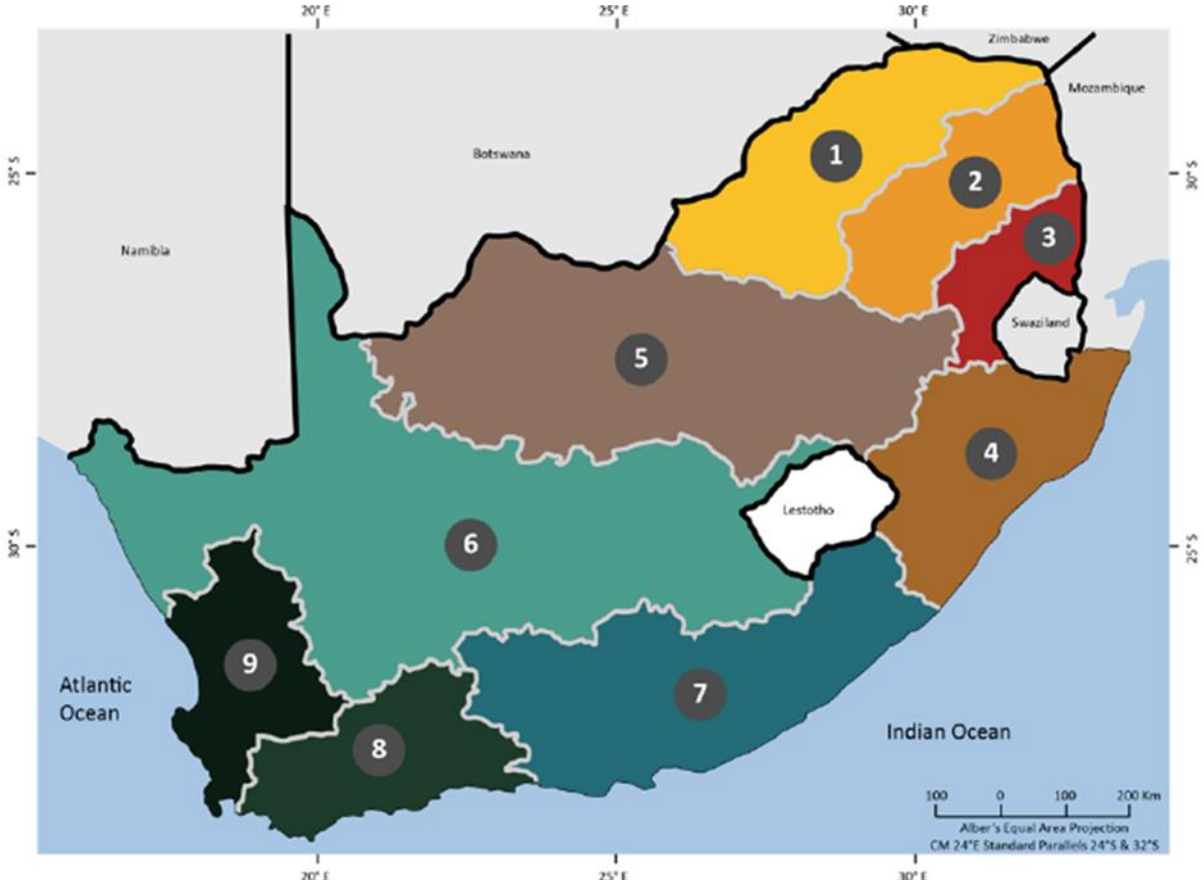

Figure 2.7 South Africa's nine Water Management Areas (WMA). 1) Limpopo 2) Olifants 3) Inkomathi-Usuthu 4) Pongola-Mtamvuna 5) Vaal 6) Orange 7) Mzimvubu-Tsitsikamma 8) Breede-Gouritz 9) Berg-Olifants (Department of Water and Sanitation DWS, 2016).

Hindrances to the implementation of IWRM and AM include high staff turn overs in government resulting in a lack of knowledge and expertise within DWS, which is important for the application of IWRM, AM and capacity building (Funke et al., 2007; Partnership,

2009; Weaver et al., 2017; Wegelin and Jacobs, 2013). There is a lack of co-ordination between DWS and other government departments, a lack of leadership (Dent, 2012; Pollard and du Toit, 2011) and, the absence of IWRM in the planning stage of development. In addition, not all water managers have accepted IWRM into governance regimes and not all stakeholders in rural areas are involved in the decision-making process (Funke et al., 2007; Meissner et al., 2017). This was evident in the Mhlatuze catchment which forms part of the Usutu-Mhlatuze catchment extending from the province of KwaZulu-Natal to the Northern part of Mpumalanga province (Funke et al., 2007). CMAs also have the reputation of functioning as a politically related enterprise where the objectives or mandates are confused. CMAs have been found to benefit individuals who occupy positions within the organisation rather than the communities who need assistance with accessing water resources, which makes IWRM implementation more difficult (Bourblanc, 2012; Sadiki, 2020). It is evident that IWRM is reflected in South Africa's water legislation but the country is focusing too much on establishing the enabling environment and neglecting the actual implementation of IWRM and AM (Anderson et al., 2008; Colvin et al., 2008; Partnership, 2009; Pollard and du Toit, 2011; Shanono and Ndiritu, 2020). Furthermore, Lubell and Edenlenbos (2013) point out that South Africa lacks a general public that is experienced, innovative and competent when it comes to water issues and, they are not willing to take advantage of participatory approaches which is a contributory factor to the problem.

At a local level, Water User Associations (WUA) which are statutory bodies and local government/municipalities are better positioned to engage with IWRM and AM (Cox et al., 2008; Wilkinson et al., 2015). Within a catchment there are competing water users i.e., urban and rural water users, tourism and recreation departments, commercial and subsistence farming, industry, mining, ecosystem functioning and local government. Water usage expresses itself through the abstraction of water from the water cycle, water supply partly through the contribution of wastewater treatment. In cases where over abstraction occurs or water is not treated appropriately, water quality and quantity are negatively affected. Furthermore, municipalities have numerous functions or mandates they need to fulfil that directly or indirectly effect water quality and quantity, which are listed below.

Firstly, water supply concerns the maintenance of infrastructure i.e., pipelines and pumps, to ensure that there are no water leaks. Water quantity is greatly reduced when leaking pipes are not taken care of. Municipalities need to focus on the accessibility of potable water to reduce the risk of people consuming contaminated water. Secondly, local government needs to

ensure that there are functioning sanitation systems in place. Without functioning lavatory facilities, there are increased chances of ground water contamination from the use of pit latrines or the pollution of rivers which causes illness among people living and relying on rivers for their livelihood (Cox et al., 2008). The discharge of sewage into water resources causes the concentration of oxygen to decrease thereby harming aquatic life and decreasing water quality and quantity. Thirdly, storm water management is essential to ensure that storm water does not build up in urban areas or cause flooding and does not cause erosion due to increased run-off. Storm water also modifies river channels and riverbeds. Fourthly, municipalities often transform open land to built-up areas for housing or similar development. Consequently, there is less infiltration and increased run-off which ultimately causes flooding. Similarly to sanitation management, housing development should have functioning lavatory facilities to avoid groundwater contamination. The lack of housing in peri-urban spaces results in people using rivers for domestic reasons. As a result, the water quality drops along with water availability for supply (Cox et al., 2008).

Solid waste management is as important to ensure that refuse does not pollute water resources. Landfill sites need to have infrastructure that deals with leachate which is produced from collected waste and can potentially contaminate groundwater stores. The change in land-use, the construction of roads, local economic development and the development of parks for recreation ultimately causes less infiltration and increased chances for run-off. There is also an increase in water use to irrigate parks and golf courses. Lastly, disaster management is imperative to reduce the effect of flooding on communities. This is usually done by ensuring that people and development are nowhere near a floodplain.

Boakye and Akpor (2012) state that IWRM was adopted in SA to change the past management regime characterised as being centralized and not considering the interests of stakeholders. This entailed the establishment of Catchment Management Forums (CMFs) which are legitimised by the NWA No 36 of 1998. CMFs are non-statutory water management institutions that promote citizen participation in water resources management at a grassroots level. CMFs allow for stakeholders to come together and discuss water issues within their catchment area which is aligned with the characteristics of AM. The study by Boakye and Akpor (2012) focused more on community participation in the forum within the Msunduzi catchment. The study found that participants felt ignored after giving their input within the forum meetings. Representatives from the DWS, did not return to check up on issues raised (Boakye and Akpor, 2012). A point is made that a CMF is a non-statutory

organization therefore, the publics' opinion does not necessarily need to be implemented, which defeats the purpose of the CMF (Boakye and Akpor, 2012). Therefore, government is not abiding by what they set out to achieve when the CMF was formed. Moreover, there is a huge difference between what the community are expecting the CMF will do for them versus what the forum is supposed to do (Boakye and Akpor, 2012). Community based organisations may represent communities but may not necessarily share the information as evident in the study. Overall, the article illustrates how the dissemination of information to civil society groups has been a failure. As mentioned earlier in this review, Agarwal et al (2000) describes the importance of disseminating information so that implementing IWRM can be successful.

Participatory approaches have been applied in South Africa particularly within the context of water resources management (Brown, 2011). However, many of these have failed (Anderson et al., 2008; Boakye and Akpor, 2012).

2.8 Conclusion

IWRM is identified as a management approach for water resources and is defined as a continuous process of the development and management of water, land and related resources. The approach is promoted to maximise economic growth and social welfare without compromising environmental integrity, and thus ensuring sustainable use and development. In water management, IWRM focusses on integrating the different sectors, institutions and decision-makers that directly or indirectly impact on water resources. The GWP toolbox that assists in implementing IWRM includes three change areas: the enabling environment, institutional dynamics and management instruments. With a strong legislative and financial framework in place (enabling environment), good communication and cooperation among water sector institutions (Institutional dynamics) and regulatory measures (management instruments) in place, theoretically, there can be room for improved water resources management (Carriger, 2006). However, it is important to understand that the approach (IWRM) is not an end state that needs to be achieved. It involves a constant effort of bringing together different stakeholders to make informed decisions on water resources as the biophysical and human system is in constant change.

The concept has been criticised as being a buzzword however, it is relevant and the principles have contributed to achieving the Millennium Development Goals (MDG), now Sustainable Development Goals (SDG); and has encouraged co-operation among water professionals

especially in Southern Africa (Van der Zaag, 2005). Despite these efforts, IWRM was not well designed in relation to dealing with uncertainties, such as climate change or the consistent change within governance institutions. It is also criticised for not providing guidance or clear steps to water professionals on attaining a more integrative approach to water resources management (Biswas, 2004). Therefore, AM with the focus on learning, is important. The phrase '*learning to manage by managing to learn'* implies that role-players consciously examine and analyse current situations concerning water issues, before developing a policy or plan of action to deal with them. Therefore, AM accounts for uncertainties because it modifies management regimes based on the pressures acting on a system.

IWRM and AM hinge on the willingness of organizations within the water sector and other sectors, and their capacity, to carry out their respective responsibilities (Medema et al., 2008). The IWRM and AM management approaches are not about developing tools that will assist in learning but rather it is about learning what works and implementing it continuously which is why the management approaches are time consuming and require financial support (Medema et al., 2008). For the successful implementation of the approaches, it requires a radical change in the way water is currently governed (Medema et al., 2008), assuming that current governance regimes are based on 'predict and control' approaches as described by Pahl-Wostl (2007). The transition to IWRM and AM are assumed to increase adaptability in the face of unexpected conditions i.e. extreme weather conditions (Fischhendler, 2008) because of the application of knowledge from different disciplines and the input from stakeholders into the decision-making process, making water security the key objective. This is evident in the case studies presented. The case study in Nepal is of particular interest to the researcher as the institutional dynamics of the water sector in the study area is explored. An examination of Southern Africa and South Africa was also provided, more specifically on the transition of its water sectors.

Medema et al. (2008) postulates that it is likely that IWRM has not been as successful due to its focus on academia formulating the frameworks, whereas implementation is done by practitioners. Therefore, the framework and its approaches are designed in isolation from reality (Medema et al., 2008). Effective implementation of IWRM and AM is dependent on the priority water issues in that area, whether the relevant institutions have the necessary resources, the cultural and natural settings, and if institutions have a monitoring and evaluation process in place (Carriger, 2006; Funke et al., 2007). Finally, only a handful of the

articles reviewed from the published literature, make a connection between IWRM and AM. Instead, they focus completely on one or the other. This may be an indication of the slow transition to realising the importance of AM and its complementary role to IWRM. Most of the cited literature focussing on IWRM is prior to 2010, whereas post 2010, literature begins to include AM. The literature thus informs this study which aims to assess the institutional aspects that may or may not facilitate IWRM and AM at a local (municipal) scale also in relation to the broader uMngeni catchment, and construct recommendations for effective water resources governance.

Chapter Three Methodology

3.1 Research Design and Site Selection

The nature of the study is qualitative employing the case study approach. Case study research allows for the investigation of a phenomena or a complex issue and to gain an in-depth understanding or interpretation within a specific context (Harrison et al., 2017; Lam and Law, 2016). In this study, water resources management and the implementation of IWRM and AM in the study site was investigated through the case study approach. Employing the case study approach does not require the constructs of a phenomena to be known in advance which is beneficial for this study as IWRM and AM are complex management approaches comprising of numerous components (Bhattacherjee, 2012). Thus, certain elements were explored (i.e., the institutional landscape, stakeholder's perceptions and the enabling environment in the form of water laws and governance tools) that either facilitate or hinder the implementation of IWRM and AM. The case study approach can be conducted either in a positivist method or an interpretive manner. The positivist method is popular in scientific or technical research which involves the testing or disproving of a theory (Alharahsheh and Pius, 2020; Gemma, 2018). In this study, the positivist method was not employed as IWRM and AM theory was not tested. Rather, an interpretive method for theory building was used which also contributes to the body of IWRM and AM literature that exists (Bhattacherjee, 2012; Gemma, 2018). Another benefit of the case study approach is the allowance for the exploration of a phenomena or complex issue in a specific context (Bhattacherjee, 2012; Crowe et al, 2011). This is relevant as IWRM and AM implementation is site specific and manifests differently across the world with South Africa being unique with its' history and current development trajectory Therefore, allowing for a deeper understanding of how the management approaches are applied if at all. Moreover, the approach enables the use of various data collection methods such as semi-structured interviews and the use of secondary data (Bhattacherjee, 2012; Harrison et al, 2017) in combination to gain a better overview of this complicated topic. The use of semi-structured interviews and document analysis as data collection methods to achieve the objectives is described in the sub-sequent sub-sections.

Semi-structured interviews are a form of primary data source in which the organisation of questions is considered to be loose or 'less tightly' formatted compared to a structured interview or survey (Roulston and Choi, 2018). The interview schedule comprises of open-ended questions which is designed to address the research questions and objectives (Brown and Danaher, 2019), making this the most appropriate tool for data collection. The questions

are designed to obtain information on the participants' experience in relation to the research topic and enable the researcher to steer the conversation based on the participants responses (Madill, 2011; McIntosh and Morse, 2015; Roulston and Choi, 2018). Furthermore, in semi-structured interviews, participants may recommend other individuals who are knowledgeable on the research topic making them suitable participants for the study, termed Snowball Sampling (Brown and Danaher, 2019; Etikan et al., 2016; Waters, 2015). A document analysis is a form of secondary data source which involves reviewing printed or electronic documents to obtain information (Bowen, 2009; Owen, 2014). In this case, a document analysis is used in combination with semi-structured interviews to gain knowledge on how IWRM and AM are implemented in the study site. The Department of Water and Sanitation (DWS) released the *Reconciliation Strategy Studies* for metropolitan areas and major river systems in South Africa, which identified the study site as being at risk of facing water shortages in the not-too-distant future (Kidd, 2011; KZN Provincial Planning Commission, 2016; Water, 2014); highlighting the need for adequate water resources management. The study site was selected based on proximity and access to stakeholders and decision-makers in water resource planning.

3.2 Description of the Study Area

The uMngeni catchment is approximately 4 439 km^2 in size and is located in the province of KwaZulu-Natal (Figure 3.1). Currently it is supplying water to the Msunduzi Municipality and eThekwini Metropolitan Municipality which encompasses the whole of Pietermaritzburg and Durban area. The catchment also supplies water to Mooi River, Nottingham Road, Rosetta, Howick, Cato Ridge, Wartburg and surrounding areas.

The Mooi River is a tertiary catchment which feeds into the uMngeni system through the Mooi Transfer Scheme due to the demand in the uMngeni exceeding the available water supply. Consequently, to supplement the uMngeni system, the Mearns Weir (Mearns Emergency Transfer Scheme) and the Spring Grove Dam (Mooi/uMngeni Transfer Scheme-Phase 2A) were constructed in 1983 and 2011 respectively, along the Mooi River, to divert water flow into the uMngeni (KZN Provincial Planning Commission, 2016; Water, 2014; Water, 2017). The catchment is described as having spatial and temporal climate variations as three different climatic zones are prevalent namely, Alpine, Temperate and Subtropical. Alpine/Highland climates are experienced around the Drakensberg Mountain and is characterised for its minimal vegetation growth. In the Midlands area, temperate conditions

characterised by summer rain is experienced, whereas subtropical conditions with perennial rainfall dominate closer to the coast.

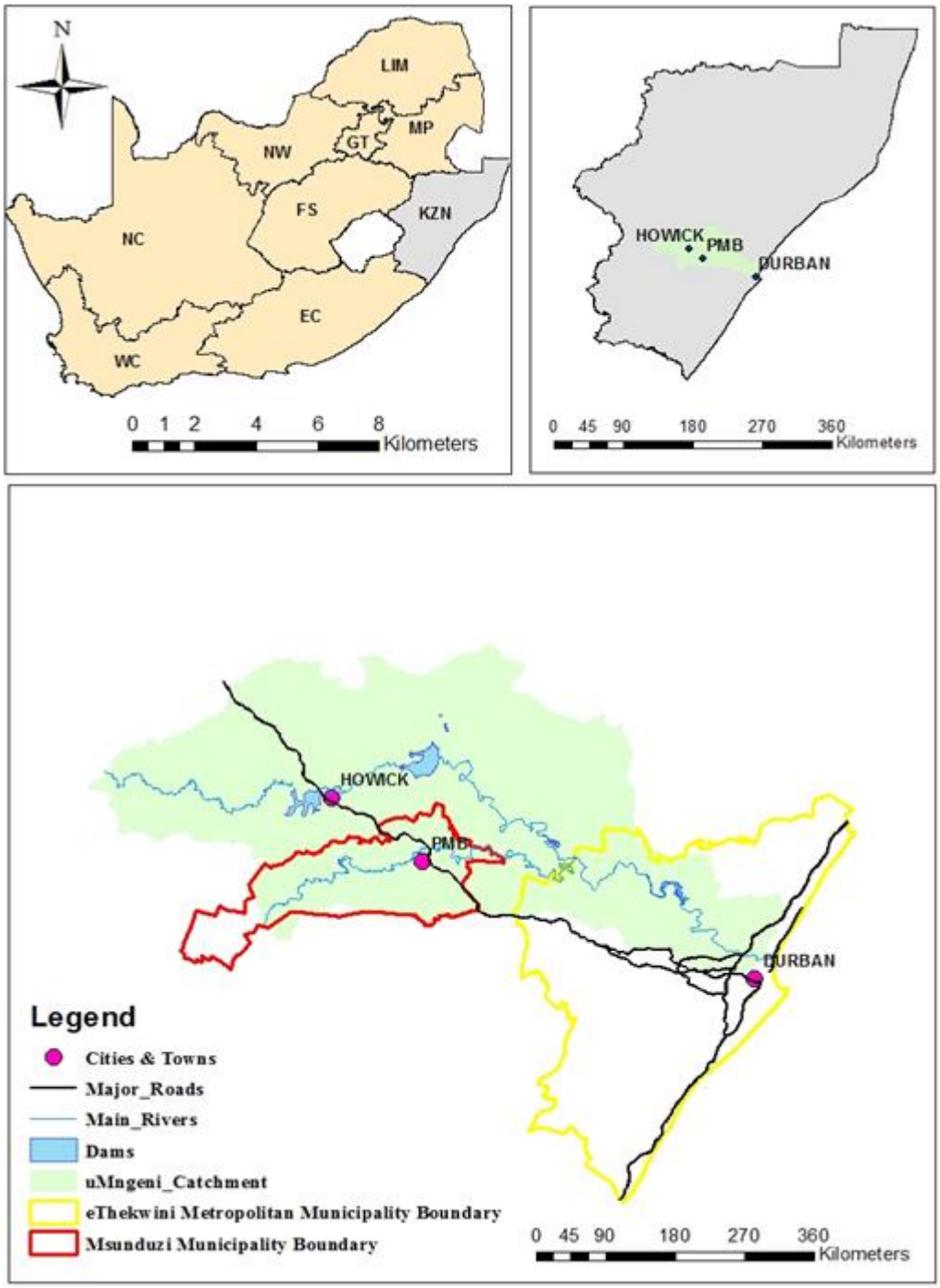

Figure 3.1 The uMngeni catchment with the Msunduzi Municipality (red) and eThekwini Metropolitan Municipality (yellow) boundaries and the major dams.

