Exploring adaptive policy management and evaluation for improved water resources management in the face of uncertainty and complexity in South Africa

by

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Declaration

To whom it may concern:

I, **Sandile Ngcamphalala**, hereby declare that the work has not previously been submitted in whole, or in part, for the award of any degree. All content in this dissertation is my own work. Each significant contribution to, and quotation in, this dissertation from the work, or works, of other people has been attributed, and has been cited and referenced.

Dedication

I dedicate this work to my wife, Carol

and our sons, Thorisho and Ndalo.

Acknowledgements

To my wife Carol, I express my sincere gratitude for your overwhelming support and love in the past six years. Thank you for taking care of our boys, reading bedtime stories and spending all the time you could with them, when I couldn't. Knowing you were there made all the difference. To big brother Thorisho, I started this PhD when you were just 2 years old. Thank you for allowing me the space to do this. I hope to give back to you even more time, love and support in your journey and to dedicate more time for us to play more golf and soccer. To the youngest member of our family, Ndalo, born in the last and most trying stages of the PhD. Thank you for your independence and lovely dimples. They carried me through rough times. To the rest of my family, thank you for your continued love and prayers. To my supervisor, Dr Olivier Crespo, at times, you believed in this project way beyond what I could imagine. Thank you for your clarity of mind, commitment and support. I remain forever grateful. To my co-supervisor, Prof Johann Louw, thank you for sacrificing your time, delaying retirement and agreeing to support this project. Thank you for your patience and continued professionalism. To all the stakeholders and key informants that participated in this study, you are the real champions of this project. Thank you for taking time to share your invaluable knowledge and experience. I remain forever indebted to you. A special thank you to Prof Sue Walker, Ms Lerato Maboa and Mr Terry Newby for your dedicated support and participation. Prof Walker many thanks for committing time to review the thesis. To the brains behind the Elephant Builder - Dr Jessica Ruvinsky and Dr Ted Wong, you rescued this project with such a useful tool. Much gratitude to Jessica for sacrificing your time to guide me.

Romans 11:36: *For from the Lord and through him and for him are all things.*

To him be the glory forever!

Abstract

Evidence-based water resources policy management is bedevilled by the challenge of uncertainty, with increased risk of policy failure and/or unintended or negative policy outcomes. Moreover, there is increased policy management complexity emerging from related systems' interdependencies particularly between the water resources policy management system with other environmental, economic, social and political systems. Such complexity imposes external interference with the performance dynamics of water resources policy management efforts. Consequently, water resources policy management strategies in furtherance of 'water equity' as the ultimate goal of water resources management policy in South Africa, may be misplaced. As a result, the performance of water resources management policy is unlikely to follow a linear logic of change/impact.

The adoption of adaptive policy management strategies to ensure policy flexibility and efficiency is warranted especially for policies managed in the face of deep uncertainty and complexity mainly driven by the interactions and interdependencies between numerous social, economic, environmental and political variables with risk for the emergence of more unpredictable policy outcomes. Successful adaptive policy management, however, must be guided through real-time credible and comprehensive evidence, which is complicated to generate in a context plagued with deep uncertainty and complexity. Using systems mapping as a systems' analysis tool, this study identified a comprehensive list of environmental, economic, social and political variables that interactively determine water resources policy management performance towards 'water equity'. The different environmental, economic, social and political variables that interactively influence 'Water

Equity' results as identified in this study, help to determine key policy drivers and leverage points that can be monitored and evaluated in pursuit of credible and comprehensive water resources policy planning, implementing and performance evidence.

The availability of credible and comprehensive evidence, however, does not imply automatic success of the adopted adaptive strategy. The study found that there are numerous other barriers on different aspects and levels of the policy that would have to be addressed to ensure the contextual success of adaptive and integrated water resources policy management in South Africa. These include, transformational changes in substantive water resources management policy design to ensure proactive intentionality to improve water resources policy management in the face of deep uncertainty; designing institutional policy governance structures that demonstrate clear appreciation of the heterogeneous water resources management needs across the country; and active commitment to fully and timely implementation policy decisions in a manner that ensures continuous learning, capitalises on policy performance opportunities, defends working policy strategies and facilitates real-time policy corrections.

Terminology Used

The terms presented here may be understood differently across the different scholarly and practice communities. The following are the key frequently used terms in this thesis. These are used as a rough guide to better assist the reader in understanding the language used in this thesis.

Adaptive and Integrated Water Resources Management: a concept built out of the combination of IWRM (see IWRM) and Adaptive Policy Management (see Adaptive Policy Management).

Adaptive Policy Management: part of a continuum of adaptive policy planning strategies that demonstrate different levels of robustness, flexibility, and responsive capacities to policy uncertainty (in terms of both vulnerability and opportunity) including assumption-based planning, robust decision-making, adaptation tipping points, adaptive policy pathways, and dynamic adaptive policy pathways (Walker et al., 2013).

Complexity: a state in which the interactions and interdependencies between different social, economic, environmental, and political variable produce deeply uncertain policy outcomes such that the stakeholders involved are increasingly conflicted on the solutions (Head & Alford, 2015; Patton, 2011; Walker et al., 2010).

Deep uncertainty: the gap between available knowledge and the knowledge that policy makers need to inform specific decisions or value judgements about a particular policy as well as the incalculable and uncontrollable issues, which especially affect public policy issues where no specific level of probability can be attached (Morgan et al., 1992; Quade & Carter, 1989; Head & Alford, 2015).

Dynamic Adaptive Policy Pathways: a policy management approach that explicitly considers the timing of policy management actions and alternative routes into the future based on specific adaptation tipping points that underpin the conditions under which a given policy plan is most likely to fail (Haasnoot et al. 2013).

Evidence-based Policy Making: a policy management approach that helps policy makers to make well-informed decisions, by putting the best available evidence from research at the heart of policy development and implementation decisions (Davies, 2004).

Evaluation: systematic investigation of the effectiveness of social intervention programmes in ways that are adapted to their political and organisational environments to inform social policy action to improve social conditions (Rossi, Lipsey, and Freeman, 2004).

Flexible policy: a policy that can be easily modified to keep on meeting the desired objectives as new information becomes available or as the needs and implementation conditions changes (Marchau, et al., 2019).

Integrated Water Resources Management (IWRM): process aimed at promoting the coordinated development and management of water, land, and related resources, to maximize equitable socio-economic benefits without compromising the sustainability of vital ecosystems (Global Water Partnership, 2001).

Logical Framework: a planning tool for managing development projects in a structured tabular form showing the different programme Components in a clear, concise, and logical format (Mertens & Wilson, 2012).

Resilient Policy: a policy plan that can meet the desired policy objectives reasonably quickly after a shock to the system or in the face of significant situational changes (de Haan et al. 2011).

Robust Policy: a policy plan that can keep on meeting the desired objectives as the implementation situation or conditions changes (Marchau, et al., 2019).

Scenarios: a narrative of the future that can be used to stress test a policy option or future policy impact pathway for robustness (Marchau, et al., 2019).

Signposts: a warning signal that triggers a particular policy action to adapt the policy and ensure continued effectiveness (Marchau, et al., 2019).

Systems Thinking: an approach to thinking that emphasises a holistic view to a policy system rather than in parts with an interest in understanding interactions within and between systematic variables, as well as how the main system of interest interacts with external environmental, economic, socio-cultural, and political variables that influence the interactive outcomes (Alcamo, 2015; Patton, 2011).

Theory of change: the perceived theoretical assertions of the logical effect of a particular set of policy actions on a public problem (Rogers (2013).

Trigger point: events that are predetermined to help trigger certain policy actions within a sufficient lead time required to implement any required changes in time before a particular adaptation tipping point is reached when a policy may no longer be able to achieve its objectives (Kwadijk et al. 2010).

Water Equity: reliable availability and access to an acceptable quantity and quality of water for sustained social-welfare and economic activity, coupled with an acceptable level of water-related risks such as flooding, drought and water pollution (Grey and Sadoff, 2007).

Water Security: as a state where every person has access to enough safe and affordable water to lead a clean, healthy, and productive life, while ensuring natural and environmental protection and enhancement (Global Water Partnership, 2000).

Abbreviations and Acronyms

AIWRM	Adaptive and Integrated Water Resources Management
AMD	Acid mine drainage
ARC	Agricultural Research Council
CDKN	Climate and Development Knowledge Network
CMA	Catchment Management Agencies
CMF	Catchment Management Forums
CMS	Catchment Management Strategy
DAFF	Department of Agriculture, Forestry and Fisheries
DBSA	Development Bank of South Africa
DEA	Department of Environmental Affairs
DED	Department of Economic Development
DMR	Department of Mineral Resources
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
ELU	Existing Lawful Use
ESWADE	Eswatini Water and Agricultural Development Enterprise
FAO	Food and Agriculture Organisation of the United Nations
GDP	Gross Domestic Product
GCM	Global Circulation Model
GWM&ES	Government-Wide M&E System
GWP	Global Water Partnership

IPCC	United Nations Intergovernmental Panel on Climate Change
IWRM	Integrated Water Resources Management
JCSEE	Joint Committee on Standards for Educational Evaluation
JPTC	Joint Permanent Technical Committee
JWC	Joint Water Commission
LHWP	Lesotho Highlands Water Project
LWC	Limpopo Watercourse Commission
M&E	Monitoring and Evaluation
NAS	National Academy of Sciences
NDP	National Development Plan
NEPF	National Evaluation Policy Framework
NPC	National Planning Commission
NRC	National Research Council
NW&SMP	National Water and Sanitation Master Plan
NWA	National Water Act
NWRS	National Water Resources Strategy
NWRS1	National Water Resources Strategy - First edition
NWRS2	National Water Resources Strategy - Second edition
NWSRSS	National Water and Sanitation Resources and Services Strategy
PDA	Provincial Departments of Agriculture
PWC	Permanent Water Commission
RSA	Republic of South Africa
RWU	Regional Water Utilities
SADC	Southern African Development Community

SANPARKS	South African National Parks
Stats SA	Statistics South Africa
ToC	Theory of Change
Union of SA	Union of South Africa
UN	United Nations
WMA	Water Management Area
WRM	Water Resources Management
WSA	Water Services Authority
WSA	Water Services Act
WSP	Water Services Provider
WUA	Water Users Association
WWAP	World Water Assessment Programme
WWDR	United Nations World Water Development Report
WWF-SA	World Wide Fund - South Africa

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CHAPTER 1 : INTRODUCTION

1.1. Introduction

In 2018, Farinosi et al. (2018) published a paper in which they argued that intense competition for increasingly scarce water resources could lead to social unrest and regional instability, unless steps are taken to prevent these conflicts over access to water resources. Water scarcity problems, however, are not exclusively expressed through the water sector but are rather manifested mainly through wider national and international challenges, demonstrated through other environmental, economic, socio-cultural and political issues. The risk for such social unrest could become a reality especially in a country like South Africa - with high and increasing unemployment, poverty, and inequality (National Planning Commission [NPC], 2012). For example, in the first quarter of 2020, the unemployment rate was estimated at 30.1% (Statistics South Africa [Stats SA], 2020). The national poverty rate is estimated at 25,2%, 40,0% and 55,5% for the food poverty line (R441), the lower-bound poverty line (R647) and the upper-bound poverty line (R992) per capita per month, respectively (Stats SA, 2018a). The country is rated in the top five most unequal societies in the world, with a Gini coefficient of 0.67% (Stats SA, 2019). Water is one of the central resources that could help facilitate transformational change through inclusive and equitable economic growth and sustainable development in South Africa. Efficient water resources management is therefore mandatory to ensure greater and equitable access to the direct and indirect economic, social and environmental benefits accrued from the utilisation of water as a critical sustainable development resource.

This study takes up the challenge of managing water resources efficiently in the South African context. Equitable access to water resources remains one of the most contested public management problems in South Africa (Department of Water Affairs[1] [DWA], 2013a; Department of Water Affairs and Forestry [DWAF], 1997; Republic of South Africa [RSA], 1998; van Koppen & Schreiner, 2014). About 26 years into a democratic South Africa, access to water resources remains extremely skewed favouring the well-off and predominantly white users who were priority citizens for decades in the apartheid era over the poor, black majority of South Africans (DWAF, 1997; van Koppen & Schreiner, 2014). As such, at the centre of water resources management policy in South Africa is a strong drive to reform and redress the negative impact of the unjust and discriminatory policies of the apartheid government (DWA, 2013a; DWAF, 1997; RSA, 1998). The ultimate goal is to ensure national water security and, importantly, equitable and sustainable access to water resources for all (RSA, 1998).

With water as one of the key and central resources for equitable and sustainable development in South Africa (socially acceptable, ecologically friendly and economically viable), water resources policy management efforts cannot afford to fail. In this context, management efforts must not only be accelerated but should also be effective and efficient. However, the pursuit of the water resources management policy objectives in South Africa plays out in the face of extremely complex, uncertain, and rapidly changing conditions through which water resources policy management decisions must navigate to ensure

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[1] Between 1994 and 2010, the Department of Water Affairs included Forestry and was referred to as the Department of Water Affairs and Forestry. In 2010, the Water and Forestry functions were separated. The Department was then referred to as Water Affairs until it was formally established as the Department of Water and Sanitation in 2014.

effectiveness and efficiency. These include issues such as water scarcity, reduced and unpredictable rainfall, population growth and density, high and growing inequality and poverty, stagnating economic growth, unemployment, food insecurity, regional political instability and migration, as well as, climate variability and climate change (NPC, 2012). These interconnected issues risk the increased chances of water resources management policy failure.

To ensure policy efficiency and effectiveness, policy makers have embraced management principles that build on evidence to guide water resources policy making, programmes and projects. As such, the concept of evidence-based policy management has recently taken hold as ‘good practice’ in formulating and evaluating policy performance (Rabie, 2011). Evidence-based policy management is defined as a process where all policy development and implementation decisions made are informed by the best available evidence from research (Davies, 2004). A key phrase in this definition is ‘best available evidence’ with implications about what counts as such, especially for water resources policy management in South Africa, which occurs in the face of uncertain environmental, economic, socio-cultural and political challenges that are complex and rapidly changing.