Consequently, weather conditions are influenced by the Drakensberg Mountain as warm air is forced to rise along the mountain before reaching condensation level, causing rainfall (Water, 2017). The interior part of the catchment is located within the rain shadow or leeward side of the Drakensberg which is why the area experiences less than 700 mm of rain. Toward the coastline, the mean annual precipitation can reach 1000 mm between October and March which is the summer and rainfall season. The maximum air temperatures are experienced between December and February and minimum temperatures are experienced between June and July. Minimum temperatures range from 20 °C to 22 °C along the coast, and 12 °C to 14 °C in the interior. Frost days are recorded at approximately 31 to 60 days in the interior annually (Water, 2017). The uMngeni River is described as being a short river and receiving erratic and seasonal rainfall; leaving the catchment open to heavy flooding and seasonal droughts (Shoko et al., 2016). In addition, the underlying lithology at the head of the uMngeni River around the Pietermaritzburg and Howick area is dominated by mudstone and Shale of the Ecca Group, whereas granite and gneiss of the Natal Metamorphic Province dominate the sides of the river around the Nagle and Inanda Dams (Water, 2014).

The different landcover and land-uses within the catchment include a mixture of farmlands, grasslands and wetlands further upstream, before the increase in built-up cities and residential areas in the middle of the catchment. Moving further eastward toward the coast, there are industrial corridors, sugar cane fields and natural bush before the uMngeni River opens up to the Indian Ocean (Shoko et al., 2016).

Pietermaritzburg is the capital city of the province of KwaZulu-Natal (KZN) and consists of many economic activities and residential areas. Similarly, Durban is the largest city in KZN and the third largest city in South Africa. This speaks to the high demand on water resources and relatively low or poor water quality in the uMngeni catchment due to poor sewerage infrastructure and inadequate management of farming and industrial practices (Water, 2014). Moreover, the uMngeni catchment consists of four major and important dams namely Midmar Dam, Albert Falls Dam, Nagle Dam and Inanda Dam which the Umgeni River flows through respectively, before opening out into the Indian Ocean. The catchment is considered a ‘closed’ catchment because all the water has been allocated based on the prioritisation of water allocation i.e., industry, commercial and subsistence farming, rural and urban domestic uses, utilities, tourism and ecological functioning. Therefore, no further water licenses are available as the remaining water is for the environmental and human reserve. The National Water Act 36 of 1998 defines the environmental reserve as the amount and quality of water

necessary for sustainable ecological functioning of all aquatic ecosystems. Similarly, the human reserve is defined as the amount and quality of water required to meet the basic needs of the people who rely on the water resource, now and in the future. Therefore, the catchment being 'closed' prevents the reduction of stream flow in the catchments to an unsustainable level (Water, 2014). Lastly, to augment the water supply from the closed Mooi-uMngeni catchment, the uMkomazi-uMngeni Transfer Scheme also known as the uMkomazi Water Project is currently under development (Water, 2014).

3.3 Data Collection and Analysis

In addressing the research aim which is 'To assess the institutional aspects that may or may not facilitate IWRM and AM at a local (municipal) scale generally but more specifically in relation to the broader uMngeni catchment; and propose recommendations for effective water resource governance taking IWRM and AM into consideration', a desktop document analysis was conducted. The documents which were analysed include the National Water Act (NWA) 36 of 1998, the Water Services Act (WSA) 108 of 1997, the Proto Catchment Management Strategy (CMS) for the Pongola-Mtamvuna Water Management Area: 90% Draft Version October 2019, the Msunduzi Integrated Development Plan (IDP) 2018-2019, the Msunduzi Local Municipality: Water Master Plan for Pietermaritzburg 2016, the Msunduzi Sewer Master Plan and the eThekwini Water Services Development Plan (WSDP) 2012. The water legislation and CMS were selected because they inform water resource planning and management. The water services, environmental and development tools assist in guiding water-use activities thus affecting the quality and quantity of water in the uMngeni catchment. Furthermore, the tools were reviewed to investigate whether IWRM principles were considered in each tool which is the second research objective.

Twenty-one semi-structured interviews (see Appendix A) were conducted between May and December of 2019. Ten participants were identified prior to the commencement of data collection and the remaining 11 participants were identified through the Snowball Sampling technique. In total, the 21 participants represented 11 different institutions (Table 3.1) that are directly or indirectly involved in water resources management in the uMngeni catchment. The interview schedule was structured (see Appendix A) to accommodate all the participants' field of specialisation and experiences within the catchment. The first four questions (see Appendix A) were background questions to understand the participants role in their respective organisation, water resources management in the catchment, and their understanding of IWRM and AM. These questions provided information that addresses the

first two research objectives of the study. The remaining eight questions (see Appendix A) were exploring the participants' perceptions on water resources management in the catchment, the challenges that are experienced, the shortcomings in management institutions and their ideas or recommendations for effective water resources governance. These questions addressed the third and fourth research objectives. In efforts to avoid Social Desirability Bias which is characterised by participants providing favourable answers or not expressing their true thoughts (Bergen and Labonte, 2019), all the participants names are not included in the study and are referred to by alphabetical letters (e.g., Participant B).

Table 3.1 The number of participants across 11 organisations representing different stakeholder groups involved in water resources management in the uMngeni catchment.

Organisation	No. of Participants
Catchment Management Forums (CMFs) or Irrigation Board	4
Department of Water and Sanitation (DWS)- Provincial	2
Duzi Umngeni Conservation Trust (DUCT)	1
Department of Environment, Forestry and Fisheries (DEFF)- Provincial	1
KZN Department of Economic Development, Tourism and Environmental Affairs (EDTEA)- Provincial	1
EThekwini Municipality	4
Msunduzi Municipality	1
South African National Biodiversity Institute (SANBI)- uMngeni Ecological Infrastructure Partnership (UEIP)	1
Research Institution- University of KwaZulu-Natal (UKZN)	2
Umgeni Water	3
Water Research Commission (WRC)	1
Total	21

Each interview session was conducted at the participants' place of work and lasted approximately 40 minutes. All the participants read and signed a consent letter agreeing to be voice recorded during the interview session and for anonymity. The sessions were recorded and transcribed for analysis. The transcripts enabled the verification of statements made, cross-referencing the views expressed and extracting quotes to be presented in the research results.

Thematic Analysis or Coding was the approach employed in analysing the water services, environmental and planning tools along with the interview transcripts. Thematic Analysis involves grouping information and responses that relate to a theme or concept (Clarke et al., 2015; Kyngas, 2020; Vaismoradi et al., 2016). Therefore, to address the research objectives, all the data in the planning tools and the responses from the interviews that alluded to the institutional landscape were clustered together and analysed. The same approach was applied to understand how IWRM and water services provision and planning were integrated, and the perceptions on IWRM and AM.

The research limitations that were encountered included the unavailability of various potential participants who are knowledgeable and involved in water resources management in the catchment. This meant that not all the stakeholders that were identified or recommended through the snowball sampling technique contributed to the study. However, the study provides a good insight into the perceptions and opinions from local experts. Furthermore, the use of the snowball sampling technique and the need to re-schedule interview sessions meant that data collection went over the allocated time period. The process of setting appointments to conduct interview sessions was a challenge for some participants as they are professionals required to abide by working hours. Thus, interview sessions had to accommodate the busy time schedule or working hours of participants.

3.4 Ethical Clearance

Initial contact with the Environmental Management Unit in the Msunduzi Municipality and, the Environmental Planning Unit and the Municipal Institute of Learning (MILE) in the eThekwini Metropolitan Municipality was made to obtain Gatekeeper Letters. The two gatekeeper letters provided support and granted permission for the respective municipalities to be used in the research study. The signed gatekeeper letters were attached to the ethical clearance application form which was approved by the University of KwaZulu-Natal (UKZN) Humanities and Social Sciences Research Ethics Committee (HSSREC). After

obtaining ethical clearance, each participant was contacted via email and each participant signed a consent letter granting permission to partake in the study, to be voice recorded for transcription purposes and for anonymity.

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Chapter Four – Paper One

Pandora's Box: Assessing the current trends and challenges of IWRM in the uMngeni Catchment

4.1. Abstract

Integrated Water Resource Management (IWRM) is a management approach that seeks to integrate different water use sectors into water resource planning to ensure the sustainable use of the resource. The Global Water Partnership established the IWRM toolbox as a guideline for governments to implement IWRM. The toolbox advocates for the establishment of legislation, policies and financing structures, institutions and organisations, and management instruments that will facilitate the integration between the water sector and water using sectors. IWRM has been criticised as being a 'one-size-fits-all' approach. This is problematic from the start as there is no blueprint to implementing the approach as it is severely dependent on the institutional set-up in a catchment. This paper investigated the extent to which IWRM is implemented in the uMngeni catchment, KwaZulu-Natal (KZN), South Africa, with a focus on the institutional dynamics present. The purpose of the study was to assess the institutional aspects that may or may not have facilitated IWRM. This is done firstly by identifying the relevant organisations and their sphere of influence with regards to water resource management; and secondly by investigating how water resource management features in development planning and environmental management tools. The study is qualitative in nature whereby 21 semi-structured interviews were conducted in combination with a desktop documentary analysis of development planning and environmental management tools. The collected data showed that the catchment has not established Water User Associations (WUAs) at the local level which are statutory bodies and does not have an operational Catchment Management Agency (CMA) at the regional level. Consequently, water resource planning and the implementation of IWRM has been very limited. The establishment of the uMngeni Ecological Infrastructure Partnership (UEIP) has facilitated the integration of role-players in the absence of an operational CMA. Most of the spatial planning and environmental management tools feature water resource planning with the exception of the integrated waste management plans. As a result, poor solid waste management contributes to the poor water quality in the uMngeni catchment. The challenges remaining are the poor implementation of plans due to a lack of human and financial resources. Therefore, the gap created by a non-existent operational CMA means catchment management activities will continue to negatively affect water resources and the degree to which water resource management is integrated.

Keywords: IWRM; water resource management; uMngeni; South Africa

4.2. Introduction

Integrated Water Resource Management (IWRM) is described as an ongoing process that aims to challenge conventional water management approaches which have been characterised as highly fragmented, top-down and largely technical (Elias, 2017; Godinez-Madrigal et al., 2019). Instead, IWRM seeks out integrated decision-making across multiple sectors regarding water use. The implementation of IWRM depends largely on ensuring transparent processes, including a wide array of interest groups in the decision-making process, holding role-players accountable, and ensuring equity and efficient use of water resources (Clement et al., 2017; Kluge, 2018). In addition, IWRM requires an enabling environment, institutional dynamics and use of management instruments which are collectively referred to as the IWRM Toolbox or Change Areas (Agarwal et al., 2000). An enabling environment is the suite of legislation, policies and financing tools that allow for an integrated nature in water management. The institutional dynamics are the roles and functions of organisations, their capacity to fulfil their mandates and the channels for public participation in the decision-making process. The toolbox is completed by the management instruments which assist decision-makers in making informed decisions. These include regulatory instruments, demand management, communication and information systems and evaluation techniques (Agarwal et al., 2000; Grigg, 2016; Tejada-Guibert, 2015).

The literature cited in this paper demonstrates the efforts of water professionals in striving towards a high degree of integration between the water sector and development across agricultural, domestic, industrial and environmental activities. However, IWRM is heavily criticised for being vague and promoted as a ‘one-size-fits-all’ approach (Biswas, 2004; Kluge, 2018; Lubell and Edelenbos, 2013). The rejuvenated advocacy of IWRM post multiple conferences (e.g., the Earth Summit in 1992 and the World Summit on Sustainable Development in 2002) saw many countries incorporating the principles of IWRM in their water legislation and a review of macro-scale projects from across the world aiming to improve water governance; but the universality of the concept remained questionable. How could a single concept be applied in different context and conditions? The implementation of IWRM in developed countries cannot be used as a blueprint in developing countries because of the social and economic challenges and institutional landscape that exists (Lenton and Muller, 2009a). Thus, examining the institutional dynamics in a site-specific context is important in understanding the implementation of IWRM. This paper investigates the extent to which IWRM is implemented at a local (municipal) level with a focus on the institutional

dynamics. The purpose of the study is to assess the institutional aspects that may or may not facilitate IWRM in the uMngeni catchment. This is achieved firstly by identifying the relevant institutions or organisations and their sphere of influence with regards to water resource management. In this context, the sphere of influence refers to the organisations' individual and/or shared responsibilities and mandates. Secondly, the paper investigates how water resource management features in development planning and environmental management tools in relation to service provision and municipal functions.

4.2.1 Study area

This study was conducted in the uMngeni catchment which is approximately 4 439 km^2 in the KwaZulu-Natal Province of South Africa (Figure 4.1). The Msunduzi Municipality and eThekwini Metropolitan Municipality are the most populous municipalities in the catchment and depend on the catchment for potable water supply. Furthermore, the catchment accommodates various land-use activities. A range of farmlands, wetlands and grasslands are located upstream before reaching the middle of the catchment which is built-up and residential areas. Industrial activities, natural bush and sugar cane fields are prevalent downstream before opening up to the Indian Ocean. Informal settlements and communities are located along the uMngeni River as they rely on the water resource for domestic purposes (Shoko et al., 2016; Water, 2017).

The catchment is plagued with numerous challenges that indicate the lack of integration in water resource management and planning. Challenges include inconsistent rainfall, poor maintenance of water infrastructure which is evident through leaks, high levels of effluent waste flowing into rivers and ineffective solid waste management which negatively affects water quality (Kidd, 2011).

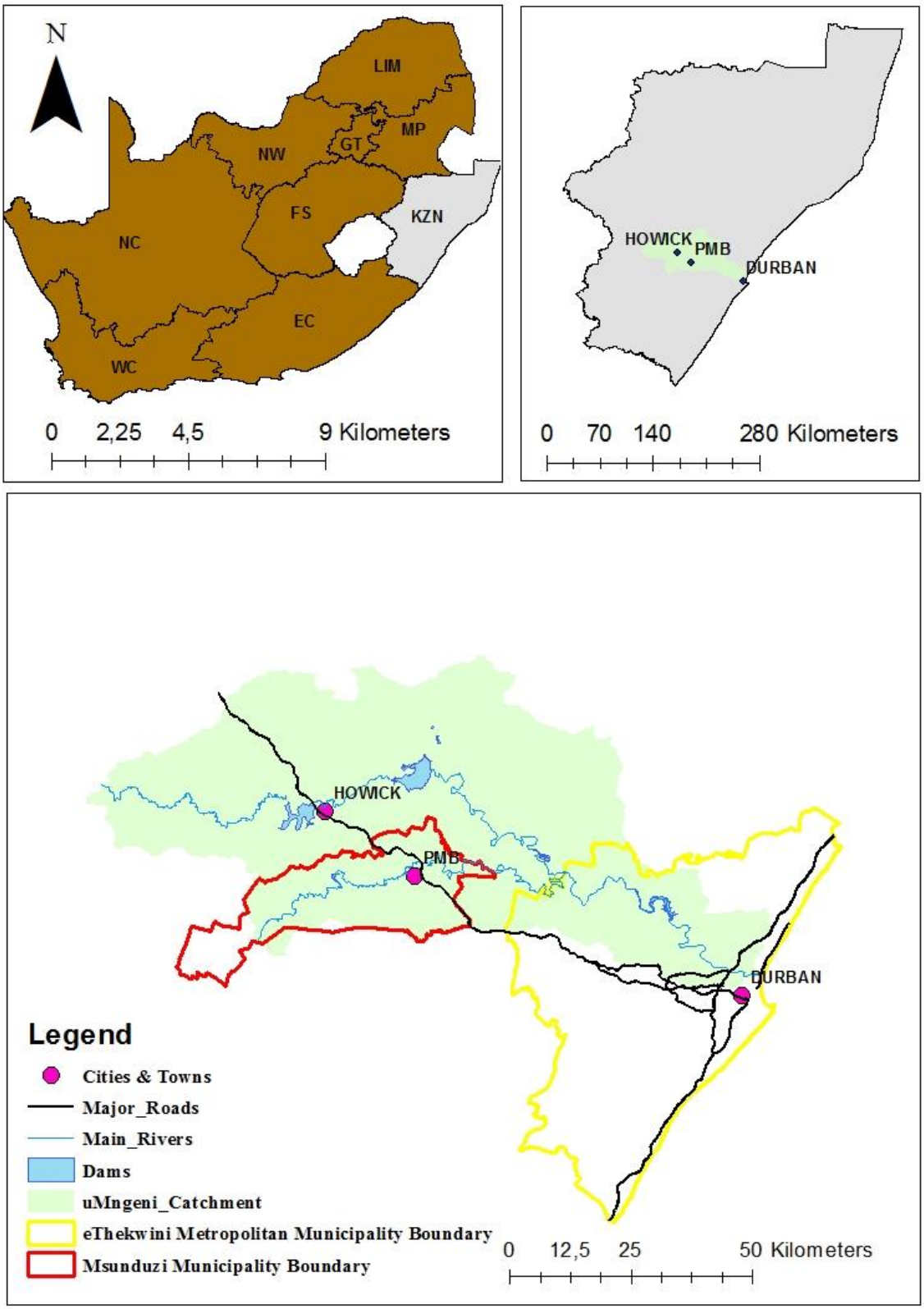

Figure 4.1 uMngeni catchment boundary relative to the Msunduzi Municipality (red) and eThekwini Metropolitan Municipality (yellow) boundaries.

4.3. Materials and Methods

This section describes the research design, methods employed for data collection, the method of analysis and research limitations.

4.3.1 Research Design

The case study research method was employed to assess the institutional aspects that may or may not facilitate IWRM implementation within the uMngeni catchment. This research approach enables an in depth understanding of a phenomenon within its context including its natural setting (Bhattacherjee, 2012; Harrison et al., 2017; Lam and Law, 2016). In this case, the approach was an appropriate method to gain an authentic interpretation of IWRM implementation in the current institutional landscape. The case study approach is limited in the sense that the findings may not be applied in a different setting therefore, reflecting the uniqueness required by IWRM.

4.3.2 Data Collection

This study relied on primary and secondary sources of data. Primary data was collected through 21 semi-structured interviews (see Appendix A) which were conducted between May and December 2019. Each interview was structured according to the participants' field of specialisation to gauge their understanding of IWRM, their perceptions on the current challenges, and their willingness to adopt an integrative management system. Ten participants were initially identified by the researcher and through the snow-ball sampling technique, additional participants were identified (Table 4.1). Snowball sampling was essential in building up the sample size as the researcher had difficulty identifying the professionals of interest in the catchment (Etikan et al., 2016; Waters, 2015).