Programme evaluation plays a great part in determining what best evidence is, and how it can be generated to inform policy management decisions. As noted by Rossi, Lipsey, and Freeman (2004), programme evaluation is a purposeful political activity, undertaken to affect the development of policy, to shape and improve the design, implementation and management of policy interventions. Achieving this purpose could be influenced by a number of factors including how the programme performance dynamics are assumed to play out in practice in order to produce certain policy outcomes (Rossi, Lipsey & Freeman, 2004). Such theory-based assumptions or evidence-based theoretical performance conclusions on a programme are in practice influenced and affected by a number of factors including especially those which might never have been considered when designing the programme performance logic or theory of change (ToC) (which is the perceived theoretical assertions of the logical effect of particular set of policy actions on a public problem). In theory-based evaluations such as logical frameworks and ToC (Chen & Rossi, 1997), such uncertain and complex issues (which often include external variables to the programme of interest in terms of management control) are often treated as risks or assumptions that may support or hinder the assumed theory from being manifested as observed in the programme outcomes. This study argues that in their traditional form (Coryn et al., 2011), theory-based evaluation approaches could be limited in helping to generate credible and comprehensive planning and performance evidence, especially within the context of policies implemented under uncertain and complex management conditions.

This research focuses specifically on how uncertainty applies to the domain of water policies within South Africa and how it affects the generation of credible evidence (through monitoring and evaluation) so as to inform evidence-based policy planning and performance management decisions. This study therefore considers other innovative means to strengthen traditional theory-based evaluation to better comprehend the policy performance dynamics presented by a set of internal and external influences on water resources policy management.

1.2. Research problem and objectives

The search for best evidence in many policy areas is bedevilled by the challenge of 'uncertainty', broadly defined as the unquantifiable knowledge gap between available knowledge and the knowledge policy makers would need to inform specific decisions or value judgements about a particular policy (Walker et al., 2003). In this regard, Head (2010) noted at least two main policy domains that run on a continuum of two knowledge extremes. On the one hand, are relatively stable and sustained continuity policy issues that can be managed through ongoing processes with minor adjustments and fine-tuning. Within this policy domain, there is a reasonable expectation for cumulative understanding of trends, causes, and impacts, which effectively constitute evidence-based policy analysis and development. On the other hand, however, of particular interest to this research, are the policies where knowledge tends to be inherently uncertain thus requiring major reconsiderations for effective policy management strategies due to numerous competing variables that together represent greater potential risk for policy failure (Head, 2010). Here, policy issues are characterized by incomplete or uncertain knowledge inputs, knowledge gaps, changing conceptions about the underlying problems, competing values and perspectives, and rapid shifts in policy targets and management conditions. Such policy issues are often referred to as 'wicked' especially when policy uncertainty challenges interface with issues related to policy complexity and the divergence of stakeholder views on how to address the policy problem (Head & Alford, 2015). It is the contention of this research that water resources management policies are confronted with such issues characteristic of the domain of wicked problems.

Policies designed to operate within a certain range of conditions often face multiple other challenges outside the anticipated range and thus run the risk of policy failure or unintended policy outcomes (Swanson et al., 2010). Uncertainty in policy management is guaranteed. It must therefore be managed rather than avoided; thus, the need for the design of policies that are not only adaptive to changing conditions but are also robust across a range of futures (Head, 2008; Swanson et al., 2010). Even for anticipated future policy conditions there is still great room for error in judgement (Walker et al., 2013). Probabilistic measurements do not completely eliminate uncertainty. Over 60 years ago, Dewey (1954) already recognised these challenges, arguing that:

> In its strict sense, knowledge can refer only to what has happened and been done. What is still to be done involves a forecast of a future still contingent and cannot escape the liability to error in judgement involved in all anticipation of probabilities. (pp. 178-179)

This is effectively the case in water resources management and particularly in relation to climate variability where seasonal and weather forecasts are generally uncertain.

Importantly, uncertainty limits the efficiency and effectiveness of static policy approaches with limited flexibility and limited adaptive capacity (Walker et al., 2013). Although policy makers are generally aware that they are facing uncertain, rapidly changing, and complex management conditions, in practice, uncertainty is generally downplayed, with policy makers assuming that the future can be predicted (Walker et al., 2013). As such, most traditional policy planning processes, as is also the case in South African water resources management policy, do not reflect a deliberate plan to deal with uncertainty. Not to say that traditional policy planning is not thorough or does not hold potential to achieve the best possible results, however, such policies are commonly designed for a single or a few highly probable futures and therefore carry no guarantee to perform in the face of different contexts other than was initially conceived (Bankes, 2002). As such adaptive policy management approaches hold greater potential to navigate through the challenges presented by uncertainty (for definition of adaptive policy management - see Chapter 3, Section 3.4,).

Even in cases where there are opportunities to manage or reduce uncertainty, it is generally accepted that uncertainty cannot be completely eliminated. Therefore, the credibility of evidence-based water resources policy management outcomes could be extremely reduced by the challenge of uncertainty, such that the risk for policy failure or unintended negative (and positive) outcomes increases significantly. As a result, traditional policy monitoring and evaluation (M&E) approaches that reduce policy performance into deterministic logical frameworks or theories of change could be extremely limited under uncertain environmental, economic, socio-cultural, and political variables affecting water resources management. Traditional M&E approaches are often designed to cater for internal policy interaction aspects, where the policy managers involved have almost full control. The external variables of the core policy problem of interest are often treated as policy risks or assumptions with limited effort made to address them. Yet the interdependencies between such internal water resources policy management variables that are within the control of water resource policy managers and the multiple external variables could interactively present greater risk to blunt or nullify water resources policy management efforts, regardless of how efficient the responsible policy managers.

Moreover, there is increased policy management complexity emerging from related systems' interdependencies particularly between the water resources policy management system and other environmental, economic, socio-cultural and political systems. Such complexity risks greater external interference with the performance dynamics of internal water resources policy management efforts. Consequently, water resources policy management strategies, in furtherance of 'water equity' as the ultimate goal of water resources management policy in South Africa, may be misplaced. As a result, water policy performance is unlikely to follow a linear logic of change/impact.

The accuracy and reliability of the evidence generated for adaptive and integrated water resources policy planning and performance management is confronted by the challenges of uncertainty and complexity. If not intentionally and appropriately managed, these challenges could risk policy failure and/or unintended or negative policy outcomes. Uncertainty and complexity stimulates volatile, turbulent and rapidly cascading systems' interactions that could produce highly improbable, unpredictable, uncontrollable, unknowable and unexpected policy outcomes (Patton, 2011). In such a context, the credibility of the evidence generated to guide water resources policy planning and performance M&E could be questionable. The uncertainty associated with the performance dynamics of internal water resources policy management efforts in furtherance of sustainable national water security and water equity as the ultimate goal of water resources management policy in South Africa, may be misplaced. As a result of the uncertain water resources policy management performance dynamics, the policy impact pathways are unlikely to follow a linear logic of change/impact thus the justification to consider a different approach to determining the policy planning and performance variables that should be monitored and evaluated ensure efficient policy success. This research seeks to address this problem by investigating the conditions that could be managed or adjusted in order to successfully adopt and implement Adaptive and Integrated Water Resources Management (AIWRM) and to determine a comprehensive list of variables that could help improve the policy planning and performance M&E process in the face of uncertainty and complexity. To facilitate this study, the research objectives are:

- ***Objective 1:*** *To determine how the historical context and legacy of the racial discriminatory policies of the colonial and apartheid era inform current water policy problems and policy positions in South Africa;*
- ***Objective 2:*** *To identify the sources of uncertainty and complexity for water resources policy management in South Africa and their implications for evidence-based policy management;*
- ***Objective 3:*** *To identify the conditions that would be required for the adoption of a successful adaptive and integrated water resources management strategy in South Africa; and*
- ***Objective 4:*** *To identify the variables that should be comprehensively monitored and evaluated to ensure the credibility of the policy evidence-base generated in the face of complexity and uncertainty in South Africa.*

Objectives 1 and 2 will be used to establish literature-based evidence that inform the problem being investigated in this study. Objective 3 and 4 will form the primary knowledge contribution of this study. Ultimately, the aim of this study is to investigate the conditions that would be required for the adoption of a successful adaptive and integrated water resources policy management strategy and to determine the variables that should be comprehensively monitored and evaluated to ensure the credibility of the policy evidence-base generated in the face of complexity and uncertainty in South Africa.

1.3. Structure of the thesis

This thesis comprises eight chapters as briefly summarised below.

- **Chapter 1** introduces and outlines the research rationale and context. The chapter presents the research problem, objectives and structure of the investigation and concludes with a brief summary overview of the various chapters.

- **Chapter 2** presents the research design and methods adopted to facilitate the investigation.

- **Chapter 3** presents the conceptual framework utilised as the theoretical basis for this investigation.

- **Chapter 4** explores the historical context of water resources policy in South Africa. The chapter looks at the apartheid government's racial discriminatory water resources policy management stance and legacy, in order to contextualise current challenges and management priorities for this resource.

- **Chapter 5** presents the sources and implications of uncertainty for evidence-based water resources policy management. In a context of uncertainty, policy planning and evidence-based policy performance management decisions are considered the most strongly impacted aspects of public policy management. The chapter also highlights complexity and stakeholder divergence as additional policy management challenges that could potentially tip water resources policy management into the domain of wicked policies.

- In **Chapter 6,** the relevance of adaptive policy management approaches for policies implemented under uncertain management conditions is interrogated. The value of adaptive management is considered in addition to current integrated water resources management efforts. The first part of the chapter is based on a review of literature on adaptive policy management. The latter part of the chapter contextually investigates the feasibility for adoption of adaptive and integrated water resources management in South Africa, based on the expert opinions of key informants.
- **Chapter 7** considers the collective knowledge of key water resources management stakeholders and experts who participated in the study research workshops. The chapter presents a list of environmental, economic, socio-cultural and political systems' variables that could be considered key to developing a M&E framework tailored to support the generation of a comprehensive evidence-base, upon which water resource policy planning and performance management could be based.
- **Chapter 8** presents the study findings and provides lessons and recommendations on how water resources policy management M&E efforts could learn from this thesis towards the generation of comprehensive and credible water resources policy planning and performance information, to guide evidence-based water resources policy management decisions.

The study acknowledges the value of evaluation research for the evidence-based policy management value-chain, and it seeks to improve this value especially for policy management contexts plagued with uncertainty and complexity. The study is conceptualized from a systems' thinking and adaptive policy management perspective towards an innovative and comprehensive policy evaluation framework. It is argued that this could strengthen the credibility of evidence generated through M&E and thus ensure effective and efficient evidence-based water resources policy management. In line with the research objectives, **Figure 1.1** presents the four key components of the study that together represents the research design.

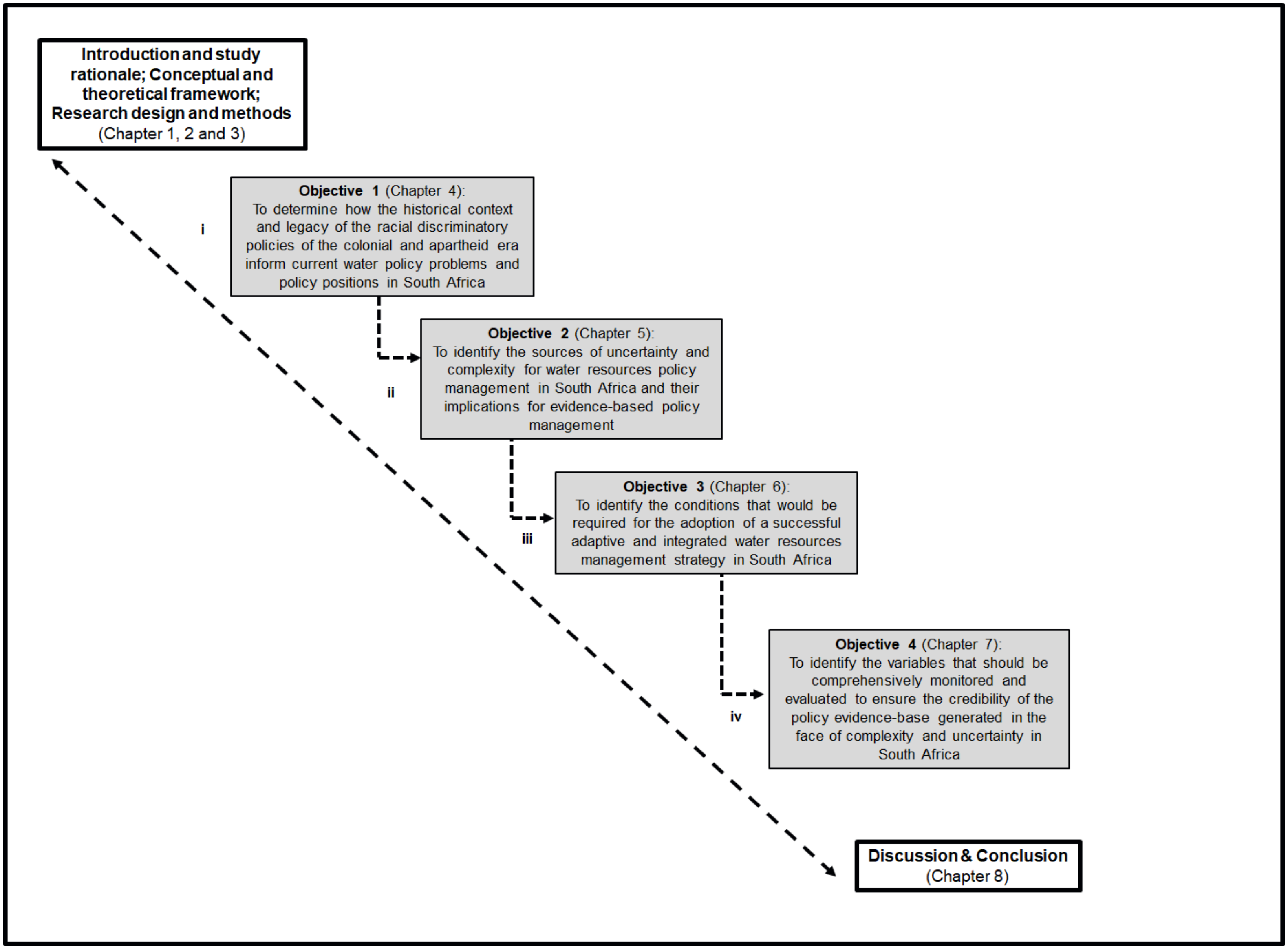


Figure 1.1: Research design.

Figure 1.1: presents the following aspects as the key components of the research:

1) **Step i** sets the scene for the study to ensure that the research did not occur in a vacuum, but rather within the context of water resources management as a real public problem for South Africans. The first task therefore was to contextualize water resources policy management in South Africa.

2) The aim of **Step ii** was to establish the challenges presented by uncertainty for the generation of planning and performance evidence towards evidence-based water resources policy management.

3) **Step iii** emerged from the recognition that one of the strategies for managing uncertainty would be the adoption of adaptive approaches to policy management, so as to facilitate real time navigation of policy management decisions as the future unfolds. Importantly, a learn-and-adapt approach to policy water management is proposed for South African policy management conditions. This study also investigated the policy management conditions that would be required with the adoption of adaptive policy management approaches in South Africa.