Table 4.1 The list of participants and their respective organisations including the municipality in which the organisation operates (eThekwini Metropolitan Municipality and/or Msunduzi Municipality)

Participant	Organisation and/or Department	Municipality	Date of Interview
1. Participant A	*Local Municipality*- Environmental Planning and Climate Protection Department	eThekwini Metropolitan Municipality	18/09/2019

2. Participant B	*Local Municipality*- Catchment Management Department (Stormwater, catchment and Coastal)	eThekwini Metropolitan Municipality	25/10/2019
3. Participant C	*Local Municipality*- Pollution and Environment (Water Quality	eThekwini Metropolitan Municipality	17/09/2019
4. Participant D	*Department of Human Settlement, Water and Sanitation (DWS)*- Institutional Management Directorate	Both	18/11/2019
5. Participant E	*Local Municipality*- Water Services	Msunduzi Municipality	14/05/2019
6. Participant F	*Local Municipality*- Climate Protection Branch	eThekwini Metropolitan Municipality	18/09/2019
7. Participant G	*Umgeni Water*	Both	31/05/2019
8. Participant H	*Umgeni Water*	Both	31/05/2019
9. Participant J	*Umgeni Water*	Both	28/06/2019
10. Participant K	*Msunduzi Catchment Management Forum (CMF)*	Msunduzi Municipality	11/07/2019
11. Participant L	*Upper uMngeni Catchment Management Forum (CMF) and World Wide Fund for Nature (WWF)*	Both	12/09/2019
12. Participant M	*Water Research Commission (WRC)*	Both	28/11/2019

13. Participant N	*University of KwaZulu-Natal (UKZN)*-Centre for Water Resources Research (CWRR)	Both	09/12/2019
14. Participant O	*Msunduzi Catchment Management Forum (CMF)*	Msunduzi Municipality	26/06/2019
15. Participant P	*Mooi River Farmers Association and Mooi Mpofana Agricultural Association*	Msunduzi Municipality	27/06/2019
16. Participant Q	*Department of Economic Development, Tourism and Environmental Affairs (EDTEA)*- Environmental Planning	Both	01/17/2019
17. Participant R	*Department of Human Settlement, Water and Sanitation (DWS)*- Catchment Management Sub-directorate	Both	10/07/2019
18. Participant S	*Duzi Umngeni Conservation Trust (DUCT)*	Both	15/07/2019
19. Participant T	*Department of Environment, Forestry and Fisheries (DEFF)*- Environmental Affairs	Both	09/09/2019
20. Participant U	*University of KwaZulu-Natal (UKZN*)- Department of Law	Both	20/09/2019
21. Participant V	*South African National Biodiversity Institute*	Both	21/11/2019

	(SANBI)- uMngeni Ecological Infrastructure Partnership (UEIP)		

Semi-structured interviews was the most appropriate tool as the research questions required subjective knowledge regarding IWRM in the catchment; which could not be obtained from literature (McIntosh and Morse, 2015). A review of published literature was conducted to understand the nature of water resource planning and management in South Africa and in the catchment. However, published literature provided limited information pertaining to the institutional landscape of the catchment. Therefore, the interview schedules were designed to assist in mapping out the current institutional landscape and the sphere of influence of each organisation. The schedules also assisted in understanding the challenges prevalent in the catchment, the perceptions professionals held toward the management approaches and ideas to provide recommendations moving forward. The first couple of questions were to identify all the organisations involved in water resource management and their sphere of influence. The following two questions were aimed at depicting the level of integration and coordination among the organisations: with the remaining questions exploring the participants' perception on the challenges in the catchment and the management approaches. The questions were open-ended with the purpose of the participant engaging with the questions. Furthermore, in an attempt to avoid participants providing favourable responses termed social desirability bias (Bergen and Labonte, 2019), all the participants are anonymous.

Each interview session lasted approximately 40 minutes starting with the participant signing a consent letter. The interviews were recorded and transcribed for analysis. The recording of the interviews allowed for in-depth analysis, verifying statements made, cross-referencing facts and extracting quotes to be utilised in the results.

Secondary data sources involved a desktop documentary analysis of the National Water Act (NWA) 36 of 1998, Water Services Act (WSA) 108 of 1997, the Msunduzi Integrated Development Plan (IDP) 2018-2019, Msunduzi Local Municipality: Water Master Plan for Pietermaritzburg 2016, Msunduzi Sewer Master Plan, eThekwini Water Services Development Plan (WSDP) 2012 and the Proto Catchment Management Strategy (CMS) for the Pongola-Mtamvuna Water Management Area: 90% Draft Version October 2019 to

supplement the interviews. This data was also used to assess how these environmental management and planning tools incorporated IWRM and understand the link between water service provision and IWRM at the local level. The listed tools are current, and some are designed to be implemented over a 5-to-10-year time frame.

4.3.3 Analysis

Interview transcripts along with the environmental and planning tools were analysed by grouping responses together according to themes and reoccurring responses, termed Thematic Analysis or Coding (Clarke et al., 2015; Vaismoradi et al., 2016). As described in the previous sub-section, the first few questions addressed the institutional landscape that exists in the uMngeni catchment. The next set of questions explored the degree of coordination and integration among the organisations, and the last set of questions explored the perceptions of the key actors concerning, the challenges experienced in the catchment and their views on IWRM as a management approach. The responses were grouped accordingly and analysed through inductive reasoning (Kyngas, 2020).

4.3.4 Ethical Clearance

Ethical clearance was obtained from the University of KwaZulu-Natal (UKZN) Humanities and Social Sciences Research Ethics Committee (HSSREC) upon obtaining gatekeeper letters from the respective municipalities. Initial contact with participants was made via email or telephone call detailing the nature of the research. Each participant signed a consent letter granting permission to conduct the interview and to be voice recorded.

4.3.5 Limitations

The unavailability of a few potential participants meant that not all professionals identified as key role-players contributed to the study. Moreover, relying on the snowball sampling technique and re-scheduling of interview sessions led to an extended amount of time allocated to collecting this dataset.

4.4. Results

4.4.1 The Institutional Landscape in the uMngeni Catchment

The institutions involved in water resource management in the uMngeni catchment are depicted in Figure 4.2 based on the discussions with the participants (primary data sources) and was further informed by the then Department of Water Affairs and Forestry's IWRM guidelines and pilot implementation in 2002 (secondary data source).

Each organisations' sphere of influence which, in this context refers to the responsibilities and mandates, are described in detail. In the interviews, the data reveals that at the national level, the Department of Human Settlements, Water and Sanitation (DWS) formerly known as the Department of Water and Sanitation, are the national regulator and lead institution in water resource planning for South Africa. As the custodians for water resources, DWS is responsible for monitoring water resources, enforcing water legislation and guideline tools for water resource management, establishing the national water resource strategy, determining the pricing strategy and implementing tariffs, determining water resource classes and Resource Quality Objectives (RQOs), establishing reserves, authorising and allocating water-use licensing for strategic purposes and/or inter water management areas. Based on the interviews and the IWRM guideline and pilot implementation, the organisations that play an impacting role at the national level include the Water Research Commission (WRC) and the Department of Mineral Resources (DMR). The WRC is a non-statutory, non-governmental research funding organisation that strives to be a water knowledge hub in South Africa and globally. A respondent stated that the WRC funds research that has been identified as a research need or priority in the water sector in South Africa. They are also involved in setting research agenda's and implementing measures that will facilitate information dissemination when research has been concluded. According to the IWRM guidelines and pilot implementation, the DMR is the national governmental department responsible for promoting and regulating the minerals and mining sector in South Africa; for transformation, development and growth that leads to the overall benefit of South African citizens. In analysing the interview data, the role of the DMR in water resources management relates primarily to the issue of sand mining, as it negatively affects catchment management in the uMngeni. Sand mining causes massive sedimentation in water resources and reduces water quality leading to significant loss of dam capacity. DWS and DMR are represented in red due to their roles as regulators while WRC is represented in orange as an 'other institution'.

At the regional level the Catchment Management Agency (CMA) is represented in red for its role as a regulator. Through published articles, it is identified that CMAs are statutory river basin organisations responsible for resource protection and water use management within a Water Management Area (WMA). Responsibilities include formulating a CMS, determining reserves and RQOs when it is delegated to them by DWS, authorising and enforcing water use, setting and collecting water use charges, planning of water resources, overseeing water

transfers, resource rehabilitation, licensing, managing river health and protecting the state of rivers in a WMA.

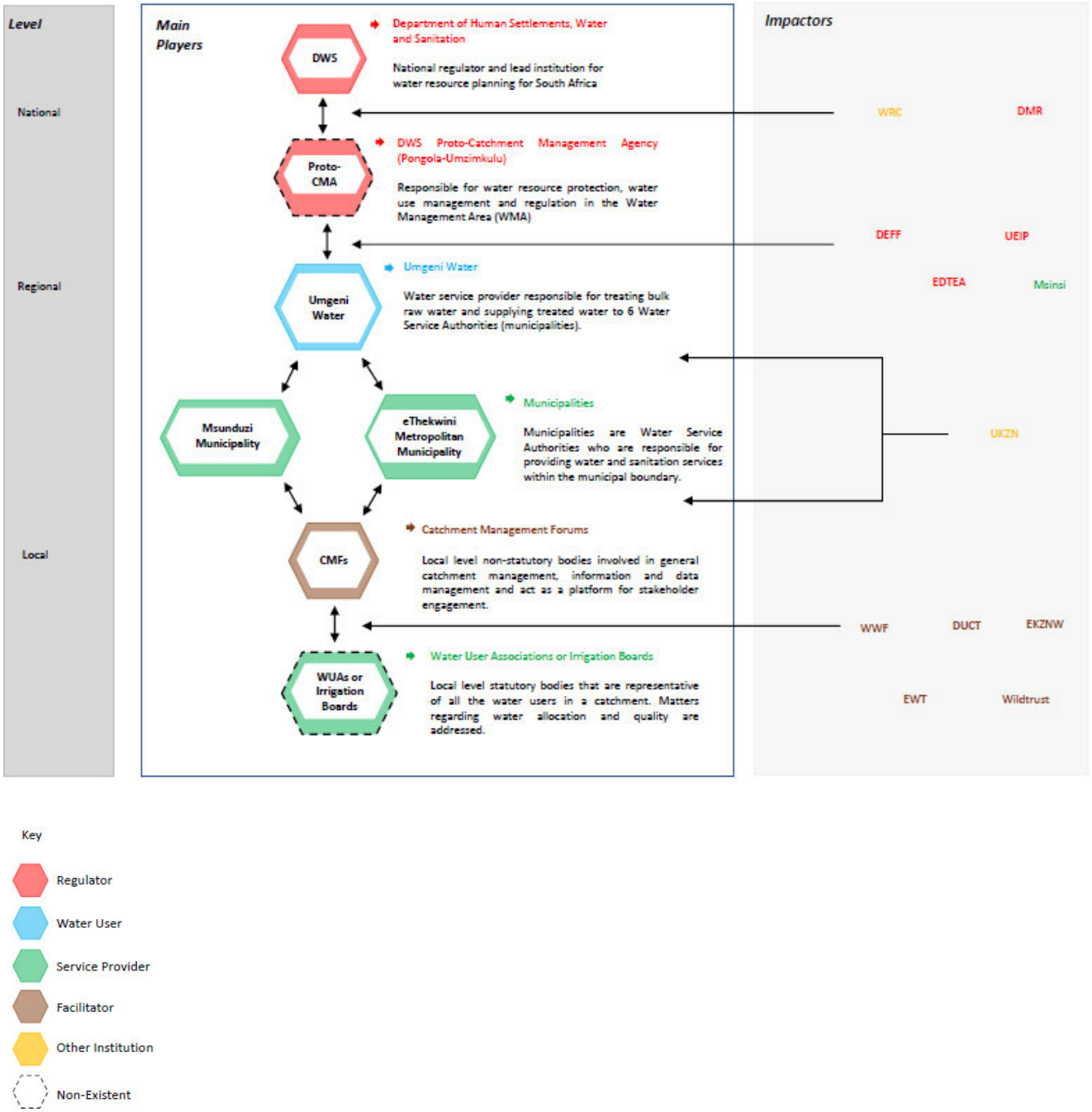

Figure 4.2 A layout of the institutional landscape in the uMngeni catchment, informed by the interviews.

Most of these functions are delegations that the Minister would need to transfer to the CMA once it is established and operational. A CMA's responsibility further extends to regulating and monitoring resources, including civil society in decision-making and commissioning studies or investigations that will contribute to planning and making informed decisions. However, participants state that a CMA for the Pongola-Umzimkulu WMA which would be responsible for the uMngeni catchment is not operational due to political factors; hence the dotted line representation in Figure 4.2. Instead, DWS formed a sub-section known as the Proto-CMA which fulfils some of the functions a CMA would. This is supported by published articles on CMAs in South Africa. Participants described Umgeni Water as a water board and Water Service Provider (WSP) responsible for treating raw bulk water at Darvil treatment works, before supplying 6 Water Service Authorities namely eThekwini, Ugu, uMgungundlovu, iLembe, uThukela and Harry Gwala. Water flowing from a source is diverted to Darvil where it is treated before ending up in a reservoir where the municipality allocates water to the respective water users. Wastewater is also treated by Umgeni Water before entering the river system and flowing downstream. The organisation is represented in blue because it is a water user but can also be represented as green because it is a service provider. In addition, a respondent pointed out that Umgeni Water is responsible for managing bulk water infrastructure on behalf of the DWS and is positioned to bridge the gap between water resource management occurring at national level and reticulation by municipalities at a local level; thus, playing an instrumental role in water resource management. Impacting organisations at the regional level include the Department of Environment, Forestry and Fisheries (DEFF) formerly known as the Department of Environmental Affairs (DEA), the uMngeni Ecological Infrastructure Partnership (UEIP), the Department of Economic Development, Tourism and Environmental Affairs (EDTEA) and Msinsi Holdings which are described below.

Secondary sources reveal that DEFF is the national department that provides leadership in environmental protection, management and conservation and is the custodian of the natural environment (air, water and land), including forestry and fisheries. DEFF is identified as the 'watch dog' in the water sector by the participants and published articles. A respondent stated that DEFF plays a role in dealing with spillages and implementing a variety of programmes directed at improving catchment management. The UEIP is a non-statutory catchment wide partnership comprising of representatives from various organisations (i.e., private sector, academic institutions and Non-Governmental Organisations (NGOs)) and government and is

therefore not considered as a formal institution. In the interviews, the data reveals that the UEIP is a loose partnership based on the representatives signing a Memorandum of Understanding (MoU) for 5 years. Representatives agree to attend biannual meetings to discuss issues prevalent in the catchment and possible solutions that can be implemented by the respective organisations. The partnership may be found operating beyond the borders of the uMngeni catchment. Moreover, the partnership was formed to bridge the gap in planning regarding ecological infrastructure (EI) investment in the catchment as a supplementary approach to water security and resource management. A respondent stated that the UEIP does not have its own mandates, but the individual organisations do, therefore the partnership ensures that signatories are fulfilling their responsibilities through collaboration and coordination, reducing institutional gaps. This allows for institutional reflection so as to improve the effectiveness of the individual organisations. This contributes to the UEIPs role in water resource management in the catchment as it fosters coordination among the role-players in the water sector. In addition, a respondent clarified that the partnership is concerned with enhancing the capacity of the proto-CMA and the main CMA when it is established and operational. The UEIP is categorised in Figure 4.2 as an impacting 'institution' and not as a main role player due to its non-statutory status.

EDTEA is a commenting authority (regulator) working alongside DWS in assessing the impacts of development on the environment, and either deny or approve development plans in the catchment. The interview data further reveals that, the department also manages and polices land management activities with the aim of ensuring best practice and environmental sustainability. Their impact on water resource management is evident through their efforts of protecting water production areas by limiting development, which ultimately protects water quality. A respondent stated that EDTEA professionals are known to attend Catchment Management Forum (CMF) meetings where they may discuss potential developments in the catchment and the associated implications. Lastly, Msinsi Holdings operating as Msinsi Resorts and Game Reserves is a subsidiary of Umgeni Water. The organisation is responsible for managing the water resources in proximity to the dams owned by Umgeni Water and runs the nature reserves the dams are located on. This was stated by a respondent and supported by a secondary source. Their role as an impactor and service provider as represented in green, is essential in ensuring that the activities on nature reserves does not impact on water resources in a negative manner.

At the local level, interview data reveals that water resource management is dealt with by the municipalities as they are the Water Service Authorities. They purchase bulk water from Umgeni Water to supply cities for domestic and industrial use. As a service provider represented in green, they are by law mandated to provide access to basic water and sanitation services to ensure good quality of life for citizens. Services include collection, removal, disposal, purification, supply and regulation of water and sanitation. Moreover, they are to uphold tariffs, develop and implement WSDPs and develop bylaws for the conditions regarding water services. The University of KwaZulu-Natal (UKZN) has been identified as an impactor institution for their role in conducting research that feeds into water policy and law. Participants state that the university also has a good relationship with some of the organisations involved in water management enabling the communication of research needs. UKZN also contributes toward capacity building and training of water professionals and preparing of graduate students for the sector and is represented in yellow.

Published articles supported by the interview data state that CMFs are non-statutory bodies that fall under CMAs at a local level and are considered by some as the ‘eyes and ears’ of DWS. An operational CMF in a specific area is a platform where residents can communicate issues prevalent in the catchment and discuss possible solutions. A respondent stated that forum meetings are attended by DWS representatives and NGOs, but they may not attend on a regular basis. CMFs also assist with the public participation process as department officials seek out CMFs to engage with civil society regarding developments in an area. Moreover, interview data reveals that there are a number of CMFs which have been established and are making notable contributions to water resource management. The Msunduzi CMF focuses on the Msunduzi River as it feeds into the uMngeni River. Their focus is on water quality due to the industrial activities taking place along the river and the communities that depend on the river for domestic purposes. The forum meets on a quarterly basis annually where they are able to provide advice on initiatives that will be implemented by external organisations, provide support to the municipality when required and assess the state of the Msunduzi River based on the water quality reports from Umgeni Water and the Msunduzi Municipality’s environmental health department. The Upper uMngeni CMF primarily focus on areas draining into Midmar Dam which are facing challenges. The Mooi area is under poor conditions due to farming activities whereas Mpophomeni is facing poor sanitation and solid waste management negatively impacting on the uMngeni River. Representatives from provincial government, service authorities, rent payers and NGOs attend forum meetings

where DWS often disseminate information and communicate with locals regarding water classification and the monitoring of water allocation and usage. A respondent highlighted that forum meetings are well attended and active. Due to the role of a facilitator, the CMFs are represented in brown in Figure 4.2.

Based on the NWA 36 of 1998, irrigation boards which were local level bodies under the management of large-scale farmers, where their interests with regards to water use were discussed; were to be transformed into Water User Associations (WUAs) which are statutory bodies and representative of not only farmers, but all water users even if they do not have formal water entitlements. This is in efforts of including previously disadvantaged individuals in water resource management at a local scale. In the uMngeni catchment, a few participants reiterated that there had not been any irrigation boards. Similarly, there are no WUAs operating in the catchment. Due to the role of a service provider, WUAs are represented in green and in a dotted line indicating the lack of these in the catchment. Impacting organisations at the local level include the Duzi Umgeni Conservation Trust (DUCT), World Wide Fund (WWF), Ezemvelo KwaZulu-Natal Wildlife (EKZNW), Endangered Wildlife Trust (EWT) and Wildlands Conservation Trust/Wildtrust; represented in brown as their role as facilitators. Based on the responses, DUCT is an implementing agent well known for their extensive work in the Msunduzi River and beyond regarding catchment management interventions e.g., sand mining, biodiversity stewardship, alien vegetation clearing and dealing with sewerage charging. The organisation has hopes of having a more strategic influence regarding where and how funds are spent and implementing policy. Similarly, a respondent described that WWF has different people working on different environmental issues. However, their recent contribution is through their work of engaging dairy farmers in the uMngeni catchment and expanding beyond, regarding water usage, generation of waste and improving self-governance. They are engaging with Nestle, Danone, Fair Cape and Woodlands Dairy as these businesses are operating in the catchment and have an impact on the water resources. Lastly, the responses reveal that EKZNW is the provincial conservation organisation in KZN and engage with various catchment management activities. Whereas EWT and Wildlands perform wetland work and waste management respectively.

4.4.2 Alignment of Water Resource Management, Water Law and Governance Tools

To implement IWRM, water resource management needs to be featured in environmental and development tools. In this section, resource management and governance tools refer to implementing plans and documents which includes the National Water Resources Strategy

(NWRS) and the Catchment Management Strategy (CMS) at the national and regional level respectively. The range of tools also include the Water Services Development Plan which assist in implementing the NWA No 36 of 1998 and the WSA No 108 1997. The alignment of water resource management in water policy and the respective national level tools is described below.

National Water Act (NWA) No 36 of 1998

The act guides water governance through water allocation standards, defining powers and duties of the minister and CMAs, which support the implementation of IWRM. The act seeks to protect, use, develop, conserve, manage and control water resources to enable current and future generations to meet their needs, promote equitable access to water, readdressing past injustices and discrimination, sustainable and efficient use of water, social and economic development, ecosystem health and diversity, protection of resources from degradation and harm, managing floods and droughts and striving toward meeting international standards.

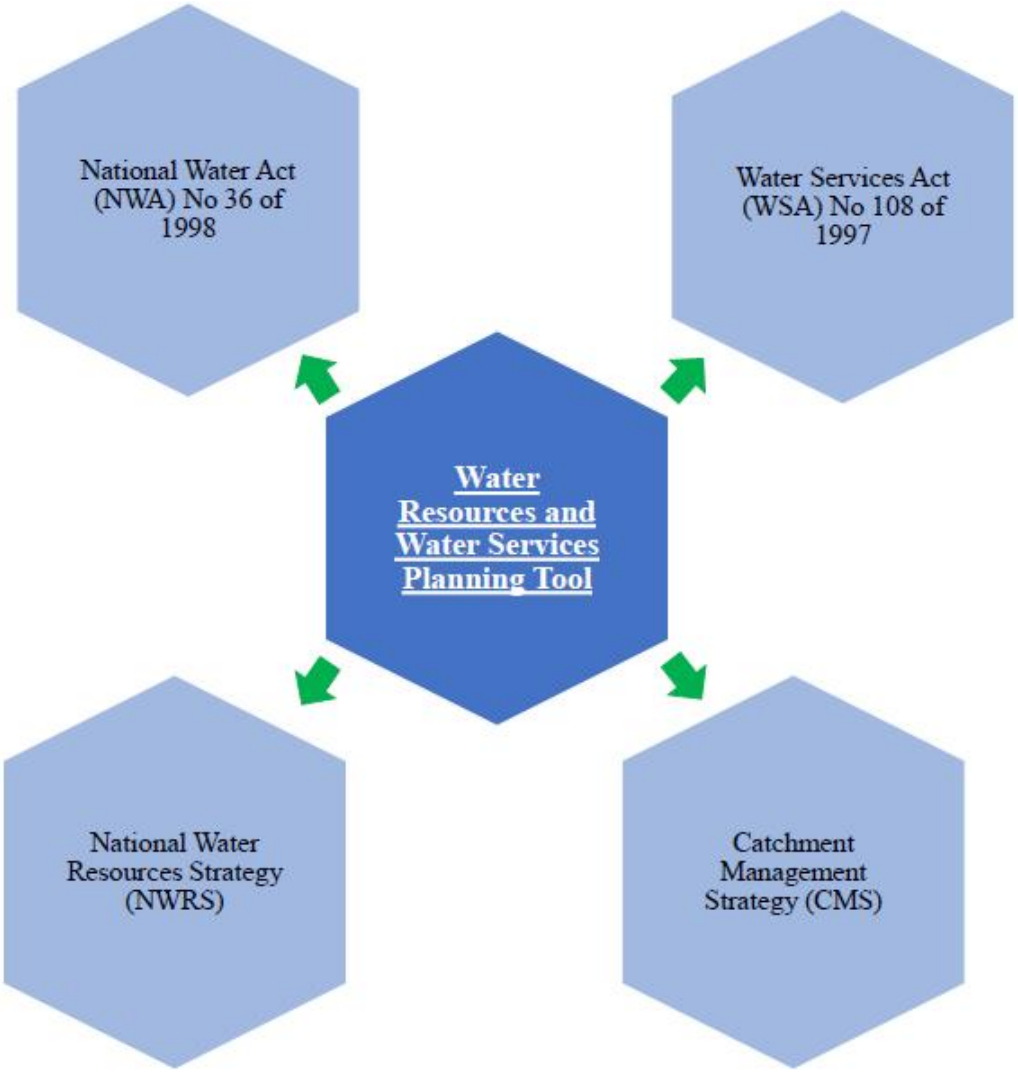

Figure 4.3 National level legislation and associated implementing plans

Water Services Act (WSA) No 108 of 1997

The act serves as an instrument that guides parastatals or private entities to provide water services and the roles and responsibilities of each organisation. Local government does not have the mandate to manage water resources, however the quality of water is affected by water service provision actions thus having an indirect influential role in resource management.

National Water Resources Strategy

The 'National Water Resource Strategy: Water for an Equitable and Sustainable Future 2013' 2nd edition (NWRS-2) builds on the 1st edition NWRS published in 2004. The 1st edition provided a blueprint or framework for water resources management in South Africa and was the first of its kind. The NWRS-2 recognises the goals and directives of the National Development Plan (NDP) regarding economic development and poverty alleviation, and the NWA and its directive to protect, conserve, use and manage water resources equitably and sustainably. The strategy identifies 3 objectives; water supports development and the elimination of poverty and inequality, water contributes to the economy and job creation, and water is protected, used, developed, conserved, managed and controlled sustainably and equitably. In response to these objectives, strategic themes are identified detailing the prominent challenges, the main principles that need to be practiced, the set of objectives for the respective themes and the interventions that need to be actioned to achieve the objectives.

Considering the Reconciliation Studies, the strategy highlights that water is a scarce resource. Although the water resources planning, infrastructure and development theme aims to increase water availability through engineering approaches, the cost of construction and maintenance of infrastructure provides a limitation. Thus, the strategy identifies the need to explore different approaches to increasing water supply such as conservation and demand management, groundwater sources, recycling wastewater and treating acid mine drainage, desalination, rainwater harvesting and catchment rehabilitation efforts such as invasive alien clearing. Moreover, equitable access to water refers to; equitable access to water services, equitable access to water resources and equitable access to the economic, social and environmental benefits attained through development and management.

Through the water allocation reform programme, general authorisations, partnerships and development support, the strategy intends on delivering on water resource equity. The strategy seeks to address the challenge of water resource pollution and resource depletion through resource protection, determination and preservation of the ecological reserve and water demand management. The implementation of the strategy rests on competent and accountable management therefore, the strategy outlines the institutional arrangements that will be established or requires strengthening in order to implement actions toward water resource management.

The strategy dedicates a chapter to the financial resources required to implement the necessary programmes and is done so off the backdrop that the private sector, government, external funders and development institutions combine forces to support water resource management. Through the collaboration of universities, universities of technology and Further Education and Training (FET) colleges, a plan is in place to identify the skills needed in the water sector and develop the necessary training materials and improve competencies in all levels of management, in contribution toward water resource management. The strategy identifies that a major challenge in the water sector is the lack of implementation of plans, policies and programmes. Therefore, the NWRS-2 is accompanied by an implementation plan which prioritises programmes aimed at water resource protection, compliance and monitoring and the maintenance of infrastructure. The implementation plan was complied with the assistance of partners in the water sector to define roles and responsibilities and install measures toward effective monitoring.

Catchment Management Strategy

The 'Proto-CMS Strategy for the Pongola-Mtamvuna WMA: 90% Draft Version October 2019' has been drafted and is in the process of being completed. The strategy outlines the various sewerage problems in Mpophomeni and the Pietermaritzburg (PMB) Central Business District (CBD), and how this negatively affects the water resources (quality and quantity) in the WMA and the uMngeni catchment. To initiate an effective water resource management approach, the strategy identifies 6 strategic themes namely; Water resource protection, water availability, water allocation, stakeholder engagement, cooperative governance and institutional arrangements. Each theme is described and is accompanied by a set of objectives, and main actions and interventions to be fulfilled by the water sector. Considering that initially a CMS had not been drafted, the current draft version which is 90%

complete is progress toward focussing on developing and managing the water resources in the WMA and the uMngeni catchment.

Water resources management partially features in various municipal level governance tools which is described below. The most up to date plans were reviewed in the order of the Msunduzi Municipality followed by eThekwini Metropolitan Municipality (Table 4.2).

Table 4.2 The range of governance tools within the respective municipalities and how water resources management is featured in each tool

	Water Resources and Water Services Planning	**Other**		**Environmental Management**
		Development Plans	**Spatial Plans**	
Msunduzi Municipality	Water Master Plan 2016	Integrated Development Plan 2018-2019	Spatial Development Framework 2009	Integrated Waste Management Plan 2014-2018
	Sewer Master Plan April 2016			Environmental Management Framework 2010
eThekwini Metropolitan Municipality	Water Services Development Plan 2012	Integrated Development Plan 2017/2018-2021/2022	Municipal Spatial Development Framework 2019-2020	Integrated Waste Management Plan 2016-2021 (Draft)

Msunduzi Water Master Plan 2016

The plan describes the bulk water system, the standards for water use, average daily demands and the unmetered consumption of water in informal settlements (serviced by standpipes). It further provides information on current and future demands, operational criteria i.e., flow velocities and identifies future areas for development through the Spatial Development Framework (SDF); whereby the needed water supply is already incorporated into the master plan. This is necessary for resource planning especially as Umgeni Water plays a fundamental role in service provision and service delivery in the catchment.

Msunduzi Sewer Master Plan 2016

Most of Edendale and the rest of Pietermaritzburg are served with a waterborne reticulation system that is treated at Darvil Wastewater Treatment Plant. Edendale is known to rely on conservancy tanks but there are plans for transformation toward a waterborne reticulation system. The need for functioning infrastructure is demonstrated; Darvil has the capacity of 65 Ml and has been operating at 85 Ml. The daily demand is at approximately 311 Ml therefore the treatment plant cannot accommodate the current or future demand. An issue that is linked with sewerage management and resource planning is that storm water is directed into this system; the quality of storm water may worsen as the treatment plant is not operating effectively. Therefore, the poor maintenance of water resource infrastructure causes a decline in the overall quality of water resources in the catchment.

Msunduzi Integrated Development Plan 2018-2019

The IDP refers to the *National Development Plan Vision 2030* economic infrastructure objective which has 18 Strategic Integrated Projects (SIPs). Five of the SIPs are applicable to the Msunduzi and the relevant one is SIP 18 'Water and Sanitation. This is aimed at new infrastructure, rehabilitation and improving the management of infrastructure. Based on these, the IDP has identified quality water and sanitation for the city as a strategic priority area. In actioning this, the 'Non-Revenue Water Reduction Project' aims to reduce water loss with an estimated budget of R 0,5 billion. In assessing the state of the Msunduzi, catchments are in fair, poor or seriously modified ecological state. Wetlands have declined significantly where most are transformed, and the remaining ones are in a degraded state. Information pertaining to the functionality of these wetlands is lacking. Water quality monitoring done by Umgeni Water confirms poor water quality attributed to solid waste disposal in rivers, industrial effluent and sewerage leaks in water resources. Consequently, water resources are not suitable for recreational activities and human consumption. In addition, increased development has resulted in increased run-off, wetland degradation, the inappropriate use of riparian zones and increased risk of flooding. Moreover, the IDP states that the predicted annual rainfall for the catchment will remain constant with less storm events and increased intensity and severity. Thus, predicted flash floods in Allandale, Imbali, Oakpark, Prestbury, Rosedale, Sobantu and Townbush Valley. Therefore, mitigation and rehabilitation plans are needed, and more opportunity for social learning studies toward adaptive management. Lack

of solid waste removal and catchment management activities as described are to blame for the poor quality of our catchment which has been described by a respondent to be failing.

With regards to the execution of service delivery, pipelines that have reached their 30-year lifespan are failing and require upgrades or complete replacement. The IDP has set strategies for early detection of leaks, repairs, inspecting reservoirs and accurate meter readings to name a few. The housing projects that are listed in the IDP and mostly planned for the Edendale and Vulindlela area need to be considered for resource planning as this creates increased demand.

Overall, the 5 units in the municipality namely, infrastructure services, community services, economic development, financial services and corporate services will need to integrate their sector plans to achieve sustainable water resources

Msunduzi Spatial Development Framework 2009

The SDF forms a large part of the IDP and is a spatial representation and framework of the municipality's development vision by representing the current and future land-uses. This SDF incorporates the 2025 Development Vision. The framework incorporates water resource management by setting guidelines when dealing with zones not suitable for development. The guidelines are:

a) Hardened surfaces should not be located within 15m of wetlands, dams or drainage corridors.

b) A vegetated buffer of 20m is required between a wetland and stormwater drainage so as to reduce the flow energy, erosive power and pollution in the outflow; before entering a wetland.

c) Measures required to ensure minimal damage from construction.

d) Roads alongside wetlands need to be 20m away with feed-off points at 100m intervals for minimal damage.

e) Off-site mitigation is required for wetlands lost due to development.

f) Wetlands maintained by groundwater require surrounding residential areas to be 60% permeable and industrial or commercial areas to be 30% permeable; porous surfaces are preferred to promote infiltration.

g) Development must abide by the NWA and should not occur within 32m of a water course.

Off-road access to wetlands by livestock or vehicles should be avoided

Msunduzi Integrated Waste Management Plan 2014-2018

The IWMP provides the status quo regarding solid waste management (waste quantity, treatment facilities, equipment and financing) in the municipality. Water resource management is not included directly or indirectly in this tool. However, the inefficiency in the municipality to provide effective waste management is negatively affecting water quality. According to the plan, the city centre and suburbs are swept, and refuse is bagged, transported and landfilled every night. Despite this, littering is still a major challenge. A large majority of the residents receive weekly door-to-door service collection while 39% do not. Consequently, many households are forced to illegally dump, burn or bury their refuse. The lack of service delivery is attributed to a shortage of staff and equipment that is not maintained or replaced due to a restrictive budget. Thus, solid waste makes its way into rivers and streams through stormwater drains or being blown by wind from dumping sites into water courses.

Msunduzi Environmental Management Framework 2010

Similarly to the SDF, the EMF is gazetted and has to be considered in decisions for planning and development. The EMF provides a distribution map of the wetland areas and buffer zones, flood zones and catchment water quality within the municipality, descriptions of the biophysical features, the sustainability objectives for each feature and the guidelines on land-use on or near these features with regards to potential development impacts. The tool indirectly incorporates water resource management because it requires all development proposals to conduct assessments that will investigate the impacts on water resources, and thus rejecting proposals that negatively affect water resources. It also guides decision-making regarding the location of future development, where water resources should be avoided. This is process is paired with conducting Environmental Management Assessments (EIAs) and applying for a Water Use License (WUL).

eThekwini Water Services Development Plan 2012

The eThekwini Water and Sanitation Unit (EWS) implemented priority initiatives that are aimed at improving river water quality and reducing non-revenue water in the municipality.

The Green Rivers Programme coordinates the different functions within EWS to reduce overflows into rivers i.e., illegal discharges of pollutants, accumulation of silt and inflow of illegal stormwater. The Non-Revenue Water Reduction Program was initiated in 2008 with the goal of reducing non-revenue water from the then 36.4% to 25% by 2019; by infrastructure management and upgrades, monitoring of leakages and accurate reading and recording of water meters. In addition, the municipality has a participatory approach-based awareness and education programme that promotes a two-way interaction with communities regarding appropriate use of water services. Over the years, the city's residents have publicly or passively protested the failures in water service provision evident through non-payment, vandalism, wastage and misuse of water. To reduce this and non-revenue water, the programme is actioned through the distribution of posters and leaflets, organising street theatres, house visits, creating models, running school programmes and investing in professional development of educators. Similarly, the EWS spends approximately R3.8 million on in-house training and sending staff to external training courses. The plan further describes the state of the treatment works in the municipality and their efforts of incorporating water availability in development planning through the Water for Growth and Development Framework

eThekwini Municipality Integrated Development Plan 2017/2018-2021/2022

The municipality is committed to fulfilling the objectives set out in the Paris Agreement, Addis Ababa Agreement, Sendai Framework for Disaster Risk Reduction 2015-2030, National Development Plan, Strategic Integration Projects, SDGs, Medium Term Strategic Framework (MTSF) and the national Key Priority Areas, which are focussed on development goals and indirectly affect water resources. The municipality aims to become Africa's top liveable city. In achieving this, the goals and projects geared toward development are pursued. In assessing the municipality's current state of the environment, bio-monitoring programmes have identified that most of the rivers are in poor condition (no mention of ecological functioning). This is attributed to illegal discharges and spills into rivers, inadequate wastewater treatment works, sand mining activities, solid waste disposal and flow reduction due to the construction of dams. It is essential to note that the municipality is at the end of the catchment area and are heavily reliant on water resources from surrounding catchments therefore, relationships with neighbouring municipalities is essential. In addition, rivers supply sediments to the coastal areas however due to sand mining and land management activities; the natural deposit of sediments has reduced by 2/3. The municipality

is committed to investing in ecological infrastructure to address these environmental changes in a cost-effective and sustainable manner. Aligned with SDGs, ecological infrastructure will be considered as a non-negotiable foundation for social and ecological development in the city. The municipality works toward environmental compliance by assessing development applications against D'MOSS impacts, Water Use License (WUAL) requirements, and impact assessments according to the National Environmental Management Act 107 of 1998. The municipality is also committed to the Municipal Climate Protection Programme (MCPP) focused on climate adaptation

eThekwini Municipal Spatial Development Framework 2019-2020

As described in the Msunduzi SDF, this tool assist decision-making regarding the location of future development while managing natural resources. The tool also assists in planning out service delivery projects, planning out how and where investments should be directed, allows for inclusive spatial transformation to occur and maps out the municipality's current state of land-use to assist in developing short, medium and long-term goals for development. The SDF is very comprehensive as it outlines the various international plans that feed into the local plans, the policies and legislation applicable to development planning, current land-uses and its contribution to the local economy, and areas identified for future development based on environmental assessments and the benefits to the municipality's growth. Regarding water resource management, the SDF outlines the municipality's existing water network. The Water and Sanitation Unit strives towards an integrated use of water resources to ensure equitability and sustainability, by having a secure water supply system in place. Awareness of population numbers and current land-uses means the municipality can foresee the demand for water services, the necessary infrastructure needed and the demand for water from different water use sectors. The SDF details projects that will supplement the municipality's current water supply and alternative water resources, a 5-year strategy directed toward non-revenue water and plans toward climate change mitigation and adaption to improve the water supply network. The Water Master Plan and a new WSDP are in the process of being finalised.