4) **Step iv** focused on the identification of a list of variables that could be considered in the development of a comprehensive M&E framework tailored to support effective adaptive and integrated water resources policy management in the context of uncertainty and complexity.

CHAPTER 2 : RESEARCH DESIGN AND METHODOLOGY

2.1. Introduction

This chapter outlines the research design and methodological approaches employed to conduct this research. A distinction is made here between research design and research methodology. Mouton (2001) defines research design as the plan or blueprint of how the research is conducted, while the research methodology is effectively the process employed in conducting the research, in terms of the research tools used and how they are utilized to facilitate the research process.

2.2. Research methods

The research methods employed for this thesis were guided by the study research objectives, which form the foundational elements of the study. As demonstrated in **Figure 2.1**, three research methods were utilised in this investigation. These included conducting a literature review, conducting interviews with key informants, and facilitating research workshops with multiple stakeholders for the iterative and collaborative analysis of the water resources policy management system.

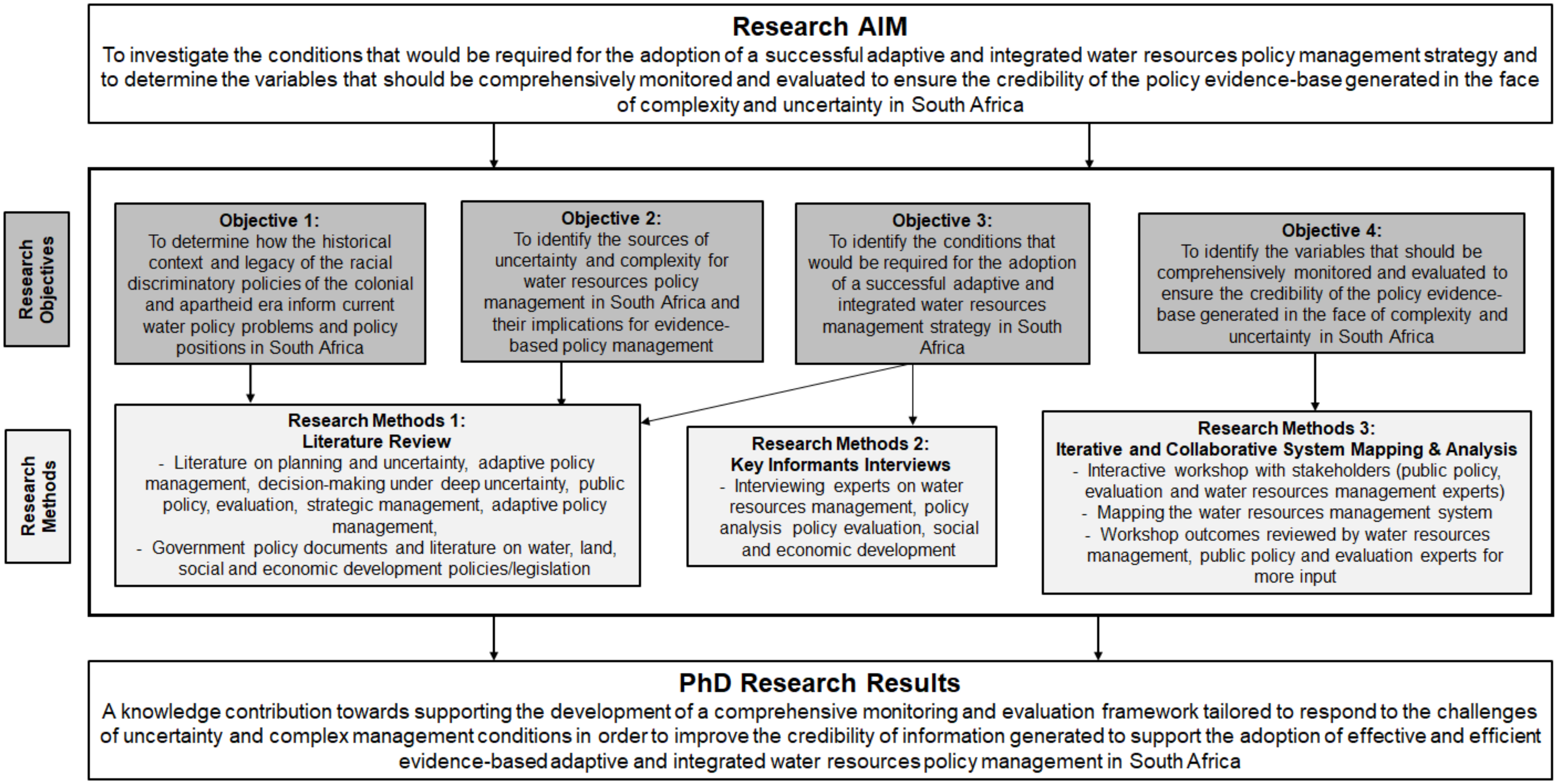


Figure 2.1: Research objectives and methods.

2.2.1. **Research method 1:** Literature review

A literature review was conducted as the first but continuous phase of the research. The literature review was helpful to determine the knowledge gaps thereby justifying the need for this research, as well as ensuring that the researcher was thoroughly informed of the current state of knowledge and the subsequent gaps therein. Furthermore, the insights gained through the literature review were especially helpful for the purposes of conducting interviews with key informants and the facilitation of research workshops, during which key informants and stakeholders could provide additional information. Furthermore, due to the invaluable information and knowledge gathered through the literature review, the structure and focus of the study was continuously refined. This included improving the research objectives and the research methods. For example, the initial focus of the study was on environmentally induced uncertainties on water resources policy management such as climate variability and climate change, this was later revised to include environmental, economic, socio-cultural, and political variables, which widened the management context for adaptive and integrated water resources policy management.

2.2.2. **Research method 2:** Interviews with key informants

One of the emerging issues throughout the literature review of this study was the argument that unless the adopted policy design and implementation approach purposefully addresses policy uncertainty through learning and adapting, then any innovation whatsoever in the generation of policy planning and performance evidence would only offer limited value to the policy management process. This argument emerged as one of the key reasons to include adaptive water resources policy management strategies as a precursor to improving the value of water resources policy M&E as the primary objective of this study. The overwhelming consensus on the employment of adaptive policy approaches in the management of policy issues that are plagued with uncertainty, dictated the need to also investigate the feasibility of implementing such adaptive approaches to water resources policy management in South Africa. Therefore, interviews with key informants were conducted to establish what the key requirements for the adoption and implementation of adaptive and integrated water resources policy management, within the South African policy management context, might be. In this research, key informants, as well as individuals with expertise in a variety of areas such as water resources policy management, water resources management, water management research, water engineering, public policy analysis and management, development management, policy monitoring and evaluations, and water sociology were engaged with. In seeking individuals who could potentially offer contrasting and/or objective views on the subject, efforts were made to include a diverse group of experts to ensure a balanced texture of experience, views, and information to better inform the study. Purposeful sampling (Bryman et al., 2018; Newman, 2011) was utilised to identify the key informants for this study. These were mainly renowned senior level individuals in government, the private sector, civil society, academia, research councils as well as international development partners working in areas related to water resources management. The criterion used was, as far as possible, to include South African experts with current or previous experience working in the public sector, academia, and civil society pre- and post-democratic South Africa. However, two more experts from the public sector and civil society were suggested by other key informants during the interviews. This is referred to as snowball sampling where key informants, not originally considered for participation in the study, emerge through referrals from one or more individuals (Bryman et al., 2018; Newman, 2011). A total of nine key informants participated actively in the study. The expertise of these individuals covered areas of water resources management, water resources management sociology, water engineering, public policy management, M&E and sustainable development. Although there were several sources with overlapping development of adaptive policies' themes (Allen & Gunderson, 2011; Borowski & Kastens, 2009; Butler et al., 2016; Hamarat et al., 2013; Kwakkel, Haasnoot & Walker, 2016), an interview schedule **(Table 2.1**) was developed based on comprehensive scholarly work on the development of adaptive policies by Swanson et al. (2010). All interviews with key informants were conducted in person and guided through the interview schedule.

Table 2.1: Interview Schedule with key informants.

Proposed Adaptive Policy Tools	Tasks for Adaptive Policy Makers	Guiding Questions for the Discussion with the study key informants
1. Integrated and forward-looking analysis 2. Promoting variation	• Policy planning • Providing a range of policy options	• Does South African water resources management policy sufficiently cater for adaptive actions? • What is the feasibility of pre-planned policy options towards ensuring variation?
3. Multi-stakeholder deliberation 4. Enabling self-organisation and social networking 5. Decentralisation of decision-making	• Engaging stakeholders to ensure a comprehensive and adaptive policy • Institutionalising Catchment Management Agencies (CMAs)	• Is IWRM able to achieve multi-stakeholder deliberation for effective and inclusive policy management? • What are the challenges for the implementation of Catchment? Management Agencies (CMAs) • What is the role of the State in this regard?
6. Automatic policy adjustment	• Monitoring performance indicators to ensure automatic adaptive action	• Is it possible to invoke automatic adjustments for water resources policy management in the context of South Africa? • Would you say M&E in South Africa is suited to track water resource policy management given the complexity and uncertainty of the implementation conditions?
7. Formal review and continuous Learning	• Commissioning of water policy reviews e.g. 2013 Water Policy Review	• Does water resources management policy cater for such policy reviews? • What other conditions could trigger a review?

All interviews were conducted between August 2017 and February 2018, following an ethics approval from the Faculty of Science - Research Ethics Committee (see **Appendix 1**). The key informants were formally requested through e-mail to set-up a face-to-face interview appointment (see **Appendix 2**). Each interview was recorded for later transcription to facilitate the analysis. The interview data was managed and analysed manually (Neuman, 2011; Smith & Humphreys, 2006). The employment of manual methods of data management and analysis allowed for better insights through repeated handling of the data. For example, taking notes during the study interviews, transcribing and analysis the interviews' data. Key themes of meaning were extracted to further help provide holistic relationships between elements, concepts, and themes (Brink & Wood, 1998). The emerging themes were continuously refined to ensure that the data collected was well structured for analysis and reporting. Each of the emerging themes were labelled according to the emerging conceptual patterns and further analysed to establish the narrative presented in Chapter 6. The views of key informants were also contrasted with secondary data gathered through a literature survey.

2.2.3. **Research method 3:** Collaborative system analysis with stakeholders

One of the key components to help improve the understanding of a complex system, such as water resources management, is to engage multiple stakeholders involved in the management system and related systems such as agricultural development. This is commonly referred to as transdisciplinarity (Jahn et al., 2012; Lang et al., 2012; Tejada et al., 2019). Transdisciplinarity has gained recognition as an approach to address sustainable development challenges where the integration of various disciplines and stakeholders in the process of knowledge generation is essential (Tejada et al., 2019). Transdisciplinarity research is understood here as a reflexive research approach that investigates societal problems through multi-disciplinary and multi-sectorial collaboration that enables mutual learning processes and knowledge co-production (Jahn et al., 2012; Lang et al., 2012; Seidl et al., 2013; Tejada et al., 2019). Continuous interaction between science and society is necessary, especially in context of sustainable transitions that are based not only on scientific evidence but also normative assumptions and contextual values (Seidl et al., 2013). In such contexts, it is a justifiable approach to actively engage a broader multi-stakeholder discourse, which makes it possible for the research process to access relevant and multiple expertise, values, and interests from society (Seidl et al., 2013).

The argument here is that multi-disciplinary and multi-sectorial expertise together present enhanced capacity to comprehensively map a complex system, such as water resources management policy in South Africa. Subsequently, stakeholder research workshops were held as part of the study to facilitate the collaborative mapping of the different components of the water resources management system from macro to micro levels. The workshops hosted, as part of this research, employed a collaborative co-design approach with multi-disciplinary and multi-sectoral (public, private and civil society) stakeholders with expertise specifically in water resources management, natural resources management, agricultural research and development, environmental management, public policy management, monitoring and evaluation, international development as well as social and economic development.

A total of 55 experts and stakeholders participated in four research workshops on mapping South Africa's water resources policy management system held as part of this study. The first workshop was convened with six systems thinking researchers as part of the Southern African Systems Analysis Centre (SASAC) doctoral development support programme hosted at the University of the Western Cape. The second and third workshops were attended by 17 and 27 stakeholders respectively and were hosted in Pretoria (between November 2018 and September 2019). All the stakeholders voluntarily participated in the different research workshops following a formal invitation through e-mail (see **Appendix 3**). The fourth and final workshop was attended by five individuals who were identified based on their wider insight into the issues discussed during earlier workshops. In each workshop an opening presentation was made to establish a common understanding of the research study and to set clear objectives for discussions. Workshops included group discussions and break-away sessions, where stakeholders could engage more robustly on the research subject content (see **Appendix 4** for an example of the programme for one of the stakeholder workshops). **Table 2.2** presents a list of the different institutions that participated in the different research workshops.

Table 2.2: Institutions that participated in the research workshops.

Organisation	Discipline/Unit	Sector
Agricultural Research Council	• Agrometeorology • Water Science • Training and Advisory Services • Economic Analysis • Risk and planning	Research and Development
Human Sciences Research Council	• Africa Institute of South Africa (Systems research)	Research and Development
National Agricultural Marketing Council	• Markets and Economic Research Centre	Research and Development
Food Agriculture and Natural Resources Policy Analysis Network	• Climate Change Programme • Policy M&E • Policy research and advocacy	International Development Partner
Pegasys Consulting (Africa)	Water Programme	Private Consulting
Department of Agriculture, Forestry and Fisheries[2]	Irrigation engineering	Government
Gauteng Department of Agriculture and Rural Development	Agricultural Development and Food Security	Government
Department of Environmental Affairs[3]	Climate change	Government
Department of Water and Sanitation	Water resources policy planning, M&E	Government
University of KwaZulu Natal	Life Sciences/ Southern African Systems Analysis Centre	Higher Education/ Systems Research
Central University of Technology	Water Engineering/ Southern African Systems Analysis Centre	Higher Education/ Systems Research
University of Cape Town	Environmental and Geographical Science/ Southern African Systems Analysis Centre	Higher Education/ Systems Research
University of the Witwatersrand	Health Sciences/ Southern African Systems Analysis Centre	Higher Education/ Systems Research
University of Pretoria	Natural and Agricultural Sciences	Higher Education
University of Fort Hare	Science and Agriculture	Higher Education
North-West University	Natural and Agricultural Sciences	Higher Education
National Research Foundation	Strategy, Planning and Partnerships	Research and Development
Water Research Commission	Water Resources Management and Water Utilisation in Agriculture	Research and Development

[2] Department of Agriculture, Forestry and Fisheries (now Department of Agriculture, Land Reform and Rural Development since 2018).
[3] Department of Environmental Affairs (Now Department of Environment, Forestry and Fisheries since 2018).