The municipality receives its water supply externally and are therefore concerned with catchment management activities surrounding dams, to protect the quality of water resources. The municipality does well to protect its open spaces through conservancies and NGOs, which positively impact on water resources, and to direct development away from environmentally sensitive areas

Integrated Waste Management Plan 2016-2021 (Draft)

The plan describes the status quo on the population composition in the municipality, the different categories of waste generated, the four landfill sites operating in the municipality, the strategies employed to prevent waste generation, minimise waste through recycling and ensuring an efficient waste collection system. Furthermore, the municipality's waste management goals and objectives are outlined, along with an Implementation Plan and a Monitoring and Review Programme. Compared to Msunduzi Municipality, the waste management system in eThekwini is much more resourced and efficient. Approximately 86.1% of households receive waste removal services on a weekly basis with 1.8% receiving services less regularly. On the other hand, 12.1% of households (mainly informal settlements) do not receive any waste removal services and are forced to bury, burn or dump their waste. Despite an efficient system in place, the municipality is faced with a major illegal dumping issue and spent roughly R180 000 000 annually to deal with this challenge. Water resource management is not included in this IWMP however, the issue of illegal dumping will negatively affect the quality of water resources and hydrological functioning when solid or effluent waste makes its way to rivers and streams.

With regards to IWRM, it requires long-term planning to incorporate the different sector plans. The plans described above which incorporates financial planning along with the NWA and Water Services Act creates the enabling environment for IWRM to be implemented. The institutional dynamics is where IWRM in the catchment falls short as roles and responsibilities of the different sectors and their influence on water resources are not defined; and sectors may not be well-informed of their impacts on water resources which speaks to their institutional capacity. The use of management instruments is to ensure IWRM is subjective to the organisation and their mandates. This is further discussed in the next section.

4.5 Discussion

The purpose of the study is to assess the institutional aspects that may or may not facilitate IWRM in the uMngeni catchment. Two objectives were identified namely, identify the institutions or organisations and their sphere of influence in regard to water resources management. Secondly, identify how water resources management features in environmental management and development tools regarding water services provision and municipal mandates. Based on the results presented in the previous section, each objective is discussed pertaining to whether or not IWRM is facilitated in the uMngeni catchment.

4.5.1 The Institutional Aspects and IWRM in the uMngeni catchment

Most of the participants in the study stated that there is water resource planning in the uMngeni catchment but is very limited and is characterised as reactive rather than proactive. This is attributed to the gaps in all levels of management. At the national and regional level, the DWS performs some of the functions of a CMA namely resource classification and reserve determination, whereas the proto-CMA assists the DWS in those functions while performing other functions of a CMA such as monitoring water quality, regulating water use and licencing, water supply and demand management, and investing in alternative water resources (new dams and schemes). However, the proto-CMA is not as effective in resource planning because it does not have the capacity to coordinate land-use practices and better catchment management, which has an influence on resource planning. A conventional CMA would coordinate and support the water board (Umgeni Water), incorporate WUAs to regulate farmers and their water use including other water users, the department focused on environmental affairs for monitoring and the conservation authority namely Ezemvelo KZN Wildlife (EKZNW). Unfortunately, the uMngeni catchment is not under an operational CMA and the gap created by a non-existent CMA is identified as not facilitating IWRM in the catchment. However, it is essential to mention that DWS are in the process of establishing the CMA that will be operating in the Pongola-Mtamvuna WMA, which will include the uMngeni catchment. DWS has the objective to finalise a CMA by October 2020 with an advisory committee that has sat to discuss the appointment of a governing body and establish the Terms of Reference. In addition, the committee plans on completing a business plan and appointing a Chief Executive Officer (CEO) in the CMA.

A CMS is required for every WMA which is a plan for water resource management. With the plans of establishing a CMA, plans are in place to begin implementing the new proto-CMS for the Pongola-Mtamvuna WMA, which is discussed in the next sub-section. The success of implementing the proto-CMS lies largely on the existing capacity of the proto-CMA and ensuring that individuals have the skills and equipment to fulfil their tasks. This is why it is essential to have an operating CMA as the CMA would have the resources and authority to influence land-use practices to consider water resources and coordinate effectively with sectors to action this. Based on the responses from the interviews, the capacity of the proto-CMA needs to improve to begin implementing the new proto-CMS. A few of the participants identified that most of the focus in the uMngeni catchment is on potable water supply and critical issues such as water quality in an area, rather than comprehensive resource planning.

With the drafting of the new proto-CMS a shift toward water resource planning will occur which will facilitate the implementation of IWRM.

At the regional to local level, the uMngeni catchment is fortunate to have role-players with the capacity to engage with resource planning, even though it may only be a small component, through the public participation process which is a requirement in the National Environmental Management Act No 107 of 1998 (NEMA). DEFF conducted priority studies approximately 6 years ago which indicated uMngeni catchment as a priority. Umgeni Water is involved in water resource planning with the proto-CMA despite the conflict of interest as they are also water users who need water for treatment and supply. They work with the proto-CMA regarding how much water is allocated and how much is needed for water use. Their involvement in allocation may be justified because they are responsible for supplying the municipality; therefore, they need to be aware of the municipalities long term demand and plans. Due to the interrelationship between DWS, the municipalities and Umgeni Water, these organisations need to work together using the water resource and planning tools which are discussed in the next sub-section. Umgeni Waters' primary role in resource planning is managing bulk water infrastructure on behalf of DWS, monitoring water quality and keeping up to date with activities in the catchment. The organisation realises that catchment management activities affect the quality of water found in the uMngeni River which ultimately effects their business. As a result, Umgeni Water have been in the process of setting up a new catchment management department to improve coordination in the catchment. It is hoped that the new department will have a positive influence on facilitating better catchment management and ultimately contribute to facilitating IWRM. In addition, they have partnered with SANBI on the uMngeni Resilience Project (URP) which contributes to catchment management and ultimately water quality.

Another role-player engaging with water resource planning at a regional scale is SANBI's UEIP. The UEIP is a partnership that was established to assist in bridging the gap in planning and has already established a sub-committee. Plans are in place to make the UEIP an official governing body (legal entity) to further improve integration and resource planning. This would attract funds, attract industry and increase legitimacy; but there is still a lot of work to be done in this respect. DWS are aware of these plans and are in support. The success of the UEIP becoming an official governing body can only improve the implementation of IWRM. Moreover, The UEIP have an investment plan detailing investment needs for Ecological

Infrastructure (EI) in the catchment. Once the funds are in, each organisation will be able to implement their projects which feed into the CMS.

At the local level, CMFs (Msunduzi and Upper uMngeni) involvement in resource planning is based on the fact that most of the members in the forum are engaging in resource management platforms and networking spaces; they are then able to link their individual objectives for project implementation. However, action is limited because CMFs are non-statutory. Their platform allows for connection, consultation, follow-ups and contributions, similarly to the UEIP. Another institutional factor that may contribute to facilitating IWRM at a local scale in the catchment, is the sub-directorate in DWS that communicates solely with CMFs known as the Institutional Management Directorate: Catchment Management Sub-directorate. Issues and solutions raised in CMFs are brought forward to the sub-directorate, who then pass the information to DWS to incorporate into planning. However, this may not always be the case as stakeholder groups opinions or grievances are heard during community or forum meetings but are not always considered during decision-making which is evident when an issue remains unresolved. One respondent from a CMF attributed this to the disconnect between national level DWS and local level CMFs. Moreover, environmental issues (e.g., sand mining) and the lack of available solutions hinder coordination between government and communities as people expect answers that professionals and decision-makers do not necessarily have. Thus, government officials are known to avoid contact. One respondent stated that '*cost containment and budget cuts, you find that when you deal with stakeholders, communities or users, they not going to understand the challenges that we experience, they only want to hear how you will provide water'* (pers.com, 18 October 2019). Therefore, the fact that some government departments avoiding contact with community groups is attributed to the potential hostility that may arise from communities. Therefore, improving communication between DWS at the regional and national level with CMFs and communities at the local scale will facilitate IWRM implementation. The non-existent statutory WUAs also means that water-users lack a platform to actively engage in water resources planning.

In the local municipalities, certain departments are identified as active role-players contributing to water resource planning. The Climate Protection Branch in eThekwini Metropolitan Municipality contributes to water resource planning by implementing their climate change strategy. A component of the strategy involves a monitoring and evaluation process where line functions report their findings, and the department coordinates the results

to support decision-making in the city. There are two running projects that relate with planning; Palmiet Catchment Rehabilitation and Sihlanzemvelo which is a community-based river management project. Information from these projects filter up to DWS. eThekwini Metropolitan Municipality is located downstream therefore, their role in water resource management can be difficult hence why the municipality engages in partnerships like the UEIP to build capacity and to coordinate. Furthermore, the municipalities provide their long-term plans for development in their IDP's which can be considered for resource planning, they are well positioned to influence catchment management toward resource protection and are also water service providers. Therefore, the municipalities are important actors in resource planning and are essential in coordinating catchment management activities with water resource planning, to facilitate IWRM. However, local government does not have the mandate to manage water resources, but resource quality and quantity is affected by water service provision and land-use activities in the catchment (Table 4.3). Therefore, local government has a role to play in implementing IWRM and contributing to it on a wider scale through its various mandates.

Table 4.3 The relationship between municipal mandates and water resources management

Municipal Mandate	Impact on water resources
Water Supply	The infrastructure in the reticulation system needs to be maintained as large quantities of water are lost through leaks. Issues of non-payment threatens the municipality's ability to remain financially sustainable.
Sanitation and Waste Water Management	A lack of access to lavatories or water borne sanitation contributes to sewerage spills resulting in the contamination of groundwater and surface water.
Storm Water Management	Infrastructure that serves storm water management need to be maintained otherwise they facilitate flooding upstream and erosion downstream.
Development Planning	Impact on water resources
Land-Use Planning	Different land-uses will impact water resources differently and with development projects, natural ground cover is converted into hard surfaces. This causes increased run-off, flood peaks and risks of flooding and the associated impacts. River plains are preferred locations for informal settlements due to proximity to rivers; in which domestic needs are met. Consequently, vegetation is lost; bank stability is compromised and increased risk to individuals living in these zones. Disposal of solid waste in rivers is another issue. Health care and education facilities require constant water supply to function effectively and may not necessarily affect water resources.
Housing Developments	The impacts experienced with development are associated with housing projects; and may contaminate groundwater resources when sewerage is not managed adequately.
Solid Waste Management	Inadequate solid waste management (collection and disposal) results in waste polluting water resources. Landfill sites can potentially contaminate groundwater and cause run-off due to soil compaction on site.
Parks and Recreation	The maintenance of parks may require an irrigation system to water open spaces which increases water usage. Irrigation at certain times of the day will result in more water usage due to high evaporation and wind speeds. Biking trails and

	footpaths on parks may not be maintained and cause concentrated flow of surface water, increasing erosion and siltation in near-by water resources. In addition, natural vegetation may be removed to create an aesthetically pleasing environment, causing bank instability if near a river.
Roads and Transport	Transport infrastructure contributes a lot to poor water quality as hardened surfaces concentrate water flows thereby increasing sedimentation in water sources, if measures are not incorporated during the design phase. This could transport solid waste, oils from vehicles and pollutants. In addition, bridges may increase flood affects if they are not designed for high peak flows
Local Economic Development	Local government strives for economic development and projects may be implemented by different sectors or government. Thus, in their planning phase, the impacts on water resources and water requirements need to be considered which is usually through EIA's.
Disaster Management	This function cuts across or intertwines with the functions listed above. Measures need to be in place to prevent development in river plains and early warning systems need to be in place.

Based on the results, the above table which represents a trend in South Africa is an indication that catchment management activities play a massive role in IWRM thus, emphasising the importance of an operational CMA that will coordinate these functions.

An important aspect of facilitating IWRM is the coordination within and between organisations, and among individuals at all levels of management. Coordination between DWS and other departments exists to a certain degree. One respondent attributed the lack of coordination to poor relationship building and not maintaining relationships between government departments and external organisations. Whereas other participants attribute most of the integration to long lasting and good relationships between individuals/professionals, where knowledge sharing has become easier. Individuals from organisations are well-known in the sector for being knowledgeable and easy to work with which facilitates the implementation of IWRM in the catchment. Organisations are guided by cooperative governance and NEMA regulations that promote public participation processes and thus promote coordination. However, coordination is also limited when fulfilling certain functions that are of concern (e.g., DWS will fulfil its mandate regarding water quality monitoring but that is where it would end, similar case with Umgeni Water as they are suppliers or inter-basin transfers). One respondent attributed the lack of coordination to the lack of planning and tendency of dealing with urgent matters (reactive), which does not enable engagement with other sectors.

Similarly, the issue of working in silos has gone on for so long due to organisations, departments or sectors striving to fulfil their mandates and achieve their objectives, thus less effort on initiating cross sectoral integration which hinders the facilitation of IWRM. Water resource planning will require spatial planning to be considered and it is unknown whether

spatial planners attend meetings in Pretoria regarding water resource planning. Coordination may be evident in the implementation of social projects (e.g., the URP) where there may be partner organisations but currently, there is no overall water resources planning and coordination is not continuous.

In as much as coordination is limited and there may be factors hindering it, many organisations have a budget set aside to attend meetings (e.g., CMFs and UEIP) that facilitate coordination. Such meetings are voluntary and are a success when individuals are willing to participate. A couple of the participants elaborated on intra-coordination (within an organisation) stating that it is limited as departments within organisations have their own objectives to achieve with one respondent stating '*we also need to achieve IWRM internally in terms of our processes*' (pers.com, 18 November 2019). Another respondent from Umgeni Water stated that '*the organisation recognises the need to improve on their coordination internally*' (pers.com, 31 May 2019). In actioning this, the Catchment Management Department is being established and will focus on the different activities in the catchment and have representation from different stakeholder groups. In addition, some participants attributed the poor coordination among role-players in the water sector to a non-operational CMA due to the inherit authority of the CMA to initiate coordination. Many of the participants view the UEIP has the space or partnership attempting to bridge the gap in coordination where its reach is very limited to a few organisations and individuals who attend the UEIP meetings. However, the UEIP has improved individuals' and organisations' knowledge on the issues prevalent in the catchment and the various projects that are implemented, despite one respondent describing the UEIP as very uncoordinated. Many of the participants in the eThekwini Metropolitan Municipality stated that poor coordination is largely attributed to the lack of capacity or poorly resourced divisions within the municipality's departments. One of the participants stated that it is common to find one person or a manager who is responsible for a large area which is not practical in dealing with arising issues. Moreover, the same participant highlighted the lack of willingness on behalf of individuals to initiate cross-departmental coordination and thus hindering the facilitation of IWRM.

4.5.2 Environmental and Development Tools in Facilitating IWRM

In implementing environmental and water service laws such as the NWA 36 of 1998 and the Water Services Act 108 of 1997, there are a host of environmental and development plans that are in effect. The plans described in the previous section demonstrate how water resource

planning features in all the plans which ultimately facilitates the implementation of IWRM in the catchment. However, this does not translate on the ground due to poor implementation of these plans. Moreover, the IWMP 2016-2021 Draft is the only plan identified to not include water resources planning or the protection of water resources from solid waste. A trend in South Africa and in the uMngeni catchment is the challenge of dealing with poor water quality due to solid waste transported into water resources from illegal dumpsites. This is attributed to management working in silos and actioning solid waste plans in isolation. It is evident that improved coordination between solid waste management and water resource planning is needed.

The most essential plan regarding water resources planning is the CMS. Each CMA is required to have a CMS which will govern resource planning in a WMA. At the start of this study in 2018, the proto-CMA had a two-page proto-CMS briefly stating the importance of the CMS aligning with national and provincial strategies. It further stated the vision and strategic themes for the catchment which focuses on water quality, availability, allocation, stakeholder engagement, cooperative governance and institutional arrangements. In addition, the two-paged proto-CMS outlined details on the activities that will be carried out in the catchment, current issues and possible solutions. During the data analysis process of this study (February of 2020), the proto-CMA released a draft proto-CMS which was 90% completed. As outlined in the previous two-paged proto-CMS, the draft provided detailed description of the WMA's six strategic themes, their objectives and actions toward achieving the objectives. The drafting of the proto-CMS will place attention on water resource planning which will facilitate IWRM. In addition, a Catchment Management Plan for each river or catchment will be drafted and should speak to the overall proto-CMS. Steps already taken toward this includes ongoing monitoring, the roll out of the 'Adopt-a-River' Programme and the Validation and Verification process determining the number of illegal and legal water users in the catchment (19 000 unauthorised users).

Reconciliation Studies and assessments performed by DWS determined water availability, supply and alternative methods that will supplement water supply in the WMA i.e., inter-basin transfer schemes, rainwater harvesting and clearing alien invasive vegetation. Such studies, assessments and consultation meetings are informing the drafting of the proto-CMS which will be a tool for improved planning. Prior to the drafting of the proto-CMS, a comprehensive water resource planning tool at the catchment level was non-existent and will remain this way until the completion of the strategy.

4.6 Conclusion

This paper investigated the extent to which IWRM is implemented, by assessing the institutional aspects that may or may not facilitate the practice of this management approach. The objectives were to identify the organisations involved in water resource management in the uMngeni catchment and their sphere of influence; and how water resource management is featured in development planning and environmental management tools i.e., IDP, WSDP and SDF. Upon mapping out the organisations involved in water resource management, it is evident that at the regional level, an operational CMA is non-existent. Instead, a proto-CMA within the DWS takes on some of the responsibilities of an operational CMA. Consequently, water resource management is mostly reactive and focussed on water service provision rather than resource planning. In addition, an operational CMA would coordinate and support the water board, WUAs, environmental affairs department and a conservation authority. This would ensure that role-players implementing catchment management activities in the uMngeni are incorporating measures to protect water resources and a monitoring process is in place to ensure role-players are abiding by environmental standards. Evidently, organisations in the uMngeni are facing difficulties in linking water resource planning with catchment management activities or defining the roles and responsibilities between catchment management activities and water resource management responsibilities.

At the local level, WUAs which are statutory bodies have not been established which further hinders the practice of IWRM. The implication of this is that agricultural activities and other water-use activities along the uMngeni River are not officially monitored and there is a lack of systems in place to ensure farmers are abiding by their water use license requirements. Non-existent WUAs also mean that the challenges water users are facing may not be communicated appropriately to the regional and national levels, meaning the little planning that does occur, does not take into consideration the input of water users. In efforts of facilitating integration among role-players the UEIP was established. However, it is important to note that the UEIP was not meant solely for improving coordination among organisations but is a partnership that focuses on securing investment in EI to improve water security. Either way, the UEIP became a platform that facilitates coordination among the different organisations in the catchment which is seen to facilitate better catchment management activities and IWRM overall.

Most of the planning and environmental tools have incorporated water resource planning. Tools such as the IWMP’s are focused on waste management and not water resources.

However, if the plan is implemented as outlined, the positive effects will be evident through improved water quality. This leads to the issue of implementation in the catchment due to roles and responsibilities of role-players not being clearly defined, or a lack of human and financial resources to fulfil mandates. Consequently, catchment management activities and service provision contribute to a declining water quality and water availability in the catchment. This paper provides evidence that an enabling environment has been created in the uMngeni catchment for the implementation of IWRM. There is a shortfall in the institutional dynamics and management instruments evident through poorly resourced municipal departments to fulfil their responsibilities, the lack of capacity and skills to implement IWRM and non-existent WUAs at the local level. Poor implementation of water sector plans can be addressed by ensuring that there are strong management instruments in place and will facilitate the coordination between national level and local level. In conclusion, the current institutional landscape in the uMngeni catchment allows for a limited amount of planning to occur which is why many role-players criticise the catchment for being reactive. Without an operational CMA, organisations will continue to be limited when trying to integrate the various water using sectors in resource planning.

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Chapter Five- Paper Two

Investigating the Perceptions of Role-Players on IWRM and Adaptive Management in the uMngeni Catchment.