The purpose of the research workshops was mainly to facilitate a thinking process to unpack the complexity of the interconnected variables that constitute the water resources management system. Although it was not always possible, the idea was to repeatedly convene the same group of stakeholders throughout the research process to allow for interactive learning and application of knowledge, as insights on the system improved, amongst the stakeholders and throughout the research workshops. The workshops were structured in a sequential manner, where the objectives of the follow-up workshops drew on the outputs of the previous workshops. Ultimately, the goal was to use the understanding gained through a representative mapping of the water resources policy management system to demonstrate key variables of interest in the comprehensive M&E of the system towards evidence-based policy management.

The first workshop was mainly a brainstorming exercise to help visualize a high-level overview of the water resources policy management system. The second and third workshops focused on the identification of the variables that drive the water resources management system, as well as other connected and interdependent systems such as socio-economic development, land-use, and agriculture. Stakeholder inputs were manually recorded and later used to develop a visual schematic of a management system model and the comprehensive co-designed evaluation framework. The visual presentation of data proved to be a critical aspect of the research, facilitating the communication of complex data and, most importantly, facilitating the discovery of critical system patterns and relationships that could otherwise be easily missed. As a result, the mapping of the water resources policy management system was conducted using the Elephant Builder platform[4], which allowed for the visualization of all the interactions between different variables involved in the system. The fourth research workshop was convened with a smaller focused group of stakeholders that concentrated on the validation of the output of the mapped water resources management system.

The value proposition for the utilisation of systems thinking in this research lies in the fact that it can help to structurally work through and understand the complexity of the interactions between numerous environmental, economic, socio-cultural and political systems pertinent to the water resources policy management. In systems thinking, it is generally acknowledged that everything affects everything else such that isolated and self-sustaining variables simply do not exist and this conceptualisation remains the foundational point of the argument throughout this thesis. Planning, implementing, monitoring and evaluating of the water resources management system as though it was an isolated independent system would be a misguided strategy with greater potential for water resources management policy failure. Thus, the argument for the inclusion of a systems thinking approach to water resources policy management particularly in the M&E process considerations is very necessary. In the context of multiple systems of interdependent and interconnected systems, even small changes in the interacting variables can stimulate highly improbable, unpredictable and unexpected reactions. The interactions of interdependent systems may produce emergent outcomes that are outside the realm of the preconceived intended policy outcomes. The challenge, presented by such systems, is that

[4] The Elephant Builder is a software application for collaborative stakeholder modelling of complex systems (see https://elephantbuilder.com/).

the interactions within a system, between systems, and among subsystems or parts within systems can be highly volatile, turbulent, and unpredictable. Importantly, the processes and outcomes of complex interactions cannot be determined in advance. In a context of systems thinking, the justifiable approach for effective evidence-based policy management would be one that acknowledges that water resources policy management efforts, no matter how seemingly perfect, are in practice continuously affected by variables outside the direct control of water resources policy managers and have greater potential for policy failure. Unfortunately, and indeed justifiable to some extent, is the question of what constitutes a fair boundary limit to the management of a complex system such as water resources management in South Africa. Therefore, this thesis argues for the development of a comprehensive M&E framework that is deliberate on how to deal with external policy influential variables, as part of a comprehensive policy planning and performance generation approach, that allows for sound evidence-based water resources policy management decisions, especially in the face of complexity and uncertainty.

CHAPTER 3 : CONCEPTUAL AND THEORETICAL FRAMEWORK

3.1. Introduction

This chapter presents the key concepts and theoretical framing of this study. Sustainable national **Water Security** and **Water Equity** are the ultimate goals for water resources management policy in South Africa and are thus defined as central elements pertaining to this research (DWA, 2013a; RSA, 1996; RSA, 1998). Furthermore, the study is framed from a perspective of supporting and improving the facilitation of **evidence-based policy management** as a promising approach to improve policy effectiveness and efficiency. In this regard, the study particularly considers **M&E** efforts as the means for the generation of policy design and performance evidence in support of sustainable water security and equitable access for all. The study further argues that challenges of **Uncertainty** could potentially affect the generation of reliable policy design and performance evidence upon which water resources policy management decisions are based. The investigation further acknowledges **Adaptive Policy Management** approaches as better suited to deal with the challenges of uncertainty and thus attempts to gain a better understanding of how such approaches could be successfully implemented in the context of South African water resources management policy. In this study, adaptive policy approaches are considered as an add-on to strengthen current **Integrated Water Resources Management** efforts in South Africa rather than as an independent alternative thus the concept of **Adaptive and Integrated Water Resources Policy Management.** Finally, aspects of **Systems Thinking** were utilised to help facilitate the collaborative and iterative analysis of the South

African water resources policy management system. The concepts highlighted in this chapter effectively informed the conceptual and theoretical framing of this study.

3.2. Water security and equity

Achieving water security for all remains one of the greatest challenges for South Africa. This is especially the case with regard to access to water for economic activities, resulting from the apartheid government's laws of structural exclusion for the majority of black South Africans (Cullis & van Koppen, 2007; DWAF, 1997; RSA, 1998; van Koppen & Schreiner, 2014). Grey and Sadoff (2007) define water security as the reliable availability and access to an acceptable quantity and quality of water for sustained social-welfare and economic activity, coupled with an acceptable level of water-related risks such as flooding, drought and water pollution.

The Global Water Partnership (GWP) further considers some aspects of environmental sustainability, social-welfare and vulnerability (risk exposure) as part of the water security definition. It defines water security as a state where every person has access to enough safe and affordable water to lead a clean, healthy and productive life, while ensuring natural and environmental protection and enhancement (Global Water Partnership [GWP], 2000). Water security outcomes are, therefore, generally framed against the basic elements of water resources management including availability; water-related hazards and vulnerability to those hazards; safety; access; affordability; human needs and health; environmental sustainability and economic development benefits (Cook & Bakker, 2012; Grey & Sadoff, 2007). Dickson et al. (2016) identify the following variables as relevant to help frame water security from a local perspective:

- **Water resources:** the natural raw water resources available to the community,
- **Environment:** the mutually dependent relationship between water and the natural environment,
- **Water delivery system:** the infrastructure through which water is protected, and through which water and the resulting wastewater are collected, transported, treated, and managed,
- **Community capacity and capital:** human skills and resources within, and external to, a community that are available for sustainable water security,
- **Access and equity:** the ability for current and future water users to access sufficient resources for (social, economic and environmental benefits.), and;
- **Health and wellbeing:** household access to good quality water and knowledge and behaviours related to water and health.

These definitions of water security offer a comprehensive picture that is helpful to determine sustainable access to water resources for social, environmental and economic activities (Cook & Bakker, 2012). Indeed, while a greater part of water security challenges relates to natural/ environmental variables (i.e. water availability and risks associated with the resource, such as rainfall and related extremes like flooding and drought), there are key aspects of water security that are dependent on the intentionality of water resources policy management decisions to address foundational water security issues such as water storage infrastructure and equitable access. While economic and social access to water resources could be understood as aspects of water security and equity outcomes, these activities also pose a risk to water security because they have the potential to severely impact the availability and quality of water resources, due to over-utilisation as well as direct and diffuse pollution (Muller et al., 2009). Albeit 26 years into a democratic South Africa, access inequality and limited equity in the access and utilisation benefits of water resources remain some of the major challenges for current water resources policy management efforts. A great number of these challenges stem from the era of structural discriminatory policies during the colonial and apartheid administration (Mwendera & Atyosi, 2018). Water resources are central for sustainable development, therefore successes in the sector have considerable multiplier effects across other sectors in South Africa, including improvements in health, education, energy and food security, poverty alleviation, improved human wellbeing and the economy at large (Dickson et al., 2016, GWP, 2000; Siwar & Ahmed, 2014; Varady et al., 2016). Consequently, this study aims to contribute to the acceleration of water resources management policy effectiveness towards water security for all through comprehensive and credible evidence-based adaptive and integrated water resources policy management strategies.

3.3. Uncertainty

The future cannot be completely known before it unfolds, which makes uncertainty an eminent challenge that must be managed rather than avoided (Walker et al., 2010). In this thesis, uncertainty is understood as the incalculable and uncontrollable issues, which especially affect public policy issues where no specific level of probability can be attached (Morgan et al., 1992; Quade & Carter, 1989). Uncertainty is broadly defined as the gap between available knowledge and the knowledge that policy makers need to inform specific decisions or value judgements about a particular policy (Head & Alford, 2015; Swanson et al., 2009; Walker et al., 2013). Importantly, for this study, uncertainty and complexity imply a greater possibility that not all the outcomes of different policy processes can be fully controllable. The outcome of policy planning tools such as Theories of Change (ToCs) or logical frameworks must therefore fully acknowledge that what was planned and expected may be totally erroneous. A ToC in this regard is understood to be the hypotheses which are the basis for programme design, implementation and evaluation (Weiss, 1997). According to Rogers (2013), ideally these have two components, a theory on the causal mechanism, which explains how change occurs, and a theory on the action, which explains how the programme activities trigger specific change processes. Uncertainty however is not simply the absence of knowledge. There are numerous other policy management conditions that resemble a state of uncertainty, including cases where available information exhibits some level of inexactness and/or unreliability characteristics (Funtowicz & Ravetz, 1990). For example, more knowledge could alert policy makers to the fact that their understanding is more limited than could have been initially assumed (Walker et al., 2003). Hence, reducing or addressing uncertainty is not simply a matter of strengthening research evidence.

3.4. Adaptive and Integrated Water Resources Management (AIWRM)

Current water resources policy management in South Africa is synonymous with the concept of Integrated Water Resources Management (IWRM) as the policy governance approach. According to van Koppen and Schreiner (2014) however, the IWRM dialogue in

South Africa continues to happen without sufficient representation of poor community users. Even in cases where such poor communities are included, often, they are considered equity partners only for basic water and sanitation services, rather than as economic and productive users of the resource (van Koppen & Schreiner, 2014). Summarily, van Koppen and Schreiner's (2014) argue that the biggest losers in the South African IWRM governance efforts in South Africa are therefore the poor, a majority of which are black South Africans mostly living in rural areas. In this regard, unless there is equitable access and ultimately equality, it is the overreliance on the very principles of IWRM (i.e. integrated land- and water-use planning; cross-sectoral cooperation; environmental sustainability; economic efficiency; social equity; and stakeholder participation) that may limit the country's progress towards efficient national water resources management policy.

There is a need to ensure the sustainability of the success and principles of the IWRM principles through the prioritisation and operationalisation of equitable socio-economic and developmental access to the water resource in South Africa. Through the introduction of adaptive policy management approaches as an added layer of water governance to current water resources management efforts, Engle et al. (2011) argue that it might be possible to address the gaps presented by IWRM in its current form. Over and above the current Integrated Water Resources Management (IWRM) policy governance approach to water resources, the introduction of adaptive policy management could potentially increase the changes for efficient policy performance on the technical and social perspectives. Importantly, Engle et al. (2011) asserts that, when combined, IWRM and adaptive policy management potentially hold greater potential to:

- ensuring that the water resources policy management process is intentional about dealing with uncertainty rather that treated as an externality;
- promoting flexibility and adaptability through experimentation and learning;
- increasing policy effectiveness and efficiency by integrating learning across different interdependent and interconnected environmental, economic, socio-cultural and political systems;
- adding legitimacy and promoting public policy acceptance through increased stakeholder participation, cooperation, decentralisation, and democratic decision making, and;
- incorporating different technical expertise into the policy making process by including different forms of knowledge and promotion of social learning.

In **Figure 3.1**, Engle et al. (2011) provide a very useful illustration of the value offered by IWRM and Adaptive Policy Management. Additionally, **Figure 3.1** also illustrates how combining adaptive policy management and IWRM could help water resources policy management processes to benefit from the combined potential value offered by the two approaches to effective and efficient water resources policy management.

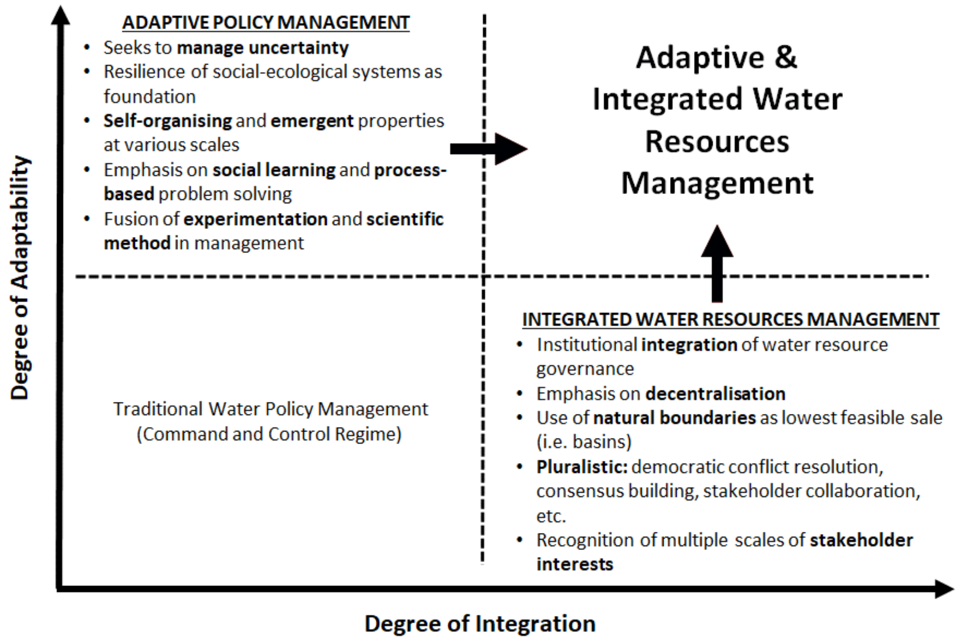


Figure 3.1: Embedding adaptive policy management approaches on integrated water resources management principles (Source: Engle et al., 2011).

AIWRM is therefore a concept built out of the combination of IWRM and Adaptive Policy Management as presented below:

- ***Integrated Water Resources Management (IWRM)***

Traditionally the challenges to water resources management were essentially financial, related to funding for the construction of water infrastructure and dams (Turton et al., 2007). In recent times, however, water scarcity challenges, driven by conflicting water demands of population growth, urbanisation, higher living standards and economic development especially for sectors such as agriculture, mining and industrial development, meant the need for a shift towards an integrated approach to water resources management, where the different stakeholders involved can manage the resources collaboratively (Blomquist et al., 2004;

Colebatch, 2006). Importantly, this shift dictated the need for an integrated approach that prioritised both demand and supply issues, while taking into consideration watercourses and land use, the hydrological cycle, as well as the economic development, institutions and social interactions in pursuit of equitable access and resource sustainability (GWP, 2017). In this regard, the GWP (2001) defines IWRM as a process aimed at promoting the coordinated development and management of water, land and related resources, in order to maximize equitable socio-economic benefits without compromising the sustainability of vital ecosystems (see **Figure *3.2*:**). Effectively, IWRM is not an end in itself but rather the means to an end (GWP, 2001, 2017). Consequently, water resources policy managers are not in pursuit of a management approach, such as that of IWRM, but an effective way to ensure that their management efforts yield the intended policy goals. As such, the IWRM should not be treated as a panacea for water resources management problems. Rather it should be seen as an approach that bears greater potential to manage the complexity represented by the interconnectedness of ecological, economic efficiency and social equity issues towards sustainability, which can be regarded as the ultimate policy outcomes, yet with different emphasis depending on the context (GWP, 2001).

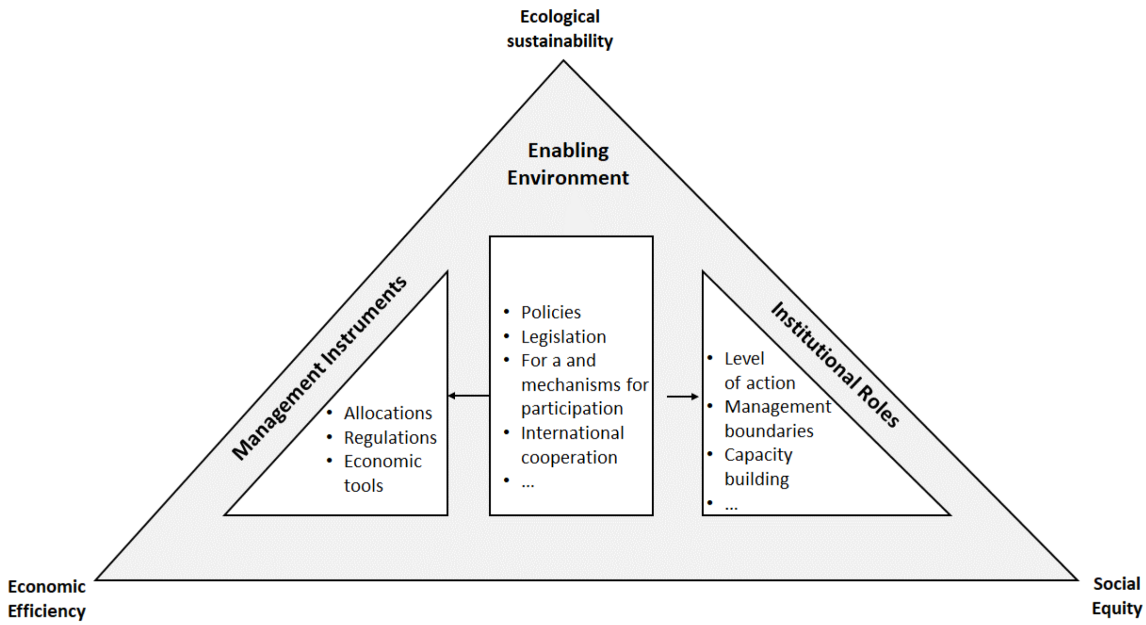


Figure 3.2: General framework for IWRM (Source: adapted from GWP, 2001).

IWRM effectively provides the principles of integrated land- and water-use planning; cross-sectoral cooperation; environmental sustainability; economic efficiency; social equity and stakeholder participation that should be at the centre of water resources management (GWP, 2017). Importantly, the principles of IWRM call for the development of networked institutional policy governance structures, which are cognisant of the interdependent nature of different uses and users of water resources and, in consequence, the need for collaborative water governance. In practice, the effectiveness of IWRM can only be realised through continued and effective stakeholder participation structures. Unfortunately, the participation of stakeholders in the South African IWRM structures remains extremely poor and inconsistent. This challenge could potentially be improved through the legislation of IWRM institutions, rather than be left to socially constituted networks of the affected parties. In this way the power dynamics between stakeholders can be formally regulated for the benefit of the policy management task and the benefits thereof.

- ***Adaptive policy management***

Adaptive policy management is introduced in this study as an extra management layer that could be considered, in addition to current IWRM, for improved management efficiency in the face of uncertainty and complexity. All policies face multiple risks related to a number of environmental, economic, political and socio-cultural factors that may jeopardise their success. Some policies face risks and challenges that cannot be anticipated and are, for that reason, at significant risk of failure or unintended outcomes (Head & Alford, 2015; National Research Council [NRC], 2004; Patton, 2011; Taleb, 2007). Climate variability, climate change, population growth, migration, economic growth, pollution, urbanisation, environmental degradation, food demand, etc. are some of the key emergent drivers with greater potential risk for water resources management policy failure (Head, 2008; Head & Alford, 2015; Kwakkel, Walker, Haasnoot, 2016; Lach et al., 2005; Williams & van't Hof, 2016). These challenges are typical of water resources policy management in South Africa. Swanson et al. (2009), argue that the future is contingent and therefore cannot totally escape liability of error in judgement, which is characteristic of all anticipation of probabilities. There are numerous strategies to identify, calculate and reduce quantifiable uncertainties through probabilistic measurements. These strategies tend to be better suited to address known uncertainty, and therefore struggle to comprehensively deal with uncertainty

(Bankes, 2002) or what has been described by Walker et al. (2003) as the ‘unknown unknowns’, which is arguably the case with wicked policy problems.

Unfortunately, today most environmental and socio-economic public policy problems involve complex and rapidly changing conditions, for which classical approaches of predictive modeling and optimization may be limited (Bankes, 2002). A great part of the challenge presented by uncertainty and complexity is the unpredictability of the performance dynamics, and the emerging outcomes that may go beyond and outside what was intended. Unintended outcomes imply that systems change in these conditions may not follow a linear logic, so that uncontrollable performance cannot be simply reduced to a programme’s Theory of Change (ToC) but must rather be intentionally managed. Employing adaptive management approaches is basically an admission by policy makers and evaluators that anything is possible, and in order to facilitate effectiveness and efficiency, the policy management process must be structured to readily embrace the change and navigate through to the policy target, using routes that could have never been conceived or foreseen at the policy formative stages.

The challenge of uncertainty in policy management does not excuse public policy makers from the responsibility of making reliable and effective decisions. Instead, policy makers must still endeavour to successfully manage complex public policies in the face of uncertainty. This is a difficult task, especially in the absence of comprehensive, reliable and credible knowledge about the future. Adaptive policy management approaches were therefore born out of a recognition that traditional policies lack the prerequisite flexibility and robustness that is required to ensure effective policy performance under rapidly changing and highly uncertain policy management conditions (Kwakkel, Haasnoot, & Walker, 2016; Lach et al., 2005; Rittel & Webber, 1973; Williams & van't Hof, 2016). Robustness, in this regard, relates to the capacity to perform according to plan under a wide variety of futures, while adaptive relates to exhibiting sufficient flexibility to respond/address (unforeseen) future conditions over time (Walker et al., 2013).

According to the World Water Assessment Programme (World Water Assessment Programme [WWAP], 2012),

> Adaptive management strategies allow changing course based on new insights, help establish and sustain institutional settings and technological systems that are flexible and error-tolerant, and offer a frame-work for transparent decision-making processes. (P. 15)

The WWAP assertions require greater emphasis on learning. Pollard and du Toit (2008), further argue that the effective management of complex water resources requires iterative learning-by-doing approaches, which are not only reflexive in nature, but are also committed to continuous learning to facilitate real-time, evidence-based decisions. Adaptive management approaches that demonstrate a great degree of flexibility allow for necessary policy adjustments, as outcomes from past management actions become better understood (Allen & Gunderson, 2011; Walker et al., 2013). According to Swanson et al. (2010) adaptive policies are designed to function effectively under uncertain, complex, and dynamic conditions and consequently demonstrate the necessary robustness to better anticipate an array of conditions. In interdependent and interconnectedness systems, as is the case for water resources management, change must be anticipated rather than predicted. In this way adaptive management approaches might be better suited to facilitate effective and efficient management decisions. In highly volatile, turbulent, rapidly changing and highly unpredictable management conditions, policy makers must expect changes beyond their prediction, and be ready to improve policies as more information becomes available.

Adaptive decisions, however, are not necessarily quick fixes that can work in all such uncertain and highly variable conditions. In water resources management, for instance, there are certainly some elements such as infrastructure development that are bound by time and money, such that benefits or impact may only be realised in the medium to long-term. There could also be strategic adaptive decisions that may demonstrate short-term gains such as water allocation or water use limitations such as agricultural irrigation systems in a particular area. In practice, adaptive policy management includes a range of adaptive measures that could be classified in terms of their temporal scale (e.g. short or long-term); their spatial scope (e.g. localised or widespread); and the timing of the actions (i.e. anticipatory, concurrent or reactive to a system change) (Walker et al., 2013). The application of such adaptive policy measures would generally be guided by the challenges present in the policy problem at hand, as well as the nature of the emergent and uncertain variables. While anticipatory adaptation has far reaching advantages, to minimize negative policy impact not all adaptive policy measures can successfully anticipate policy performance challenges: for instance, emerging from uncertainties and other complex system performance models. As a result, adaptive policy should also demonstrate appropriate concurrent or reactive actions. While temporal, spatial and timing of an action relate to the change in the system, the temporal and spatial scopes also relate to the desired state of the system and are useful for policy makers.

Overall, Engle et al. (2011) go on to argue that, individually, the IWRM or adaptive policy management may not be sufficient to achieve the combined benefits that could be potentially offered by simultaneously employing IWRM and Adaptive Policy Management to manage water resources management policy in South Africa. Admittedly, as also noted by Allen and Gunderson (2011), adaptive policy management may not be a panacea for policy effectiveness and efficiency in all public policy management contexts. However, as an embedded management strategy over and above current IWRM, this combined approach could prove extremely helpful to water managers. An adaptive policy management approach, or elements thereof, could be extremely helpful to ensure policy flexibility and real-time adaptability over and above current integrated efforts to managing the resource.

3.5. Evidence-based policy management

It is important to first establish a common understanding of the concept of 'public policy' before endeavouring to define evidence-based policy management. According to de Coning & Wissink (2018), public policy can be simply defined as 'a statement of intent', meaning both formally adopted white papers, regulations and acts as well as adopted strategies, programmes and action plans of the State and its organs. Owen (2007) asserts that policies can be considered as the most pervasive form of social intervention. The development goals of the State are often expressed as intangible, long-term outcomes of what the State wishes to achieve or change in society. Such goals are then translated into actionable policies, programmes and projects with more tangible outputs and outcomes (Rabie, 2011). The public policy management process is therefore about managing the policies, programmes and projects of the State towards achieving the intended policy outcomes. As presented in **Figure *3.3***, public policy management can also be understood as a comprehensive step-by-step process of agenda setting, policy formulation, policy adoption, policy implementation and policy assessment towards the efficient management of government's task to deliver public goods and services in a sustainable and equitable manner (Dunn, 2008; Gumede, 2011).

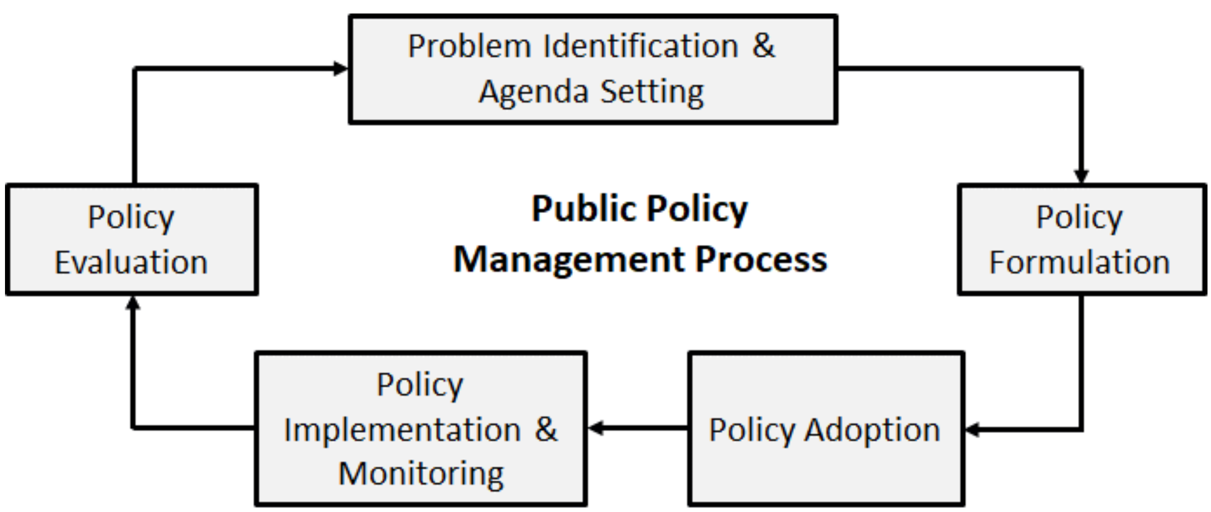


Figure 3.3: Public policy management process (Source: adapted from Gumede, 2011).

While the public policy stages are a straight forward and logical part of the theoretical definition, in practice, the public policy management process tends to be complex (Gumede, 2011). In many cases, policy managers employ a balance of different approaches as dictated by social, economic and political circumstances (Gumede, 2011). For example, Gumede (2011) notes that in most cases the 'agenda setting' is often informed by the political imperatives of the time, which may imply that certain stages such as consultations, or the involvement of stakeholders, may not occur in the theoretically determined process of policymaking. For the purposes of this study, the interest is mainly on the policy design/ formulation, as well as policy implementation, which requires the generation of credible and reliable evidence to guide related policy decisions. The study is based on the premise that the water resources management policy objectives are set to facilitate the pursuit of water security towards equitable and sustainable water access for all.

According to Rabie (2011), evidence-based policy making is a process aimed at improving the performance of organisations, policies and programmes by putting the accurate measurement of progress and results at the centre of policy management and decisions. This definition shows the central role that policy M&E plays in evidence-based policy management. Davies (2004) defines evidence-based policy making as an approach that helps policy makers to make well-informed decisions, by putting the best available evidence from research at the heart of policy development and implementation. Davies (2004) asserts that evidence-based policy making is a rigorous policy development approach that gathers, critically appraises and uses high-quality research evidence to inform policy decisions. Both definitions by Rabie (2011) and Davies (2004) bring up the idea that evidence can be accurate. However, in practice, and especially for policies plagued with uncertainty, the best and most accurate approach is debatable, as there are many variables at play that could render such evidence poor, ill-timed or simply unreliable.