5.1 Abstract

Water resource management has been characterised as challenging due to the effect of climate change on water resources, the multiple role-players involved in making decisions, the multiple sectors relying on water supply to meet their needs, the changing nature of hydrological functioning of river systems and the lack of knowledge and understanding feeding into decision-making. Integrated Water Resource Management (IWRM) and Adaptive Management (AM) are two approaches that promote the implementation of principles such as inclusivity, participation, equity and transparency: whilst embedding the practice of learning during the management process. This leads to social learning and thus, should lead to better management practices and finally to improved water quality and availability. The implementation of IWRM and AM hinges largely on the institutional landscape and the enabling environment that exists within a catchment, and the level of resources made available to ensure integration and learning across multiple sectors. However, the perceptions of decision-makers are rarely considered as a factor that influences whether or not IWRM and AM are implemented. This paper investigated the perceptions of key decision-makers regarding the management approaches and the status quo of the uMngeni Catchment in KwaZulu-Natal, and their willingness for co-management. Secondly, the paper provides recommendations for effective management in the catchment based on the participants' responses. The aim is to link how role-players' perceptions may or may not facilitate the implementation of the management approaches. The study is qualitative whereby 21 semi-structured interviews were conducted and analysed through thematic coding. It is evident through the interviews that most of the participants hold a negative perception of IWRM which is attributed to the uncertainty on how an increased level of integration among sectors is to be achieved. AM and the concept of social learning is understood by only a few participants. Although most of the participants hold a negative perception towards IWRM and lack an understanding of AM, the core challenge is poor capacity building. Focussing on Corporate Social Responsibility (CSR) as a method to build relationships among organisations could be effective in engaging previously excluded role-players such as the private sector, and potentially improve perceptions.

Keywords: IWRM, adaptive management, corporate social responsibility, water sector, partnership

5.2 Introduction

The management of water resources has become increasingly difficult as the effects of climate change have caused a drop in water availability and poor water quality (Albareda and Campos, 2018; Mosley, 2015). This compounded with the fact that there are multiple role-players or institutions who are involved in making decisions regarding water resource management, their individual objectives, and the different water use sectors, results in uncertainty around resource planning (Dent, 2012; Nyamwanza and Kujinga, 2016; Pahl-Wostl, 2015). In addition, uncertainty is further exacerbated due to the constant change in hydrological functioning of river systems and the lack of knowledge water managers may have on socio-ecological dynamics (Allen and Garmestani, 2015; Summers et al., 2015). Thus, Integrated Water Resource Management (IWRM) has been the point of conversation for the past two decades, as the management approach that embodies principles such as participation, efficiency, equity, transparency, accountability and inclusivity to ensure integration in resource planning (Pires et al., 2017; Suhardiman et al., 2017; Van Dorp et al., 2018). However, IWRM has been criticised as being an approach that is universal and assumes an assured water supply, without considering the uncertainties that exist (Biswas, 2004; Bourblanc, 2012; Dent, 2012; Fischhendler, 2008; Lubell and Edelenbos, 2013; Medema et al., 2008; Muller, 2015). In light of these uncertainties, Adaptive Management (AM) has been identified as a complementary approach to IWRM because the underlying premise is to reduce uncertainty in water management (Pahl-Wostl, 2007). AM seeks to achieve this through the process of social learning where decision-makers work alongside interest groups, specialists and researchers in establishing alternative management systems to implement in a catchment to reach desired outcomes. Set objectives and indicators are identified and a process of knowledge generation through monitoring allows for decision-makers to assess the outcomes. Overall, IWRM seeks to integrate different water users in the management of resources and AM seeks to ensure adaptability in light of the uncertainties (Pahl-Wostl and Sendzimir, 2005; Riddler et al., 2010; Varady et al., 2016).

It is apparent that the successful implementation of IWRM and AM hinges on the enabling environment and the institutional arrangements that exists in a catchment; but rarely do we speak about the people who make up these institutions as they are the ones creating knowledge on which decisions are based. Thus, perceptions of decision-makers are a key element to the consideration of IWRM and AM for planning and implementation. This paper investigates the perceptions of key decision-makers regarding the management approaches

and the status quo of the uMngeni catchment and their willingness for the improved water resources management. Secondly, this paper provides recommendations for effective water resource governance and successful management.

5.2.1 Study Area

The uMngeni catchment is approximately 4 439 km^2 and is located in KwaZulu-Natal (KZN), South Africa (Figure 5.1). The catchment falls under the Pongola-Umzimkulu Water Management Area (WMA) which is not under an operational Catchment Management Agency (CMA), but is under the administration of a Proto-CMA which is part of the Department of Human Settlement, Water and Sanitation (DWS) regional offices (Funke et al., 2007). Wetlands, grasslands and numerous farms are found in and around the headwaters of the uMngeni River. The mid region of the river is characterised by built-up areas/cities and residential areas with natural bush, sugar cane fields and industrial activities predominant downstream of the uMngeni River as it opens out into the Indian Ocean (Shoko et al., 2016). Informal settlements can be found along the entire river due to the reliance on the uMngeni River for water supply to satisfy their domestic needs.

Consequently, the catchment has an issue of illegal dumping of solid waste, sewerage discharge from residential areas and informal settlements, negatively affecting the quality of the uMngeni River. Further, water quantity is an issue as the uMngeni is a closed catchment that has no additional water available for use. These issues compounded by inconsistent rainfall makes the catchment a suitable case study to provide recommendations for effective water resource management.

5.3 Materials and Methods

5.3.1 Research Design

The case study approach is used to gain an in-depth understanding of a phenomena in its real-life setting. There are three different types of case study approaches namely Intrinsic, Instrumental and Collective (Bhattacherjee, 2012; Crowe et al., 2011; Lam and Law, 2016). The study uses the Instrumental Case Study approach because this paper aims to gain a broader understanding of the factors that may or may not facilitate the implementation of IWRM and AM in the catchment. To understand the implementation of these management approaches, investigating the perceptions of the individuals involved in the water sector is essential.

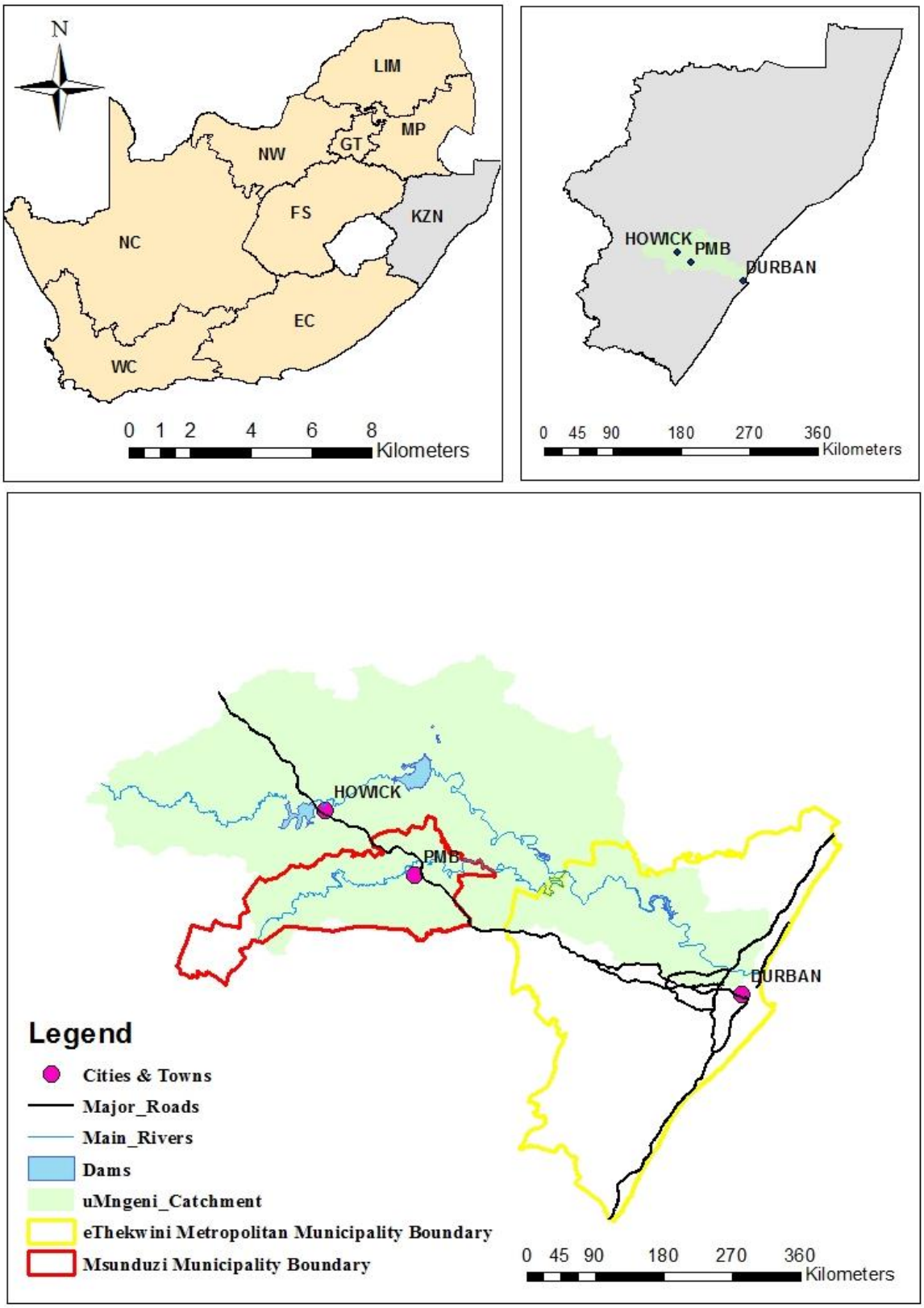

Figure 5.1 The uMngeni catchment in KwaZulu-Natal, relative to the Msunduzi Municipality (red) and eThekwini Metropolitan Municipality (yellow) which are the most populous municipalities that rely on the catchment for water supply.

5.3.2 Data Collection

Primary data was sourced by conducted 21 semi-structured interviews (see Appendix A) between the months of May and December of 2019. Participants from the Department of Human Settlement, Water and Sanitation (DWS), Umgeni Water, eThekwini Metropolitan Municipality, Msunduzi Municipality, Catchment Management Forums (CMFs), University of KwaZulu-Natal (UKZN), Duzi Umgeni Conservation Trust (DUCT), Department of Environmental Affairs (DEA), Water Research Commission (WRC), Department of Economic Development, Tourism and Environmental Affairs (EDTEA), Mooi River Irrigation Board and the Umgeni Ecological Infrastructure Partnership (UEIP) were interviewed using an interview schedule structured according to their profession. Most of the participants work for governmental departments (Figure 5.2) with five participants from both the Msunduzi Municipality and eThekwini Metropolitan Municipality: and four participants from regional offices. Three academics were also part of the sample size with a total of six participants working in organisations at the local level. This is significant to note as most if not all the participants are involved in important decision-making regarding the uMngeni catchment. Therefore, their perceptions are important to explore for the understanding of whether or not IWRM and AM are implemented/applied in the catchment.

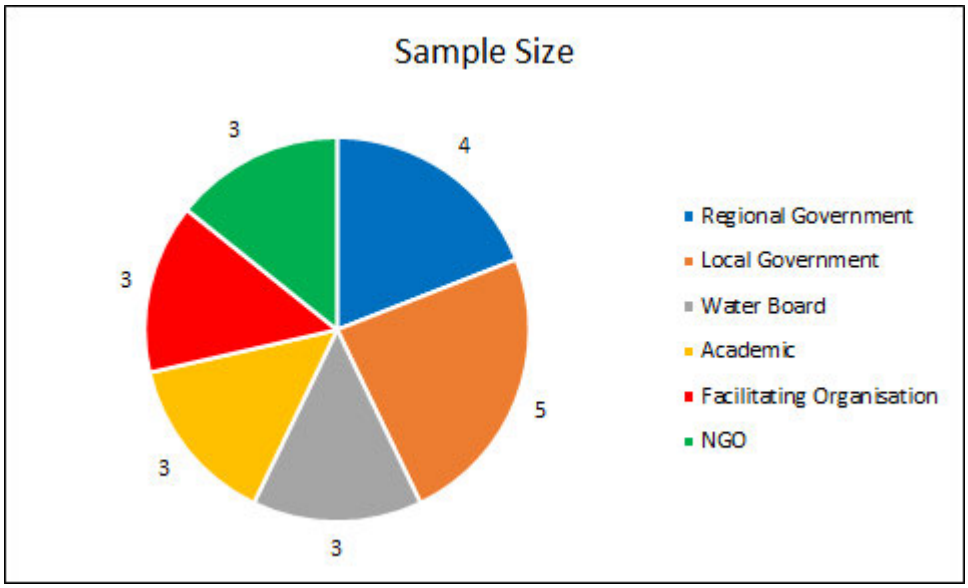

Figure 5.2 The composition of the study sample size

The initial sample size consisted of ten participants who were identified based on a quick internet search. Through the snow ball sampling technique (Etikan et al., 2016; Waters, 2015), the sample size increased, totalling 21 participants. Semi-structured interviews as a

method was appropriate because the expected responses were subjective to the participants' profession (McIntosh and Morse, 2015); and understanding of the current nature of water resource management in the catchment. Each interview session was voice recorded and lasted between 40 minutes to an hour depending on the responses provided by the participants. After each interview session, the recordings were transcribed.

5.3.3 Analysis

Interview transcripts were analysed by Thematic Analysis and Coding. Each question was analysed individually in all the transcripts before analysing the next question. Re-occurring responses from each interview was noted and grouped into a theme, providing an indication on whether or not the participants understand the management approaches. The responses provided by the participants informs the results section (Clarke et al., 2015; Kyngas, 2020; Vaismoradi et al., 2016).

5.3.4 Ethical Clearance

Initial contact with two gatekeepers was made via email detailing the nature of the research and the desire to conduct interviews with professionals in the water sector. Two gatekeeper letters were signed and attached to the ethical clearance application form, which was approved by UKZN's Humanities and Social Sciences Research Ethics Committee (HSSREC). Each participant signed a consent letter granting permission to partake in the study and to be voice recorded for analysis purposes.

5.3.5 Limitations

The reliance on and scheduling of semi-structured interviews was challenging as sessions had to accommodate the participants. The process of re-scheduling interview sessions resulted in data collection going past the desired timeframe; and the unavailability of participants resulted in their exclusion. Consequently, the perceptions captured in this paper did not achieve the set target of the research objective.

5.4 Results

5.4.1 Participants' perceptions on IWRM as an approach

Most of the participants have an understanding of the approach, what it entails and are optimistic for its realisation within the catchment. An example is the idea that water management should focus less on hard approaches with a respondent stating that building more dams is not sufficient, but it is important that we are making the shift toward rehabilitating and restoring ecological infrastructure. Reference was made to a rehabilitation

project of an old wetland which was used as a waste dump where the alternative was to install a canal rather than rehabilitate the wetland. However, in describing their opinion of the approach, every positive response was accompanied by doubt or a reason as to why IWRM is difficult to be implemented.

Box 1. Representative quotes reflecting the perceptions of IWRM

"*IWRM is a good concept on paper but in practice, I don't think we are implementing it*" (pers.com, 31 May 2019)

"There are certain aspects that seem fitted to a developed world and the concept is waved around by big development agencies…IWRM in countries like ours often tends to be quite different" (pers.com, 28 November 2019)

"*I feel IWRM is kind of a dream and underpins legislation and policy, but it is not really happening*" (pers.com, 20 September 2019)

"*IWRM is attainable and I understand that the reality is different from the concept but at the end of the day, you need to have an understanding or something in place to make it work rather than isolation and putting out little fires*" (pers.com, 18 November 2019)

"*IWRM may not be 100% attainable… but we can attain a certain degree of it because it is a process"* (pers.com, 18 November 2019)

Many of the participants described IWRM as a good approach theoretically but attributed the lack of implementation to poor human and financial resources, and a lack of participatory and integrative tools to facilitate its implementation. A few of the participants echoed this sentiment as they recognised the enabling environment that underpins IWRM but expressed that the Catchment Management Strategy (CMS), water legislation and the National Water Resources Strategy are either not upheld or there are delays in updating the documents when necessary. To worsen the situation, participants who expressed that IWRM could be implemented stated that a non-operational CMA is the main reason. A couple of the participants stated that the lack of irrigation boards and Water User Associations (WUAs) will continue to hinder IWRM implementation. In addition, the participants that highlighted the shortcomings of IWRM implementation and the challenges in the catchment stressed the need for integrative planning between the government departments/organisations mandated to solve the particular issues. In accordance with this, one respondent stated that "*putting onto paper how to link the institutions will drive the integration part of the approach*" (pers.com,

11 July 2019), thereby facilitating the implementation of IWRM. A few of the participants noted that some of the projects and initiatives mirror the principles of IWRM, which is a reflection that decision-makers in the catchment are engaging with the concept of IWRM. One respondent admitted that their opinion on IWRM is still being formed but understands that what should be applied should fit the uMngeni context. Similarly so, responses such as "*IWRM is very broad and it could be localised"* (pers.com, 10 July 2019) and *"how we make IWRM applicable locally will depend on a lot of variables"* (pers.com, 21 November 2019) were stated. Of all the participants, only two held a critical view of IWRM stating that IWRM was not developed to be implemented at a local scale because the approach does not take into account the realities on the ground.

A respondent stated that "*With regards to IWRM… it tends to happen at an ad hoc basis"* (pers.com, 1 July 2019) with more needed to make water management inclusive, decentralised and considerate of catchment management activities.

5.4.2 Participants perceptions on Adaptive Management

Two of the 21 participants understood AM as implementing adaptive measures or changing behaviour according to the changes in the environment. This included using water sparingly during times of water stress, implementing water saving measures and restrictions, educating civil society to care for their environment in light of climate change, drafting green building policies for new development and hosting river walks to raise awareness on river conditions. One of the participants stated that *"when there are water shortages we should be able to reduce water usage"* (pers.com, 18 September 2019). Another two participants stated that they were not knowledgeable on AM and the idea of social learning and could not speak on it stating that *"it's not a word that you hear all the time and I'm not too familiar with it"* (pers.com, 17 September 2019). Of these four specific participants, one stated *"I think everyone has an understanding of the two theories"* (pers.com, 11 July 2019) which is an indication that there is a general assumption that professionals in the water sector understand the core concept of AM and social learning; yet 13 participants did not engage with the notion of adaptive management at all.

On the other hand, four participants were very knowledgeable on AM and the idea of social learning. One of these participants stated that *"a certain skill set is needed such as leadership, negotiation power, managerial skills and conflict management. Capacity building is needed so as to equip individuals with these skills. Goal setting, time frames and*

monitoring processes are just as important" (pers.com, 9 December 2019). Another participant stated that the organisation they are part of has *"a long history of evidence based learning…where research programmes have been initiated for students"* (pers. com, 18 September 2019) to build capacity and create a knowledge base for informed decision-making. This participant elaborated on the formation of the Durban Research Action Partnership (D'RAP) as a working framework for research programmes and described how implementing the partnership as a learning component was possible. This was attributed to the organisation including external role-players from the conception stage. The participant understood the temporal element of social learning as they stated that *"it took a full year for the city (Durban) and research folk to find each other as it is not easy in the beginning"* (pers.com, 18 September 2019). In addition, the participants explained the difficulties in implementing AM, stating that conducting transdisciplinary research is difficult as many researchers are not open to the transdisciplinary approach. This is attributed to researchers being entrenched in a discipline-specific approach with set goals and methodologies. Secondly, the financial year of organisations usually does not align with the academic year in South Africa (i.e., financial year is from March to February in the following year whereas the academic year is from January/February to November). This is an issue because organisations can only invoice work that has been completed. Thirdly, research output is in academic format and budget needs to be allocated to change that into a useable format such as a guide. In addition, research organisations and stakeholder organisations were previously not used to the approach of identifying research needs and communicating them to research bodies. The norm was that they brought on a researcher as a consultant who would produce a report. However, this did not allow for adaptability to novel situations.