Evidence-based approaches in policy making advocate for policy development decisions reliant on relevant evidence. In practice, this is not always possible. Cloete (2018) as also argued by Davies (2004), assert that often there are numerous other dynamics that prevail for a decision to be made. Politics for example may distort the rationality of decision-making by bringing in some populism element, which may or not be evidence-informed by evidence (Cloete, 2018). Moreover, while research evidence can indeed be of high technical quality, it is not the only factor in the decision-making process. As presented in **Figure *3.4***:, the evidence-based policy making process, in practice, tends to integrate experience, expertise, judgement, resources, advocacy, values, etc. with the best available external evidence from systematic research (Davies, 2004). **Figure *3.4***: shows a graphical representation of the features that influence the evidence-based policy making process.

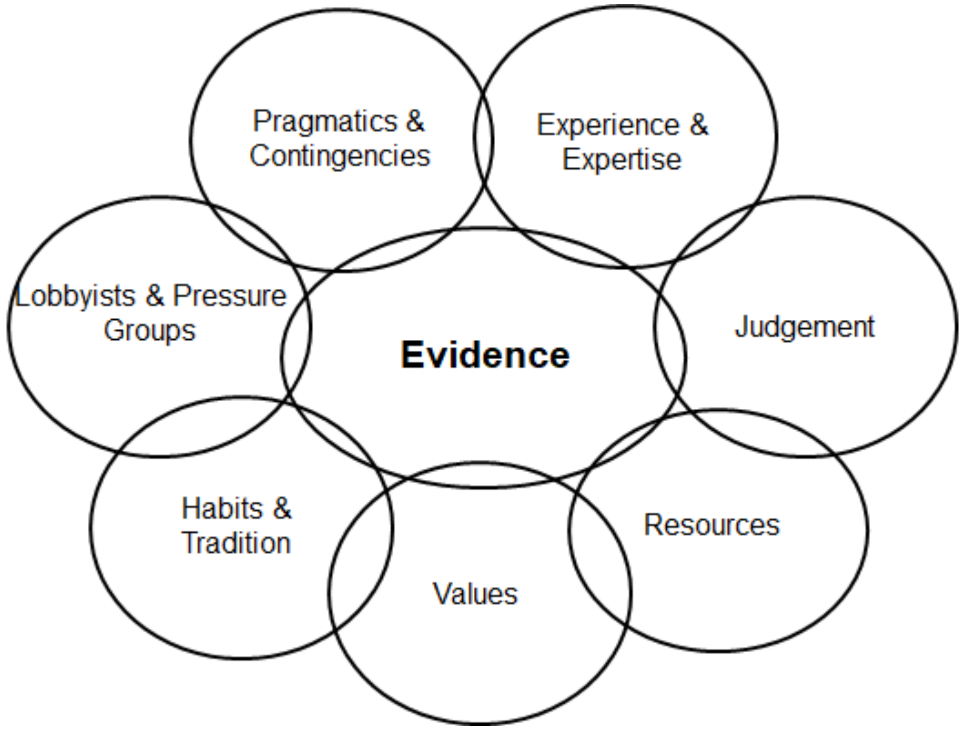


Figure 3.4: Factors influencing policy making in government (Source: Davies, 2004).

Davies' (2004), work as presented in **Figure 3.4** is the most relevant on the subject. Importantly, most the facts highlighted by Davies that could influence such the science and policy interface. Furthermore, acknowledging and integrating the different factors that influence the government policy decision-making process, as presented in **Figure *3.4***:, could help determine and clarify the practical policy targets related to what works at what costs and with what potential outcomes in a specific context, rather than generally. Appropriately designed and implemented evaluation research plays an invaluable role in the generation of reliable and credible evidence. Within the context of this study, it is argued that the policy evaluation process could be improved and leveraged for better and more comprehensive evidence generation, even in a context of uncertainty and complexity.

Moreover, in this study, public policy is further framed within the context of developmental policy management that is defined as policies that are geared to ensure that people are empowered to exercise their social and economic choices (Sen, 1999). This is contextually key for South Africa, where high levels of unemployment, poverty and food insecurity exist, and noticeably so for water management as a resource central to economic growth and social welfare of individual households. In a context where there are more social and economic public problems, the State is a key partner in the developmental agenda of the country's basic services (such as the right to food, water, education, etc.).

3.6. Evaluation

Rossi, Lipsey, and Freeman (2004) define program evaluation as "the use of social research methods to systematically investigate the effectiveness of social intervention programs in ways that are adapted to their political and organisational environments and are designed to inform social action to improve social conditions" (p. 16). A good evaluation must then be adapted to the contextual circumstances, while yielding useful answers to the questions that motivate it. As argued by Patton (2002; 1985), evaluation research refers to the very practical endeavour of evaluating and assessing programme processes and impact. Patton (1985) goes on to indicate that:

> The practice of evaluation involves the systematic collection of information about the activities, characteristics, and outcomes of programs, personnel, and products for use by specific people to reduce uncertainties, improve effectiveness, and make decisions with regard to what those programs, personnel, or products are doing and affecting. (p.1)

Within the policy evaluation context, at least two investigatory activities may be applied, namely policy analysis and policy research. In this regard, policy analysis refers to the policy development process including the alternative options available as well as the assumptions upon which decisions are made (Owen, 2007). While policy research, is concerned with determining policy impact in order to inform further policy decisions (Owen, 2007), policy evaluation refers to the evaluation of alternative public policies, particularly in terms of their individual ability to produce specific stated outcomes, as well the comparison between policies to determine which policies result in more desirable outcomes in relation to effectiveness, efficiency and peripheral consequences (Rabie, 2011).

The concept of results-based M&E could play a great role in the development of efficient and effective policies by helping to track progress and demonstrate impact (Kusek & Rist 2004). According to Kusek and Rist (2004) results-based M&E effectively aims to answer questions related to programme outcomes. They further seek to provide credible evidence regarding a programme's contribution and where and how potential design and management improvements could be made (Chen & Rossi, 1983). This is achieved by ensuring the generation of credible and reliable evidence to guide decisions. It becomes apparent that evidence-based policy making strongly relies on the continuous generation of quality, trustworthy and timely evidence that can inform policy and management decisions. Yet, it must be acknowledged that the generation of such credible and comprehensive policy management evidence is a challenging task in contexts where the perceived policy performance logic may potentially be illogical, as argued in this study.

Evaluation should not only provide relevant evidence for retrospective learning but also for conceptualisation and design of social intervention programmes. Policy evaluation is also relevant for the evaluation of alternative public policies, particularly in terms of their individual ability to produce specific stated outcomes. Furthermore, a comparison between policies to determine which result is more desirable in relation to effectiveness, efficiency and peripheral consequences is critical (Rabie, 2011). This implies four types of evaluation being relevant at different stages of water resources policy management. According to Mouton (2014) there four main types of evaluations including clarificatory evaluation, process or implementation evaluations, outcome evaluations and impact evaluations. These specific evaluation types may be applied at different stages of a policy intervention's life cycle to address specific evaluation criteria, from conceptualization, design, implementation monitoring, as well as outcome and impact evaluation stages (**Table 3.1**).

Table 3.1: Intervention dimensions, evaluation criteria and evaluation types (Source: Mouton, 2014).

<table>
<tr><th>Intervention Dimension</th><th>Evaluation criteria</th><th>Evaluation design type</th><th>Classification</th></tr>
<tr><td>Conceptualisation</td><td>Clarity of programme goals and objectives
Logical consistency between programme objectives and programme activities (horizontal alignment in the logic model)
Logical coherence of different levels of programme activities, outputs and outcomes (vertical alignment in the logic model)</td><td rowspan="2">Clarificatory evaluations</td><td rowspan="3">Formative</td></tr>
<tr><td>Design</td><td>Appropriateness of the intervention given the target group needs and expectations
Feasibility of the design (given resource constraints)</td></tr>
<tr><td>Implementation (Delivery)</td><td>Appropriateness of implementation (Was the programme implemented as designed and planned?)
Adequate coverage of the programme (Did all the intended beneficiaries receive the intervention)
Sufficient dosage (Did the intended beneficiaries receive the minimum ‘dosage’ of the intervention as intended?)
Standardisation of delivery – Was the programme implemented in the same way across multiple sites?</td><td>Process/ implementation evaluations (including programme monitoring)</td></tr>
<tr><td>Outcome</td><td>Effectiveness of programme (Were the desired outcomes achieved?)
(Cost-)Efficiency of outcomes (Value for money criterion)</td><td>Outcome evaluations</td><td rowspan="2">Summative</td></tr>
<tr><td>Impact</td><td>Impact of the programme (Was the desired and expected impact achieved?)
Sustainability of programme impact</td><td>Impact evaluations</td></tr>
</table>

Evaluations can be further classified into two types, formative (looking at the quality of design and implementation) or summative (focusing on the end-products of programme implementation) (Görgens & Kusek, 2009). It must be noted that formative evaluations may, in some cases, have summative implications for a policy or programme and vice versa (Görgens & Kusek, 2009). Formative evaluations are those designed with a specific purpose to inform programme design for improvement, while summative evaluations are meant to inform decisions to continue or terminate a programme. This thesis takes a particular interest in the formative evaluations. It is argued that evidence-based water resources policy management efforts could benefit largely from formative evaluations tailored to intentionally facilitate the generation of comprehensive policy planning and management evidence. Comprehensive planning effectively sets the base for evaluation and evidence credibility. If the planning is incorrectly positioned, the entire programme M&E process could be misguided. Programme performance evidence is framed against the plan and how that plan unfolds in practice. Therefore, if the plan is not logical in practice or considerate of multiple disruption points, even when seemingly sound, the generated evidence to inform potential design and management improvements could simply be inaccurate.

3.7. Systems thinking and complexity

Systems' thinking seeks to understand the complexity that emerges from the interactions of environmental, economic, socio-cultural and political systems from a holistic rather than a reductive perspective (Skyttner, 2005). The analysis of complex systems takes a particular interest in understanding interactions within and between systematic variables, as well as how the main system of interest interacts with external environmental, economic, socio-cultural and political variables that influence the interactive outcomes (Patton, 2011). Systems thinking can be applied as a ‘hard’ scientific approach in such areas as systems engineering and systems analysis or operations research (Edwards et al., 2007; Song, 2012). The utilisation of a ‘hard’ scientific approach tends to offer limited value to the challenges typically presented by wicked public problems, such as water resources management. This is precisely because, in such policy management cases, there are often major disagreements about the very definition of the potential problems especially as precedence offers limited lessons for the future (Head & Alford, 2015; Lach et al., 2005; Rittel & Webber, 1973; Williams & van't Hof, 2016). Here, ‘soft’ systems thinking approaches are warranted because they demonstrate an appreciation of a ‘chaotic’ policy environment. Considering the multi-dimensional characteristics of the water resources management system, both ‘hard’ and ‘soft’ approaches to systems thinking are indeed applicable. However, in the context of this study, which focuses on improving the aspects of water resources management, while acknowledging uncertainty and complexity, has chosen to employ ‘soft’ approaches to systems thinking (Song, 2012). In **Figure *3.5*Error! Reference source not found.**, the configuration of the fundamental characteristics of systems-oriented thinking in a hierarchy of systems is demonstrated by Song (2012).

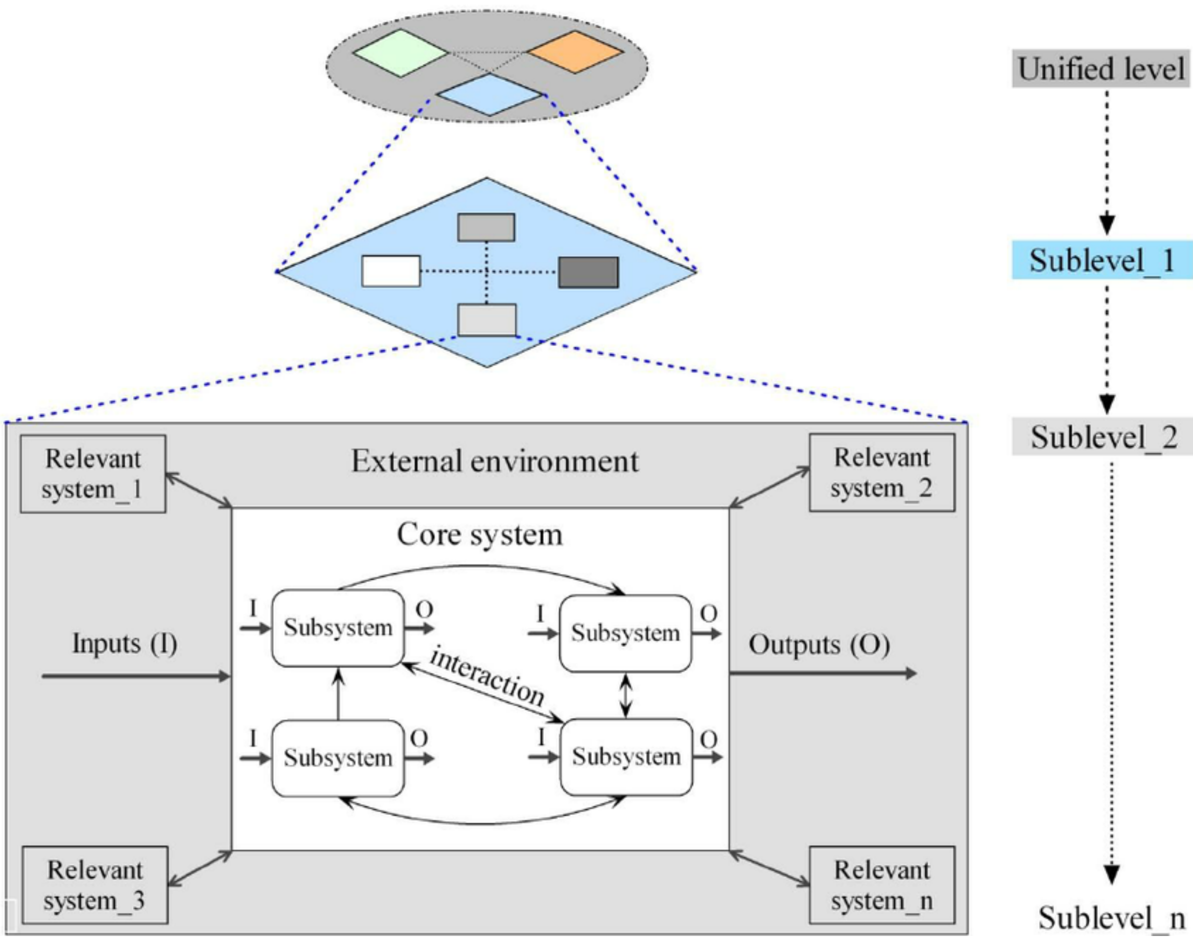


Figure 3.5: A schematic model of thinking in a hierarchy of systems (Source: Song: 2012).