One of the four participants knowledgeable on AM expressed the need for role-players to be open to research programmes, to realise the associated benefits which include reducing consultancy costs, capacity building in less experienced personnel or students and increased willingness from communities to participate in problem solving when working with students rather than government officials. The participant further elaborated on the need to understand the time-consuming process associated with social learning, the slow impact of capacity building, the financial resources required, and the importance of defining the project's objectives and presenting the project well to role-players. Participants knowledgeable on AM recognise that it will be challenging as they stated:

> *"I found that those questions are a lot more difficult to answer then IWRM…adaptive management implementation will be way more challenging…adaptive management rattles the cage…requires freedom to do and engage in activities without supervision which may be difficult for some people…adaptive management has been out there that long and there isn't a main organisation that drives it like the GWP (Global Water Partnership) does for IWRM"* (pers.com, 9 December 2019) and *"It is simply closing the loop on when you get feedback from the external environment and deciding what you do or how you do it…institutional failure is preventing this loop because there is no baseline functionality"* (pers.com, 28 November 2019)

and are aware of the lack of understanding around social learning in the catchment as one participant stated, *"I don't think there is sufficient understanding of things like adaptive management"* (pers.com, 1 July 2019).

5.4.3 Participants perceptions on the challenges in the catchment and their recommendations

All of the participants explained what they perceived to be a major challenge in the catchment (Figure 5.3). The lack of financial capacity and human resources is the main challenge as perceived by most of the participants. This relates to the issue of institutional memory loss where experienced professionals are retiring or skilled professionals are employed elsewhere. Infrastructural failures and poor maintenance are the second challenge most of the participants deem to be a priority. A decrease in water availability is partly attributed to leaking pipes which forms an additional pressure on the overall water supply. Many of the participants elaborated on the uMkomazi project which is the construction of a new dam along the uMkomazi River, located west of the uMngeni catchment, which is supposed to supplement the water supply in the uMngeni catchment. Participants stated that the infrastructural failures and leaking pipes will continue to be a challenge if not dealt with appropriately, despite the increase in water supply in the catchment. Another major challenge in the catchment is the lack of political will which relates to the delay in establishing a CMA, poor leadership, corruption and a lack of accountability regarding roles and responsibilities. A number of the participants attributed the lack of coordination in the catchment and poor implementation of IWRM and AM to an absent CMA who would be responsible for integrating multiple roles in the water sector.

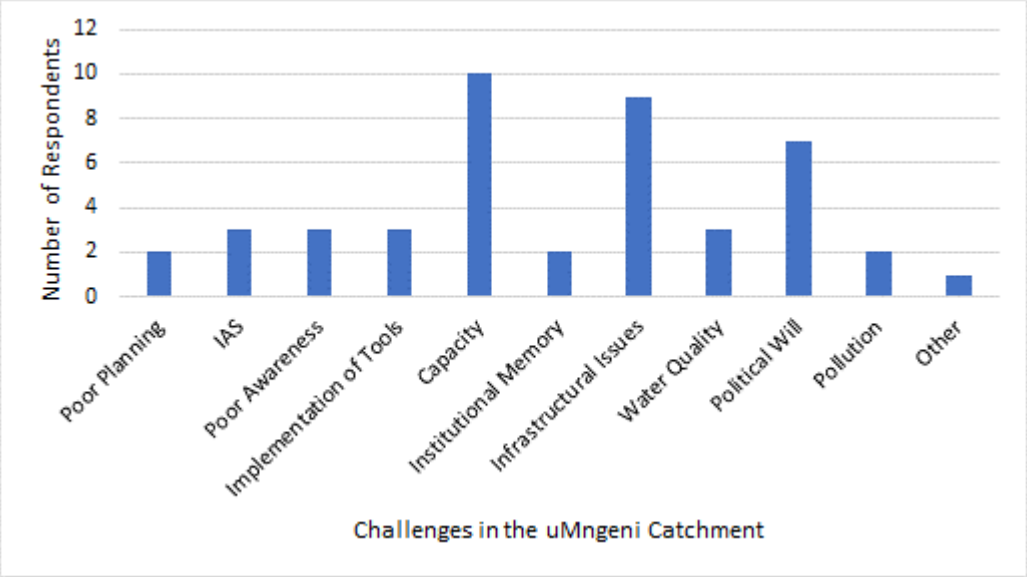

Figure 5.3 The challenges in the uMngeni catchment as prioritised by the participants

Due to the complex nature of water management and catchment management activities, some government departments have overlapping roles and responsibilities. Consequently, the issue of a department not taking responsibility over an issue as they assume it will be handled by another department becomes a reality. Moreover, many heads of departments do not have a focus on water management. The issue of corruption is publicised in the catchment as the Msunduzi Municipality is under administration and the eThekwini Metropolitan Municipality appointed a new mayor due to ongoing investigations of corruption (Magubane, 2019; Ndaliso, 2019; Singh, 2019). A fewer number of participants emphasised the issue of invasive alien species (IAS), poor awareness and education on wise water use by civil society; the implementation and enforcement of legislative tools; and poor water quality. Alien vegetation is widespread in the catchment with gum, pine and wattle trees consuming large quantities of water compared to indigenous vegetation. As perceived by the participants, civil society has a role to play when it comes to using water sparingly and reporting leaks and damaged infrastructure. In middle to low-income areas and informal settlements, the blockage of sewerage systems is largely attributed to the incorrect disposal of animal carcasses, used nappies and solid waste, which ultimately affects water management.

A few of the participants deem it important to recognise the gaps and inconsistencies in our legislative tools. Some believe that the National Water Act 36 of 1998 (NWA) is complex and needs to be updated to cater to current issues. In addition, Specific Environmental Management Acts (SEMAs) have become more complex causing a lack of understanding among role-players in the water sector. As an example is, every citizen has the right to an

environment that is not harmful to their wellbeing and health and a number of SEMAs have been enacted to enforce this i.e. the National Environmental Management: Air Quality Act (NEM:AQA), the National Environmental Management: Waste Act (NEM:WA) and the NWA. The challenge arises when role-players need to analyse the suite of laws and determine how to implement them. Similarly to the management of water resources, there is a suite of laws that pertain to water resources which need to be examined to ensure that they align and are implemented.

Other issues that were mentioned include poor water quality, illegal dumping of solid waste which is transported into rivers by rain and wind, the low degree of planning among different governmental departments, lack of knowledge to inform decision-making, variability in climate, illegal sand mining that increases siltation and reduces water availability and quality, and water being treated as a commodity rather than a precious resource. Furthermore, certain role-players or stakeholder groups are not part of the water management process. On one hand, farmers' perception on their role in contributing to the degradation of the river system may be distorted, as they believe that they manage their land appropriately and there are no cumulative effects. This is an indication that farmers may not be sensitised to the issues in the catchment. On the other hand, the private sector is also not a part of water management as they should be considering the fact that some are water users. Companies who are registered water users and have attained Water Use Licences (WUL) are not obligated to be involved in water resources management. However, when companies gain the understanding that catchment wide water resource challenges (water scarcity, poor management and water pollution) can negatively affect their business, they may see value in investing in better water resources management activities, even if it is a small component. In doing so, it is beneficial for the catchment when companies have an interest in water resources management beyond their role of a water user, considering that they may have resources which are otherwise not available or limited within local government. The lack of participation by some stakeholder groups links with the issue of poor representation in CMF meetings as attending meetings is not compulsory. Finally, the Department of Water and Sanitation (DWS), now Human Settlement, Water and Sanitation offices are in Pretoria and they may not fully understand the challenges in the catchment; and with the amalgamation of the two departments, roles and responsibilities will continue to overlap.

Based on these issues identified by the participants, three themes have been identified. Firstly, there are missing role-players in water resource planning in the catchment. Secondly,

there is confusion between water resource management and catchment management. Thirdly, the nature of water resource management in the uMngeni is largely focussed on water services rather than resource planning. However, the latter seems to be changing with the draft of the CMS. Therefore, to improve water management in the catchment and potentially create an environment for IWRM and AM implementation, a few recommendations were suggested by the participants.

Many of the participants highlighted the need for institutional development to facilitate coordination. At the regional level, there is a serious need for an operational CMA to be established which will result in additional resources directed towards water management. At the local level, under the administration of the CMA should be the establishment of WUAs which is already detailed in water legislation and are statutory bodies. With the establishment of WUAs, all water users will have a platform to participate in water resource management and could potentially attract interest groups that were previously uninvolved. WUAs are advantageous because they would allow decision-makers to tap into indigenous knowledge which could facilitate informed decision-making. The establishment of a CMA and WUAs would also enable capacity building in communities, municipalities and schools, leading to better stewardship and wise water use. CMFs need to gain legitimacy by increasing their sense of identity so as to attract funding streams and role-players. Participants mentioned that CMFs need to improve their identity by creating logo's and letterheads making them official organisations. By strengthening these organisations, not only will catchment management be streamlined in different government departments and private organisations to improve water use, but there will be improved regulation and enforcement. In addition, some participants reiterated the need to focus on overall water quality and prioritise resource protection downstream. A few participants recommended that water quality should be a Key Performance Indicator (KPI) across all sectors and departments. However, the enforcement of Resource Quality Objectives (RQOs) will depend on the institutional capacity of the DWS and the CMA once it has been established.

5.4.4 Participants willingness to change behaviour for improved water resources management

Based on the challenges described in the previous sub-section, all of the participants stated that role-players in the water sector are willing to make the necessary changes toward improved water resources management. However, irrespective of the willingness to change, five participants expressed that certain elements of management will have to change for the implementation of IWRM and AM. Until these changes are made, the willingness of role-

players will be inconsequential. Firstly, decision-makers at the national level need to demonstrate leadership by facilitating coordination which will filter down to local levels of management. When asked about the willingness of decision-makers to make changes in the management approach, a participant stated that "*It has to start at the top…it has to come from higher up*" (pers.com, 18 September 2019). Several participants stressed the importance of the DWS establishing the CMA to facilitate water resource planning and spearhead IWRM in the catchment. Secondly, departments in local government need to change aspects of their management regimes. A participant highlighted that some departments have overlapping mandates stating that "*different departments have similar if not the same mandates but we are operating separately which shows how governing structures need to change because they no longer work"* (pers. com, 17 September 2019). Some of the participants pinpointed the lack of political will for improved water resources management with another respondent stating, "*politicians are engaging just so that they can tick the boxes not because they desire to"* (pers. com, 11 July 2019). Evidently, departments in local government are working in silo's instead of working together to reduce redundancy. This relates to the previous issue of the non-existent CMA which would improve coordination.

Thirdly, change in the management of water resources in the catchment depends on the availability of financial resources as one respondent stated, "*There is room to make such changes but with more financial resources and it would have to be continuous"* (pers.com, 14 May 2019) and another "*all managers are willing however…the biggest of these (constraints) would be financial"* (pers. com, 31 May 2019). Without sufficient financial support, role-players lack the motivation to inspire change in the management of water resources. Fourthly, the need to facilitate coordination is important as a respondent stated that "*The solutions are there if we can coordinate and implement well"* (pers.com, 18 September 2019), which relates to the point of establishing the CMA. Finally, a couple of participants highlighted the need to inspire public interest and involve local communities in decision-making processes. A participant stated that "*we need to start generating environmental rights issues in communities and put it on the political agenda"* (pers.com, 1 July 2019).

5.5 Discussion

The purpose of the study is to assess the institutional aspects that may or may not facilitate IWRM and AM in the uMngeni catchment with the objectives of; investigating the perceptions of key decision-makers regarding the management approaches, and their willingness to change behaviour for improved water resources management. Secondly,

provide recommendations for effective water resource governance and successful management. Investigating the perceptions of key role-players in the water sector is important as they make up the institutions responsible for decision-making regarding water resources. In addition, there is value in investigating their understanding of the management approaches as they are tasked with water resources management; and their willingness to improve water governance is essential in implementing IWRM and AM.

Based on the data from the interviews, majority of the role-players in the water sector in the uMngeni catchment have an understanding of IWRM as a management approach. Participants highlighted the need of management approaches that invest in ecological infrastructure, promote coordination and transition from hard approaches such as building new dams. In addition, a few of the participants provided a critical view of IWRM as an approach, explaining that aspects of IWRM are better suited for developed countries, and may not necessarily be applicable in the South African context and specifically the uMngeni catchment. Both the positive and critical perceptions held by the participants on IWRM may facilitate the approach; as it demonstrates an understanding that IWRM needs to be site-specific, taking into account all the environmental and socio-economic issues prevalent in the catchment. On the other hand, there are more participants who do not understand AM as an approach and what it entails. Four participants were able to describe AM and provide insight on how AM can be implemented in the catchment. These participants described the temporal element of social learning and the need to deviate from discipline specific management styles to transdisciplinary practices. However, the ratio of those who lack an understanding of AM is far greater than those who understand AM. Evidently, the practice of AM in the uMngeni catchment is very limited.

The differing perceptions on the management approaches compounded by the challenges in the uMngeni catchment makes it difficult to implement IWRM and AM. The main challenge decision-makers are faced with in the catchment is the lack of financial capacity and human resources to effectively improve on water resource governance. Institutional memory loss whereby experienced professionals retire or are employed elsewhere characterise the Msunduzi Municipality and eThekwini Metropolitan Municipality which reduces their ability to make informed decisions in the water sector. The issue of infrastructural failures (e.g., leaking pipes) and poor maintenance is directly linked with the lack of financial capacity. Local government lacks sufficient funds for infrastructural upkeep, which affects the water available for water service provision. Without the investment in infrastructural maintenance,

water availability and quality will continue to be compromised. These issues can be attributed to what participants describe as the lack of political will, which is another major challenge in the catchment. This has been evident in the delay of establishing an operational CMA which would be responsible for promoting coordination in the water sector. Without the CMA, there is a lack of leadership and planning in water resources; poor accountability regarding the sources of water pollution; and insufficient financial resources to effectively manage catchment management activities. As a result, IAS, poor awareness and education on wise water use, poor water quality and the lack of monitoring and compliance to environmental and water resources plans has been prevalent in the catchment. Consequently, implementing IWRM and AM in the catchment has been limited.

All of the participants expressed the willingness to make the necessary changes in management to improve water resources governance, which is important for implementing IWRM and AM. However, this is dependent on local and national government demonstrating leadership and promoting coordination across the board. Essentially, the establishment of the CMA will provide the leadership and coordination in water resource planning, oversee the allocation of financial resources in the sector, and promote capacity building within the necessary institutions. Moreover, the participants highlighted the establishment of the CMA, WUAs and the strengthening of CMFs as a way forward in improved water resource governance. Establishing WUAs which are statutory bodies at the local scale will provide a platform for all water users to engage with local authorities and the decision-making processes. The strengthening of CMFs by improving on their brand and presence will increase their legitimacy among role-players in the water sector. The establishment and improved presence of these institutions can greatly improve the coordination between local government, DWS and the water service provider. The recommendations provided by the participants rest on the establishment of the CMA which is unsure at this point in time.

Therefore, to achieve the second objective of this study which is, to provide a recommendation for effective water resource governance and successful management, a proposed recommendation should be suitable for the active role-players in the water sector. The recommendation should take into consideration the lack of financial resources and political will in the catchment, the lack of participation of certain water users in water resources management (attributed to WUAs not being established); while capitalising on role-players' willingness to improve water resources management. In addition, the recommendation should be applicable in the current institutional landscape in the uMngeni

catchment. Therefore, a suitable recommendation is to encourage relationship building among decision-makers and previously excluded water users in water resources management. Relationship building does not require a large budget as many organisations have a budget for their employees to attend meetings and workshops (as stated by a participant). Initiating relationship building with water users or organisations involved in catchment management activities does not require political backing from government authorities; and will open communication and interaction between role-players and previously excluded groups (e.g., private organisations). This will enable active role-players to engage with excluded groups and learn how they can participate and gain (directly or indirectly) from water resources management.

An approach suitable for relationship building is the Corporate Social Responsibility (CSR) partnerships (Austin, 2000; Seitanidi and Crane, 2009; Selsky and Parker, 2005) (Figure 5.4). Literature on CSR provide frameworks that assist in relationship building among organisations and could be beneficial in the uMngeni catchment to include businesses in the water sector as some are water users. Based on Austin (2000), Seitanidi and Crane (2009) and Selsky and Parker (2005), a CSR model is provided to initiate relationships. The model begins with the selection of role-players where an organisation (Agent A) needs to determine the reasoning behind forming a partnership with another organisation (Agent B) and the intended outcomes. Agent A would need to outline a set of criteria for selecting an organisation to partner with. The criteria could consider the geographical region in which Agent B operates, their interests in the water sector or their history in collaborating with external actors for environmental reasons. Agent A would further need to choose the associational form or type of partnership they are seeking to form either it be philanthropic, transactional or integrative.

A philanthropic partnership is largely one-way and involves a private business funding an activity or product carried out by an NGO. There is minimal interaction among the two organisations, fewer individuals involved in the partnership and the aim of the activity may align with the mission of the private business. A transactional partnership is not as common as a philanthropic partnership as it benefits both organisations within the partnership. On the other hand, and integrative partnership involves a merging of both organisations' objectives and activities, with a higher degree of interaction and communication. In addition, a partnership can be determined on whether Agent A is seeking a public-private partnership, a public-NPO partnership, private-NPO partnership or enter a tripartite partnership including

organisations from all three sectors. This is followed by the scoping step where Agent A conducts research on potential partners (business, area of operation, CSR activities) and if there are mutual interests, to ensure compatibility. The final step involves selecting an organisation to form the partnership with, based on the previous steps.

The second phase is termed networking where Agent A makes initial contact with the potential partner (Agent B). This will include relationship building activities such as hosting meetings to better understand the organisation, the individuals working in the organisation and the prospect of forming a partnership. As both organisations become acquainted with each other, risk assessments would need to be conducted within the individual organisations and externally, to ensure the success of the partnership. Phase 3 which is the formation of the partnership begins with the first step which is determining the objectives that are to be achieved by the partnership. This is followed by the drafting and finalising of an agreement or Memorandum of Understanding (MoU). This feeds into the third step of partnership reporting which is a two-way process and where both organisations communicate their roles and responsibilities, financial commitments and non-monetary responsibilities. As the partnership becomes operational, the designation of roles and responsibilities may need to be adjusted to ensure its effectiveness. The formation of a virtual team is the final step in Phase 3 where individuals from both organisations become the point of communication in the partnership. The virtual team can be considered as a steering committee that drive the partnership. The structure of the virtual team is dependent on the sizes of the individual organisations and the tasks that need to be carried out by the partnership. Depending on the partnership, the team may decide to have a central point of contact or manager through which information is communicated. In Figure 4.4, the central point of contact in both organisations would be individuals ‘6’ who may be tasked with making the decisions in the partnership.

Individuals ‘2’ from each organisation may communicate with each other due to the similar nature of their work and responsibilities e.g., the financial managers in the respective organisations collaborating to direct financial resources toward the partnership. They may then communicate this aspect of the partnership to the central manager i.e., individuals ‘6’.

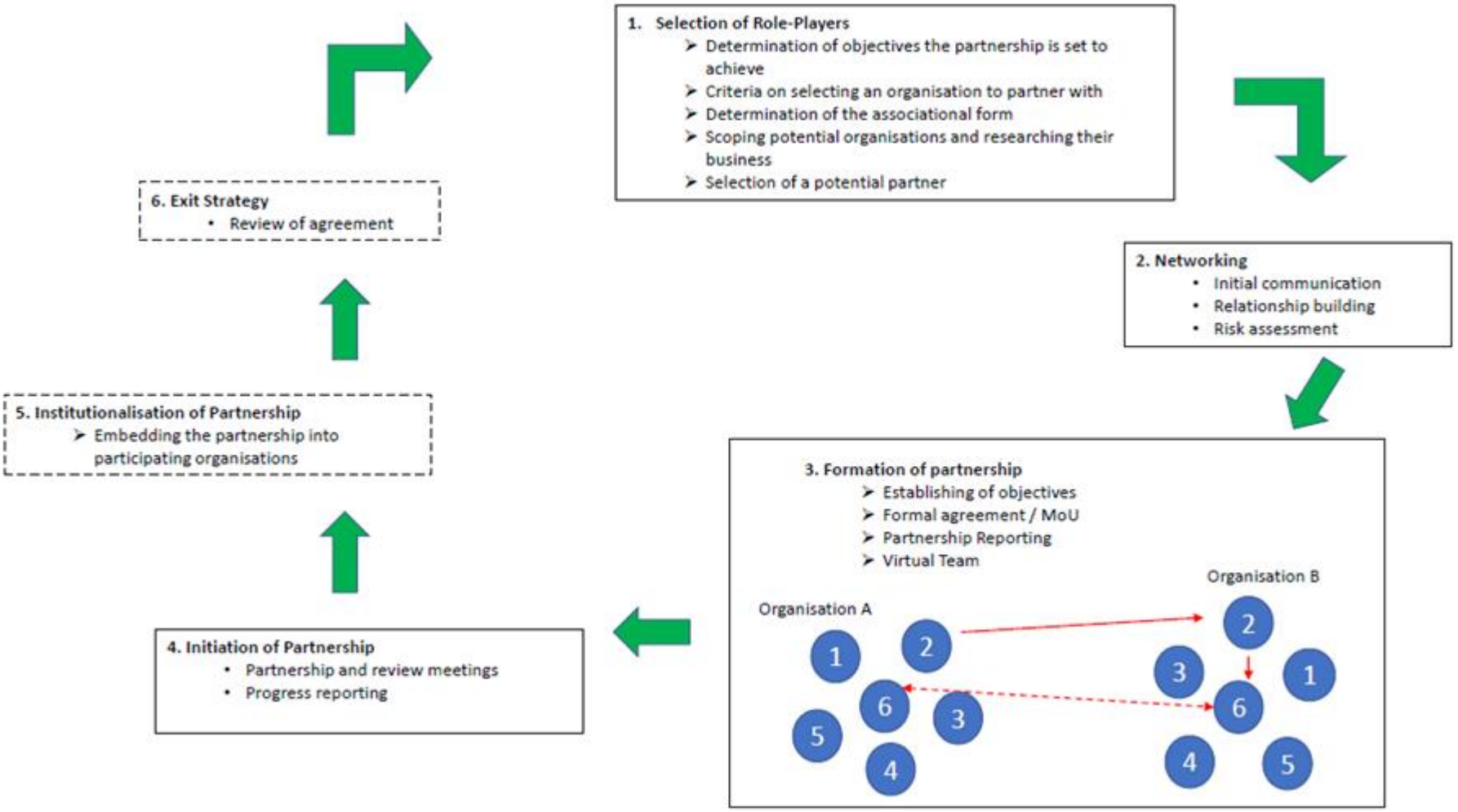

Figure 5.4 Corporate Social Responsibility (CSR) Model used as an approach to foster relationship building among organisations in the water sector in the uMngeni catchment. Adapted from Seitanidi and Crane (2008).

Phase 4 is the implementation of the partnership where activities are carried out toward the objectives, review meetings are held to assess the effectiveness of the partnership, reporting on issues encountered and the effectiveness of the team structure. Phase 5 in the model is the institutionalisation of the partnership into both organisations, making the partnership long-term or permanent. This is based on the partnerships' ability to face conflict and disagreements without terminating the agreement, and the personal relationships that have formed. However, phase 5 which is boxed in a dotted line in Figure 5.4 is an optional stage as not all partnerships are formed on a permanent basis. The partnership may be intended to solve an issue and thereafter, be dissolved. Similarly to phase 5, phase 6 which is the exit strategy is also optional as the organisations may decide to keep the partnership ongoing. Dependent of the success or effectiveness of the partnership, the challenges experienced, or the planned timeframe of the partnership, organisations may skip certain phases and move to the exit strategy to dissolve the partnership. The exit strategy will involve a review of the partnership and the agreement in place to ensure a pleasant separation.

Waddock (1989) provides a different public-private partnership model called the evolutionary model consisting of three stages. However, the manner in which each stage is to be implemented is not expressed or detailed as the CSR model, and is rather descriptive of the terms provided. Secondly, the model by Waddock (1989) details a partnership between organisations with a different mission statement or objectives and elaborates on the need to overcome negative stereotypes that are associated with the organisations (e.g., public workers are unproductive, and the private sector is socially irresponsible). Whereas, the CSR model states that organisations within a partnership should have commonalities in their organisations' mission and objectives. Thirdly, the illustration of the model in Waddock (1989) is complex with multiple steps that are intertwined indicating the steps are concurrent, which creates confusion. Samii et al (2002), Trafford and Proctor (2006), and Reich (2002) provide case studies of public-private partnerships that have been established in the industrial, public administration and health sectors; whereas Chaklader and Gautam (2013), Silvestre (2012), Ameyaw and Chan (2016), Lee (2010), and Yamount and Jamali (2007) provide public-private partnerships that have been established in the water sector for improved water management and water services delivery. The positive and negative outcomes from the partnerships were described however, each of the case studies did not provide a step-by-step model on how the partnerships were formed.

With this in mind, the CSR model provides details on the micro-processes that occur when establishing a partnership (e.g., relationship building and risk assessments), and provides insights on how partnerships develop overtime and some of the obstacles that are encountered. Furthermore, the model is practice-tested as Seitanidi and Crane (2008) provide two separate case studies in the UK (Scotland) in which the partnerships between organisations in the environmental sector and social development were analysed. Seitanidi and Crane (2008) focussed on the interactions between the individuals in the partnerships by observing the negotiation process throughout the networking step and the formation of the partnership step. The power dynamics between the individuals were observed through their interactions and questioning the participants on their perceptions. Further observation was performed on their reporting structures and processes, how the relationships between the organisations progressed, conflict resolution processes and how the partnerships were finally institutionalised.

The CSR model is significant because Seitanidi and Crane (2008) demonstrated the processes necessary to develop partnerships among organisations across sectors. Therefore, the model is applicable in the water sector, and among organisations/role-players across sectors. This is important due to the prevailing catchment management activities in the uMngeni catchment that affect water resources. Sand mining is occurring within the catchment which increases siltation in rivers and dams. Sewerage leaks and industrial waste pollute the Msunduzi River which flows into the uMngeni River. These issues in combination with other catchment management activities fall under different sectors (e.g., Mineral Resources or Commerce). Therefore, applying the model will guide the formulation of partnerships between organisations across sectors, opening dialogue on solutions to prevailing issues. In fact, the engagement of role-players with the UEIP can facilitate the application of the model in the uMngeni catchment. Individuals representing different organisations often attend UEIP meetings depending on the subject matter or issue at hand. Therefore, forming partnerships with such individuals is beneficial in improving participation of previously excluded groups in water resources management, whilst considering the fact that WUAs have not been established and capitalising on role-players' willingness to improve water resource governance.

Applying the CSR model in the uMngeni catchment is an opportunity for active role-players to improve on coordination within the current management styles, while engaging with social learning. AM is a process of improving management practices by evaluating the outcomes of

new management activities. In this context, the aim of applying the model would be to increase participation and integration in water resources management in the uMngeni catchment. Applying a positivist approach to implementing the model is a method in which the role-players will be engaging with social learning and AM, which has been limited. In addition, the formation of partnerships particularly through the UEIP is an act of making small amounts of progress toward achieving IWRM and ingraining AM practices in the catchment. In relation to the research aim and objectives, the application of the CSR model builds upon the role-players' willingness to change behaviour for improved water resources management and, facilitating the implementation of IWRM and AM in the current institutional landscape in the uMngeni catchment.

5.6 Conclusion

Implementing IWRM and AM largely depends on the institutional landscape that exists. However, rarely do we focus on the perception's decision-makers may hold regarding the approaches, and how this may influence whether or not IWRM and AM are implemented. The interviews indicate that majority of the participants who are also involved in decision-making in the catchment, do not hold a positive perception on IWRM as an approach. The responses prove that there is great uncertainty on how role-players are to implement a higher degree of integration within the water sector and across multiple sectors. AM and the concept of social learning is not as advocated for as strongly as compared to IWRM. Majority of the participants were unfamiliar with the approach which may be attributed to the lack of capacity building and institutional landscape that accommodates AM. In addition, participants who were/are involved in climate change related projects in the catchment have had the opportunity to conduct experimentation on management activities and styles, thus being more familiar with social learning.

Most of the participants highlighted the need for the CMA to be established which would facilitate the implementation of IWRM and AM. However, the time frame for the establishment of an operational CMA is unknown at this point in time. Thus, role-players will continue to be pressured into solving issues as they are the water users, regulators and managers. However, there are stakeholders particularly in the private sector who are not part of the decision-making process in the catchment, either through a lack of interest or being vilified for causing issues in the catchment. A recommendation provided is to use the Corporate Social Responsibility (CSR) model to build relationships among excluded

stakeholders and role-players in the water sector, so as to implement the core principles of IWRM and practice AM.

5.7 References

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Chapter Six Discussion

The DWS conducted the '*Reconciliation Strategy Studies*' for metropolitan areas and major river systems in South Africa. The assessment concluded that the Pietermaritzburg-Durban region is at risk of facing water shortages in the not-too-distant future. This risk has serious implications for the Msunduzi Municipality and eThekwini Metropolitan Municipality which contribute significantly to South Africa's GDP; and are the most populous municipalities in the catchment area. Thus, exploring the management approaches to water resources is relevant. IWRM and AM are internationally recognised complementary approaches to water resources management. These management approaches are often assessed at a national scale and not at a local/catchment scale. Therefore, two overarching research questions were identified; firstly, to what degree and how is IWRM implemented in the uMngeni catchment as envisaged by the NWA 36 of 1998 (water policy of South Africa)? Secondly, are there any attempts to make use of the AM approach in order to mitigate shortfalls in water resources management? If so, how and to what degree is this approach to be tracked in water resources management? In exploring the implementation of IWRM and AM in the uMngeni catchment, the current institutional landscape and dynamics were assessed in order to understand whether or not they are facilitating the implementation of these management approaches. The institutional landscape and dynamics include the organisations involved in water resource management, the governance tools that create an enabling environment for the approaches and the perceptions of the people who make up the institutions.

6.1 Institutional Landscape

For effective integration and learning to occur across multiple sectors and water users, the appropriate organisations need to be established and function effectively. In the uMngeni catchment, there is a clear demarcation of the three tiers of management in governmental and non-governmental organisations. However, the absence of an operational CMA at the regional scale has resulted in poor planning of water resources and a lack of authority that ensures integration among water use sectors and water providers. The proto-CMA within the DWS assumes some of the responsibilities of a CMA. However, water resource management remains to be reactive and focussed on water service provision rather than water resource planning. This is partly attributed to the lack of financial resources and institutional capacity to ensure water resource planning. At the local level, there is an absence of statutory WUAs, and irrigation boards had previously not been established. The implication of this is that water users are only involved in resource management through the water use license process;

and their issues are not effectively communicated to regional and national levels if they are not part of a CMF. Similarly, information cannot reach certain water user groups from national government. To compensate for the lack of leadership at the regional level, institutions such as Umgeni Water, UEIP, DUCT, and professionals from tertiary institutions and the municipalities are taking initiative of creating spaces for integration, cooperation and participation to occur. In addition, CMFs are getting more involved in resource management by inviting previously excluded groups to forum meetings. However, in as much as effort is directed toward improving integration and learning, the current institutional landscape has facilitated the implementation of IWRM and AM only to a very limited degree and on an ad hoc basis.

6.2 Enabling Environment

Upon analysing the legislation (i.e., NWA 36 of 1998 and Water Services Act 108 of 1997), environmental management, development and water resource planning tools in the form of strategies and plans; it is evident that water resource planning is featured across all tools, except the IWMP which does not consider water resources. Although water resources may feature in most implementation tools, if there is a lack of compliance it has no effect. Municipal departments have limited institutional capacity making monitoring and compliance to these tools and legislation difficult. Moreover, the tools do not provide guidance on how water users are to consider water resources in their decision-making process. In fact, an operational CMA would fill that essential role of providing guidance and assistance to water users on how to meet their objectives without seriously compromising the integrity of water resources. In addition, these tools (i.e., Msunduzi EMF 2010) are to be updated within certain timeframes (e.g., 5 years) which is not necessarily the case. Consequently, the tools (i.e., Msunduzi EMF 2010) that are available to the public are outdated which implies that current trends and challenges are not featured in these tools. Thus, the enabling environment to facilitate IWRM is there, but the implementation is limited due to insufficient guidance and compliance from an authoritative body. Another hindrance is the capacity of organisations to effectively integrate with external parties. On the other hand, legislation and governance tools do not provide regulations or guidance for AM implementation and social learning practices. This may be attributed to the lack of understanding of the management approach evident by the participants responses, where a few of the participants associated AM with using water sparingly. Thus, any attempt to make use of the AM approach in order to mitigate shortfalls

in water resources management is to the discretion of the role-players who understand the approach.

Furthermore, the limited implementation of IWRM is also attributed to the fact that in the catchment, there is a focus on water services rather than resource planning. The only tool that focusses on water resource planning is the proto-CMS which was drafted in October 2019 and remains incomplete. The rest of the tools focus on water service provision. In as much as there are numerous tools that regulate service provision, the responsibility of catchment management activities and water resource planning are misunderstood, further hindering the implementation of IWRM and AM in the uMngeni catchment.

6.3 Perceptions of Participants

Literature on the implementation of IWRM and AM mostly considers the financial limitations and the factors discussed above. However, we take in consideration the fact that people make up the organisations and people are charged with the responsibility of enforcement and compliance. Therefore, investigating the participants perceptions toward IWRM and AM is relevant to how the implementation of the approaches is facilitated. The perceptions of regulators in the decision-making process were explored. Although the perceptions of smallholder farmers and water users are important in the implementation of IWRM and AM, they fell out of the scope of the study. Regarding IWRM, most if not all the 21 participants alluded to the fact that integration within the catchment is necessary. However, the participants believe that the theoretical basis of IWRM may not be applicable at a local level, let alone in a developing country. Thus, if left up to individual organisations and professionals, certain principles of IWRM are implemented. This stems from the fact that most of the participants do not fully support IWRM in its entirety but do believe in aspects of it (i.e., participation and inclusion). Furthermore, participants alluded to the lack of knowledge and guidance on how IWRM is supposed to be implemented. Based on the interviews, it is clear that IWRM may still be considered as an ‘end point’ rather than a process; where at times there will be a higher degree of IWRM implemented and at other times there will be a lower degree. Irrespectively, it cannot be said that the participants’ perceptions are hindering the implementation of IWRM because all the participants expressed interest in a willingness to change behaviour for improved water resources management and integration. Therefore, considering the absent CMA, it is an indication that a missing authoritative body is the reason behind poor guidance and advocacy of IWRM.

On the other hand, the poor implementation of AM cannot be attributed solely to participants' perceptions because there is already a gap in governance tools that facilitate learning. Currently, the practice of AM and social learning is on a voluntary basis (at the discretion of the individual or organisation); and the number of participants who understand AM and social learning pale in comparison to those who do not understand it and have not been exposed to it.

6.4 Recommendations

The second part of the research aim is the recommendations for effective management. Based on the participants responses from the interview sessions described in the discussion sub-section of Chapter 4, clear recommendations include the:

1. Official establishment of the CMA at the regional level;
2. Formation of statutory WUAs for water users (e.g., farmers);
3. Prioritisation of rivers for stewardship and rehabilitation interventions to improved water quality;
4. Mainstreaming catchment management activities into water resource management; and
5. Adopting methods to include excluded groups into water resource management processes.

Thus, an adapted CSR model from Seitanidi and Crane (2009) and informed by Austin (2000) and Selsky & Parker (2005) is an approach which is applicable to build relationships and foster partnerships with water users and businesses, who play a role in water resource use and management. In light of the absent CMA and WUAs, forming partnerships could firstly improve catchment management and ultimately result in better water availability and quality. Secondly, these partnerships could facilitate the implementation of IWRM and AM in the uMngeni catchment due to increased financial resources, human resources, knowledge generation and participation. This may be timely as role-players in the catchment are looking to foster new relationships with the private sector. With the formation of partnerships with interested parties in the private/business sector, a sense of urgency and accountability is created which may compensate for the lack of authoritative body. Upon the establishment of the CMA, partnerships could complement the CMA.

6.5 Conclusion

The current research was conducted in the uMngeni catchment in KwaZulu-Natal, South Africa as the catchment faces challenges with regard to water resources management. These challenges include erratic rainfall, poor maintenance of water infrastructure, massive loss of water (NRW) and ineffective solid waste management which compromises the quality and availability of water resources in the catchment. A case study approach was used to gain in-depth understanding of the implementation of IWRM and AM by assessing the institutional aspects that may or may not facilitate the implementation of the approaches; and to provide recommendations for effective management.

In order to achieve the above research aim, four objectives were identified. The first objective was to identify the relevant institutions/organisations in the water sector and their sphere of influence. Secondly, investigate how IWRM and AM related to the execution of water services and how it featured in other areas of governance. Thirdly, investigate decision-makers' perceptions on the management approaches and their willingness to change behaviour for the improved management of water resources in the uMngeni catchment. Lastly, provide recommendations for effective water resources management. To meet these objectives, a desktop document analysis was done on legislation and the environmental management and governance tools for the catchment. In addition, 21 semi-structured interviews (see Appendix A) were conducted, recorded, transcribed and analysed to inform the results. It is essential to highlight that the study involved exploring the perceptions and experiences of regulators in the decision-making process. Although the perceptions and experiences of smallholder farmers and water-users in the uMngeni catchment are essential in understanding the implementation of IWRM and AM, this component fell out of the scope of the study. In providing a recommendation, additional desktop research was conducted on public-private partnerships and specifically the CSR model, that is applicable in the water sector in the uMngeni catchment. In addition, there is an opportunity for future research to explore the perceptions and experiences of smallholder farmers and water-users.

Finally, in answering the research questions, it is evident that the main institutional factor hindering the implementation of IWRM and AM in the uMngeni catchment is the absent CMA and statutory WUAs. In addition, it is evident that IWRM and AM are implemented to a very limited degree due to a focus on water services provision, rather than on water resource planning. The overlap in catchment management and service provision further hinders the implementation of the named approaches.

Appendix A

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

Exploring the Implementation of Integrated Water Resource Management (IWRM) and Adaptive Management (AM) at a local scale: A case study of the uMngeni Catchment, KwaZulu-Natal.

Semi-Structured Interview Schedule

NAME (optional):	POSITION:
CONTACT DETAILS (optional):	DATE:
ORGANISATION:	
YEARS EXPERIENCE:	

Background Questions

1. What is (the organisation)'s sphere of influence within the uMngeni System?
2. How does water resource planning for the whole catchment align or feature into (the organisation) s' mandates?
3. Can you describe what your role is within the organisation?
4. Introduce IWRM and AM. What is your personal view regarding IWRM and AM as management approaches? Do external and internal stakeholders have an understanding of the approaches? (Some see it as an additional requirement)

Context Questions

5. How is the past and current institutional set-up in the municipality with regards to WRM?
6. Concerning the idea of coordination, have the Dept. of Water and Sanitation actively involved (the organisation) and other stakeholders in IWRM planning and, do these stakeholders feel welcomed?

7. When it comes to WRM challenges, common themes in literature include: Finances, Roles & Resp., Political Support and Coordination. How would you describe the true extent of these and what would you say are the current challenges?
8. Considering these challenges and your opinion of IWRM and AM as approaches, what would you recommend should change, improve and remain the same?
9. Do you think there is room to embrace such changes and, do you think other practitioners or managers would be willing to embrace these changes, yourself included?
10. What are some of the Adaptive measures (the organisation) implements i.e. Review cycle of documents/plans, in response to climate change?
11. Does (the organisation) engage in social learning and action research?
12. In your experience working in this institution, are there questions or aspects that I did not highlight that you think may be useful to this study?