Figure *3.5* highlights the different levels from which a problem could be regarded in relation to a systems perspective. Importantly, the more deeply one goes the more complex the system becomes. While analysing a system at the high level may be tempting, improved solutions could be better generated through a detailed understanding of the system. Importantly, although there is a core system of interest, such a system also has subsystems that interact as part of that particular core system. Additionally, and of interest to this study, is how the core system of interest *i.e.* water resources policy management in South Africa, connects and interacts with other related systems. Complexity in the application of systems thinking effectively emerges from the amount of information required to holistically describe the linkages and feedback loops of any vital system (Alcamo, 2015). Importantly, the mapping outcome of environmental, economic, socio-cultural and political systems could demonstrate major differences, depending on the perspectives of different individuals. As such, the application of systems thinking dictates the need for multiple stakeholders and expert collaboration as a validation process to help unpack both internal and external connections to the system (Song, 2012).

Systems thinking helps to think about a holistic system rather than in parts, thereby showing how the parts connect and interact and with what potential outcomes overall (Alcamo, 2015). In its application for mapping complex systems, systems' thinking makes it possible to visualise the system as a whole and therefore to identify key linkages that help to identify key drivers, system pressures as well as leverage or vulnerable points of the system. Complex environmental, economic, socio-cultural and political systems, such as water resources management, could effectively balloon the complexity through the multiple linkages, connections and interdependencies that emerge. According to Alcamo (2015), understanding the system linkages could effectively help to facilitate a better understanding of the system and therefore the identification of potential solutions to a problem. The value of systems thinking is that it allows for the identification of the critical linkages (strong connectedness and sensitivity between different parts of a system) that determine the behaviour of the system. As such instead of comprehending how all the linkages work in the whole system, it rather focuses on a smaller number of critical linkages that determine system performance (Alcamo, 2015). In the context of the study, systems thinking helps to facilitate the identification and to prioritize key variables that drive the water researches management system and therefore, by implication, the need for comprehensive M&E of these variables, whether internal of external, to the core system of interest. Here it is argued that the ‘soft’ systems-oriented approach to water resources management research could be helpful to facilitate a structural and comprehensive way for understanding the emerging complexity and uncertainty of the water resources management system in South Africa. In this manner, it might lead towards an equally improved understanding of the variables that could be targeted in a comprehensive M&E framework aimed to improve evidence-based policy management efforts.

Systems’ thinking is effectively a paradigm with which to look at reality and how complex problems could be analysed and solved (Kim, 1999). Systems’ thinking seeks to establish an improved appreciation of the complexities presented by persistent public problems, which may very well give rise to further complexities (Brent, Simelane & Clifford-Holmes, 2018). As asserted by Meadows (2009), systems thinking can help to establish key causal patterns of behaviour over time that allow for an understanding of the underlying structures that determine certain patterns of behaviour. These patterns are often non-linear and non-reductionist due to high levels of interconnectedness and interdependencies (Brent, Simelane & Clifford-Holmes, 2018; Kim, 1999; Meadows, 2009). Merely establishing the different system variables and their causal relations, however, does not translate to knowing the potential performance behaviour of the system (Meadows, 2009). This is especially valid since a system’s behaviour is rather the sum of its parts, such that a simple understanding of the different variables that constitute the system is not helpful any more than understanding the behaviour of the system as a whole (Meadows, 2009; Kim, 1999). Furthermore, according to Meadows (2009), a system may often exhibit some adaptive, dynamic, goal-seeking, self-preserving, and evolutionary behaviour, indicative that the behaviour of a system is bound to evolve with time and context.

3.8. Conclusion

As represented by the top box in **Figure *3.6*:**, the ultimate goal highlighted for water resources policy management in South Africa is the pursuit of equitable and sustainable access to water resources for all in an effort to achieve water security and equity. This policy aspiration implies that water resources policy management success would effectively manifest in different areas of the national developmental agenda in South Africa including environmental, economic, socio-cultural and political systems. These systems, however, also interact with the water resources policy management system to influence specific policy outcomes. For instance, taxes raised through a thriving economy make it possible to construct and maintain water storage infrastructure. In turn, water availability through increased storage capacity makes it possible for the economy to thrive. Yet, the influence of these interactions on policy outcomes is not always predictable. A good example here is water utilisation in the agricultural sector, where the outcome of increased food production through irrigated agriculture may not necessarily imply increased food security when food is traded internationally. Economic inequality also makes it difficult to access certain types of food for the poor. As South Africa shares almost all of its water courses with neighbouring countries (e.g. Botswana, Mozambique, Namibia, Lesotho, Eswatini and Zimbabwe), there are international political obligations and complexities that have competing needs for water resources. Therefore, the intra – and inter-systems interactions represent highly unpredictable outcomes and increase the level of uncertainty for policy management. **Figure *3.6*:** goes on to illustrate how the conceptual and theoretical framework applied in this study is systematically connected to guide the study.

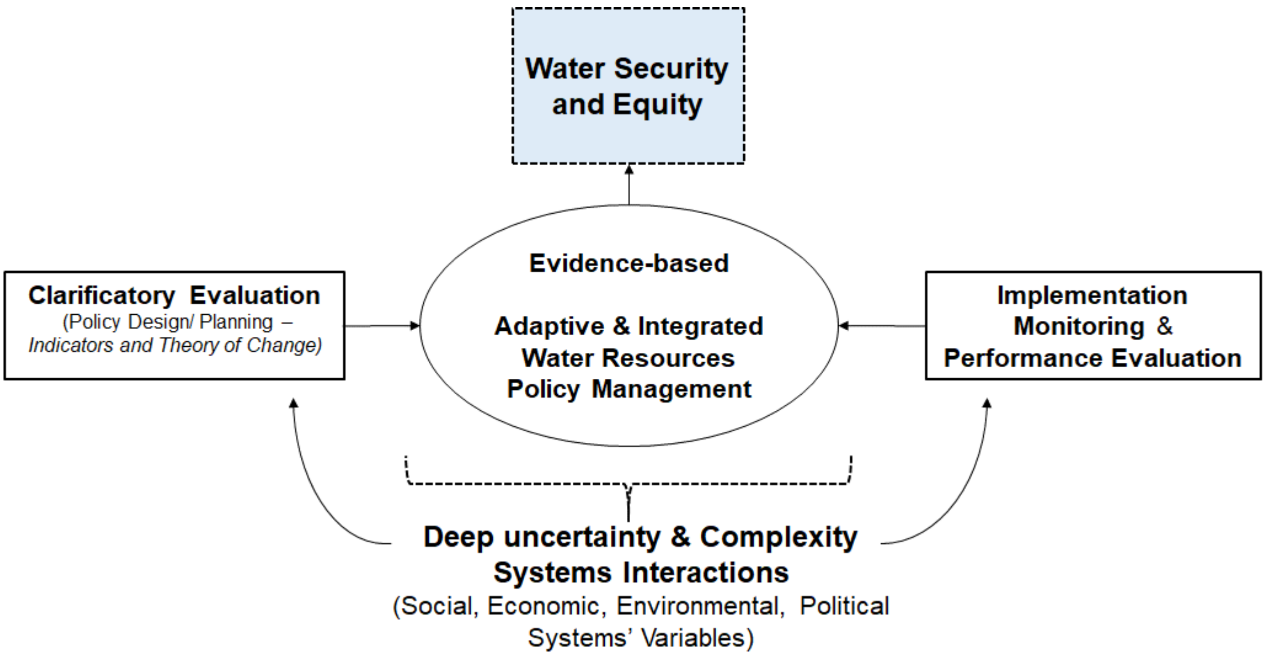


Figure 3.6: Conceptual and theoretical framework application for this study.

Achieving water security and equity in the context of deep uncertainty and complexity requires a step-wise and iterative approach in support of evidence-based AIWRM through a combination of policy design/planning and implementation monitoring and performance evaluation. In such a context, the question of what information is relevant, comprehensive and sufficient immediately becomes relevant. The later parts of this thesis attempts to contextually address these issues as informed by different water resources policy management experts through interviews with the study key informants and multiple research workshops with stakeholders (see chapters 6 and 7). In a context of limited resources and great public problems, policy management actions must demonstrate a high level of effectiveness and efficiency. Therefore, the concept of evidence-based policy management makes it possible to ensure that policy decisions are based on credible evidence and that they hold greater potential to work as intended and efficiently. There are two levels where evidence is deemed essential in this case, 1) Policy planning and 2) Policy performance monitoring and improving. This relates to the concepts of clarificatory evaluation and implementation or monitoring evaluation as the formative types of evaluations. The reliability of the policy intervention design would be determined by the credibility and comprehensiveness of the evidence utilised to inform the process. Equally, the credibility and comprehensiveness of the evidence generated to help understand the performance dynamics of the policy intervention, becomes of extreme relevance in guiding evidence-based adaptive and integrated water resources policy management decisions. The problems addressed in this thesis include helping to improve both the policy planning and monitoring evidence by identifying a list of variables that must be considered in the policy planning and monitoring evaluation activities. In this way, the evidence generated will thus be more comprehensive and a step closer to being credible for evidence-based adaptive and integrated water resources policy management.

CHAPTER 4 : HISTORICAL CONTEXT FOR WATER RESOURCES POLICY MANAGEMENT IN SOUTH AFRICA

4.1. Introduction

This chapter explores the historical context that informs the current water resources management problems and policy objectives in South Africa. The chapter looks at the past apartheid government's racial discriminatory policy and its legacy so at to contextualise the current challenges and management priorities for the resource. This study focuses specifically on water resources management, which has implications for the available water resources for water services. Water resources management policy in South Africa comprises two focus areas that are connected: water resources management and water services. Water resources management is governed through the National Water Act 36 of 1998 (RSA, 1998), which provides for the protection, use, development, conservation, management and control of national water resources. The implementation of the National Water Act 36 of 1998 is facilitated through the National Water Resource Strategy (NWRS) (DWA, 2013a). Water services are governed through the Water Services Act 108 of 1997 (RSA, 1997) which provides for basic water supply and sanitation, setting national norms and standards as well as developing a regulatory framework for water services institutions and intermediaries. Implementation of the Water Services Act 108 of 1997 is facilitated through the Strategic Framework for Water Services (DWAF, 2003). The National Water Act 36 of 1998 is effectively the overarching legislation governing national water resources management as well as related international water relations matters.

The chapter does not attempt to challenge or justify the policy positions of the colonial and apartheid regimes. Instead, it seeks to contextualise the impact of those previous policy positions for current water resources management. This chapter is necessary to highlight the unique water resources policy management challenges facing South Africa and the impetus required for the generation of comprehensive and credible evidence to facilitate effective and efficient evidence-based policy planning, implementation and performance management decisions.

4.2. Water resources management policy in South Africa (pre-1994)

A greater part of the water governance challenges in contemporary South Africa stem from the legacy of the racial discriminatory policies of the apartheid regime, which reigned for 46 years from 1948 to 1994. These policies focused on mainstreaming (through legislation) structural racial discrimination in relation to accessing natural, economic and social capital with the highest discrimination focused on the majority so-called *Bantu* peoples (black South Africans). While the United Party government (before 1948) had already instituted discriminatory policies against black South Africans, it was only after the takeover by the National Party in 1948 that saw racially discriminatory laws being effectively cemented in South Africa. According to Tempelhoff (2017), the National Party strategy, was the purposeful principle of racial discrimination that saw white South Africans, the self-proclaimed 'supreme race', as the deserving main beneficiaries of the State's interventions at the cost of all other races.

Land access policies were some of the central aspects of the legislated racial discrimination to this effect. Discriminatory land access and ownership policies, such as the Group Areas Act 41 of 1950, established residential separation between the different races in South Africa, were central to this effect. Through the Group Areas Act 41 of 1950 (Union of South Africa [Union of SA], 1950), black people were forced to live in the native homelands (also known as the Bantustans) designated by ethnic, or tribal, groups (Horowitz, 1991). This meant that all black people were designated to live in a particular homeland according to their ethnicity e.g. Zulu people in KwaZulu or Tswana people in Bophuthatswana. There were at least 10 homelands including Transkei, Bophuthatswana, Ciskei, Venda, Gazankulu, KaNgwane, KwaNdebele, KwaZulu, Lebowa, and QwaQwa as demonstrated in **Figure 4.1** (Apartheid Museum, 2021). Importantly, the legislation denied blacks the right to own or lease land other than within their designated native homelands. The physical discrimination and prioritisation of white South Africans would later pave the way for discriminatory policies that ensured superior services to white areas as opposed to the areas where people of colour resided.

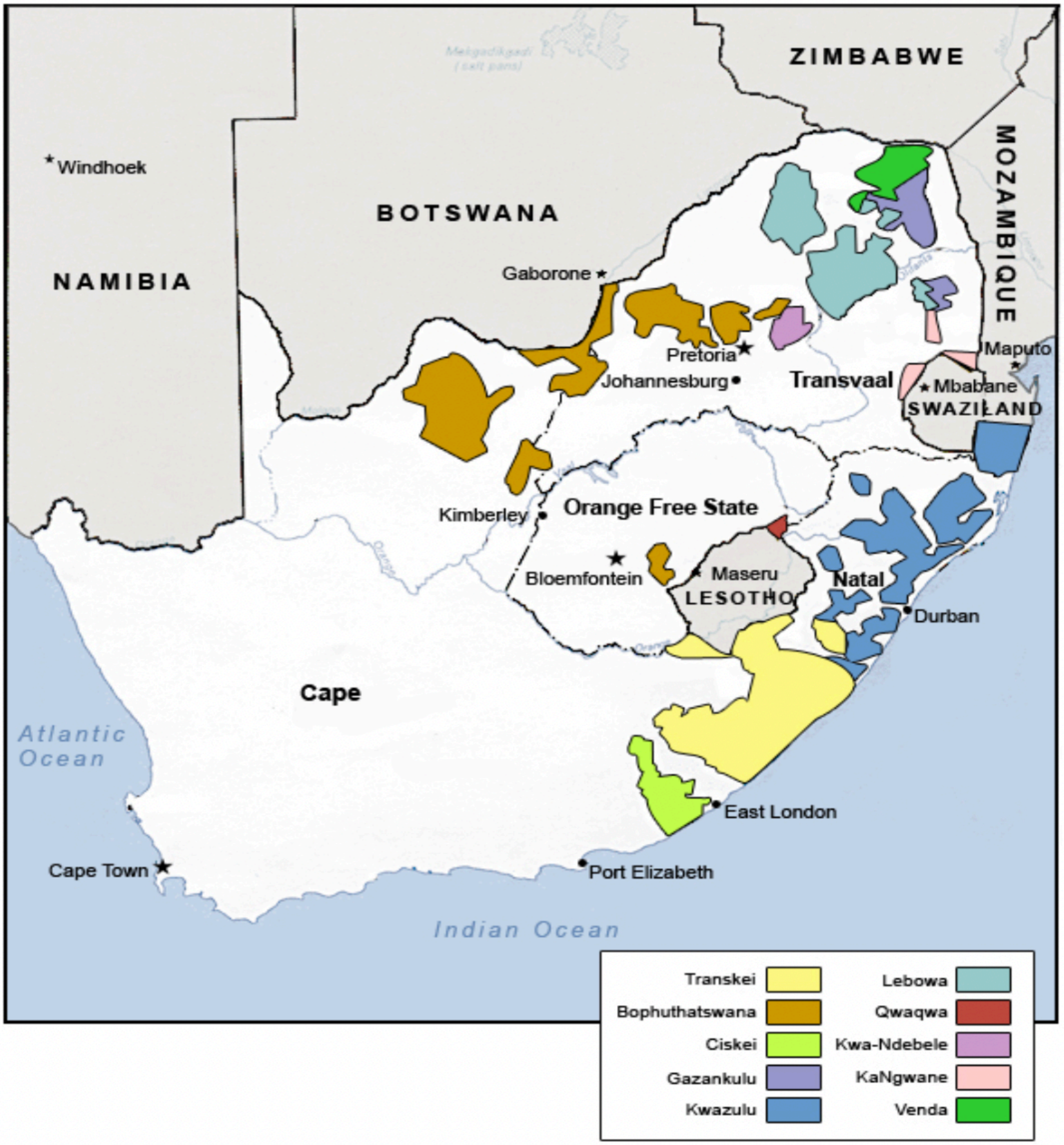


Figure 4.1: Map of South Africa's Homelands or Bantustans" during the apartheid era (Source: Michigan State University, 1984).

The racially biased policies of the colonial Afrikaner government of the National Party effectively legislated access to natural resources (i.e. land and water resources) as a privilege of white South Africans who enjoyed great political and economic power (Tempelhoff, 2017). Soon after taking over the government of the Union of SA, the National Party government introduced the Water Act 54 of 1956, which repealed the Irrigation and Conservation of Water Act 8 of 1912 (RSA, 1956). The Water Act 54 of 1956, re-prioritised water resources for diversified economic growth, which included a stronger push for urban planning and industrial development mainly through mining and agricultural development (RSA, 1956). Among other things, the aim of the Water Act of 1956 "was to consolidate and amend the laws relating to the control, conservation and use of water for domestic, agricultural, urban and industrial purposes" (RSA, 1956, p. 1203). Although the Water Act 54 of 1956 was seen as a noble drive for improved water governance towards sustainable development, it was, unfortunately, largely driven by a racial and socio-economic discriminatory agenda, driven by the National Party government. As such, the Water Act 54 of 1956 could not be separated from the larger vision of the State - to prioritise people of European descent, especially through legalised preferential access to natural resources such as land and water.

The Water Act 54 of 1956 (RSA, 1956) further strengthened the discriminatory appropriation of indigenous land and the associated economic benefits, by legislating water access as a riparian right. This meant that water access was linked to land ownership. Landowners had exclusive use rights of the water that had its source in or flowed through their land (riparian rights) (RSA, 1998; Tewari, 2009). Since land ownership was prioritised for white South Africans during the apartheid era, access to water, effectively remained skewed in their favour (Maphela, 2015). Through the Water Act 54 of 1956 and other related discriminatory policies, the National Party government, advocated for racial segregation, using these policies to spearhead its plan to ensure sustained economic growth for the benefits of white citizens only. Unfortunately, this occurred at a cost for all other races and especially the majority black South Africans (estimated at about 67.5% of the national population in 1960) and other races estimated at 21.6% and 8.6% for coloured and indian respectively (see **Table 4.1**). The population of white South Africans in the same period was estimated at 2.4%. White South Africans were allocated access to 92.5% of the land (approximately 100 ha per person), while blacks and the other races were restricted to 7.5% (approximately 2.0 ha per person) (Maphela, 2015).

Table 4.1: Population of South Africa based on the 1960 Census (Source: Steinberg, 1967).[5]

Race	Provinces				Total	Percent
	Cape Colony	**Natal**	**Transvaal**	**Orange River Colony**		
African	1,424,787	904,041	937,127	225,101	3,491,056	67.5%
White	579,741	97,109	297,277	142,69	1,116,805	21.6%
Coloured	395,034	6,686	24,226	19,282	445,228	8.6%
Indian	10,242	100,918	11,321	253	122,734	2.4%
Total	**2,409,804**	**1,108,754**	**1,269,951**	**387,315**	**5,175,463**	**100.0%**

[5] After the democratic elections in 1994, South Africa's provincial boundaries were subsequently revised and provinces renamed into the nine current ones i.e. Eastern Cape, Free State, Gauteng, KwaZulu Natal, Limpopo, Mpumalanga, Northern Cape, North West and the Western Cape.

Using the Water Act 54 of 1956, the government effectively took control of all public and private water (including surface and underground water). The legislation further facilitated the construction and control of government water works, which included the construction of dams, irrigation schemes, and the generation of electricity (RSA, 1956). Although homelands had their own entities dealing with agricultural and water resources management issues such as the Venda Development Corporation, Gazankulu Development Corporation, etc. it is important to note that the homelands were excluded from key provisions of the water legislation such as the control over and use of subterranean water as well as access to water courts, water boards, irrigation loans and subsidies (RSA, 1956). This meant that land in the homelands could be expropriated for the development of government water projects ultimately prioritising white South Africans as the main beneficiaries. For 42 years, the black majority population of South Africa effectively had no say in the allocation and management of water resources until the introduction of the National Water Act 36 in 1998. Indeed, water resources policy management decisions in the apartheid era were driven by the resource scarcity and the strategy was to sacrifice non-white access and use especially for economic activities (Tempelhoff, 2017). Unfortunately, the costs of the past racial discriminatory policies still have noticeable negative impacts on many poor South Africans a majority of which are black. In response, the focus of the democratic government (after 1994) demonstrated an emphasis on irrigation infrastructure and bulk water governance responsibilities, including a greater focus on the country's social and economic developmental priorities and more comprehensive water infrastructure for industrial development as well as water for urban areas as well as dealing with the increasing challenge of water pollution (Tempelhoff, 2017).

4.3. Water resources policy management challenges (post-apartheid)

Water resources remain a central development resource and, therefore, cannot be detached from the developmental agenda of the South African government (NPC, 2012; van Koppen & Schreiner, 2014). Although current water resources management policy provides for potentially equitable access to water resources and its economic benefits. In practice, however, direct access for economic activities remains skewed, owing to the backlog presented by the legacy of the discriminatory and racially biased policies of the apartheid regime. The country demonstrates equally poor equitable sharing of the economic benefits including those derived from water utilisation. South Africa is rated in the top five most unequal countries in the world, with a Gini coefficient of 0.67% (Stats SA, 2019). The unemployment rate is estimated at 30.1% (Stats SA, 2020) and the poverty rate is about 55.5% of the population (for the upper-bound poverty line of R992 per capita per month) (Stats SA, 2018a).

Limiting water access to a minority of economically active water users is not desirable for sustainable and equitable development. Yet, opening access to all dramatically increases water consumption and risks unsustainable water supply with significant risks for environmental collapse and social instability in the long term. While addressing the current water access inequalities is essential, it comes with major problems for the water resources management system. This presents a serious dilemma for South Africa’s developmental water resources policy managers, who must find a balance that works for all. The task to reform water access and ensure equitable and sustainable access still persists, to this day, 25 years into a democratic State in South Africa. Importantly, this challenge is reflective of the great legacy of inequality, especially to access to land which links directly to water access. This is testament to the complexity of water resources management task, as an interdependent and interconnected resource management system, plagued with great environmental and socio-economic uncertainties.

Access to water resources, allocations, use and management practices as laid out in the late apartheid era made a considerable contribution to the current state and future potential for sustainable water resources policy management in South Africa. A great part of early water resources policy management particularly in terms of the design of the water resources distribution infrastructure supported and favoured the development of white South Africans. Importantly, the discriminatory water policies of the past also created structural/material challenges that still persist today. The entire economic development structure of the State rests on an infrastructure base that perpetuates inequality. The dams and water distribution system between catchments were designed in such a manner that privileges primary mining, commercial agriculture and big industry which are all dominated by white South Africans in terms of ownership. Importantly, redress progress in terms of water access and inequality depends on progress in other areas of the economy such as mining and agriculture. The South African government’s approach to addressing inequality in water access has been a combination of promising land reform and ensuring the Broad-Based Black Economic Empowerment as redress policies. Unfortunately, the State has mainly been stuck on continuous analysis and planning with less and less impetus on implementation.

4.3.1. Water supply and access challenges

Although there are technical and resource limit challenges, the South African government's commitment to ensuring a basic human needs' reserve, set at 25 litres per capita per day, has largely been achieved. Between 1994 and 2010 at least 23.3 million more South Africans gained access to basic water supplies, increasing access from 59% of the population in 1994 to 91% in 2010 (Stats SA, 2012). Formal access to water resources for economic activities however, remains limited to a few mainly white commercial farmers and big corporates (van Koppen & Schreiner, 2014).

The goal of reforming water resources management policy in South Africa towards sustainable and equitable access for all occurs in the context of a water-stressed country. Projected climate change for South Africa will worsen the state of the country's already limited water resources and exacerbate challenges posed by the mismatch of rainfall, water storage capacity and population distribution (Climate and Development Knowledge Network [CDKN], 2012; Turton, 1999). South Africa's rainfall currently ranges from an average of less than 100 mm/annum in the western parts of the country to over 1500 mm/annum in the eastern parts and with a national average of about 450 mm/annum, which is below the global average of 860 mm per annum (Mwendera & Atyosi, 2018). The country's total internal renewable water resources (surface and underground water) is currently estimated at 942.4 m^3/Inhabitant/year, which is measurably below the global water stress threshold of 1000 m3/Inhabitant (see **Figure 4.2**). The country is one of the top 30 most driest countries in the world, and climate change projections shows that the country's rainfall pattern is shifting in dryness from the west to the east (Mwendera & Atyosi, 2018).

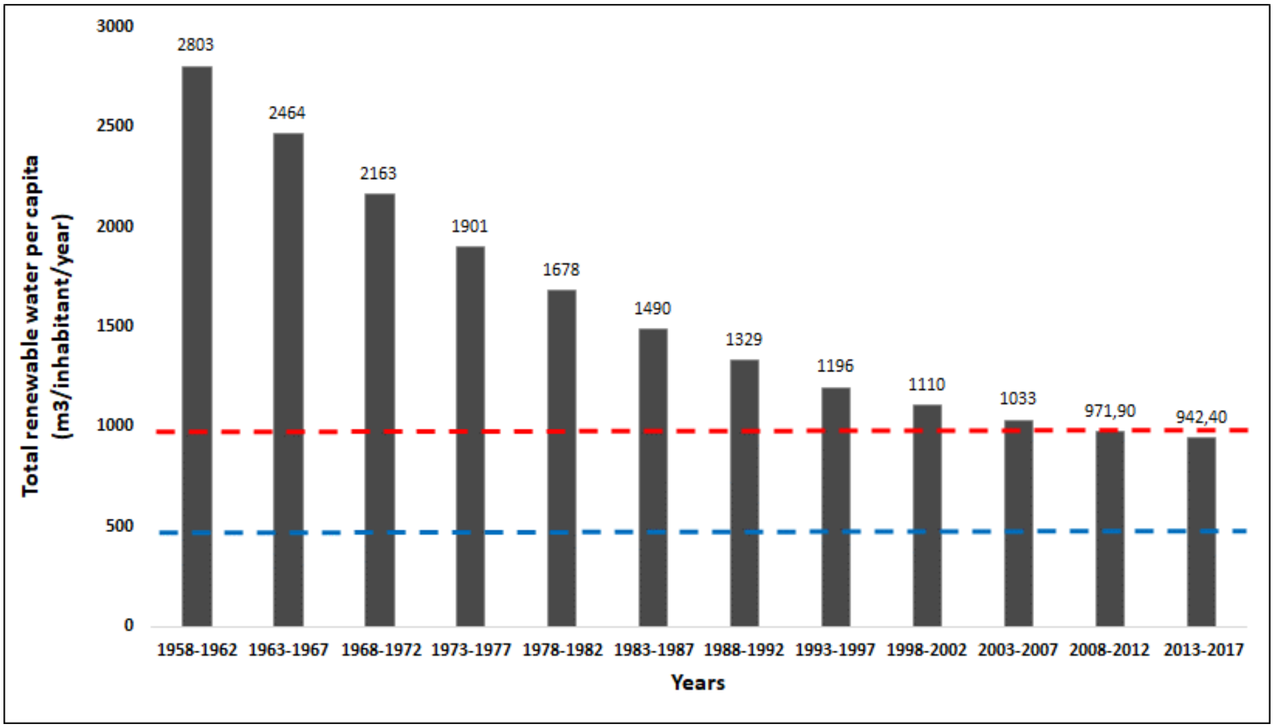


Figure 4.2: Trend of total renewable water (surface and groundwater)/capita (1958 – 2017) (Source: Mwendera & Atyosi, 2018).

Water availability and access disparities in South Africa are noted between areas (urban/rural, drought/flood-prone) as well as economic classes (between poor and well-off communities). Beside recent reference to water crisis experienced by the Western Cape Province, and most prominently the city of Cape Town between 2016 and 2018 (Wolski, 2017), water scarcity has been the norm for most of rural South Africa's dominantly black poor communities. In their study looking at the distribution of water access and its benefits, Cullis and van Koppen (2007) found that the Gini coefficient (which is a measure of skewed access to attributes where 1.0 is perfect inequality) for rural South Africa is 0.99. The study found that 1.2% of the rural households use about 95% of the agricultural/rural water with the other 98.8% of the population (the majority of whom depend on agriculture-based livelihoods) only using the remaining 5%. Even at catchment level, inequality in the distribution of water access rights seemingly follows the same pattern as that of the national average. As highlighted in **Figure *4.3***

Figure *4.3*: , using the examples of Mhlatuze, Olifants and Inkomati catchments, just over 5% of water licence holders use over 70% of the provided water per catchment.

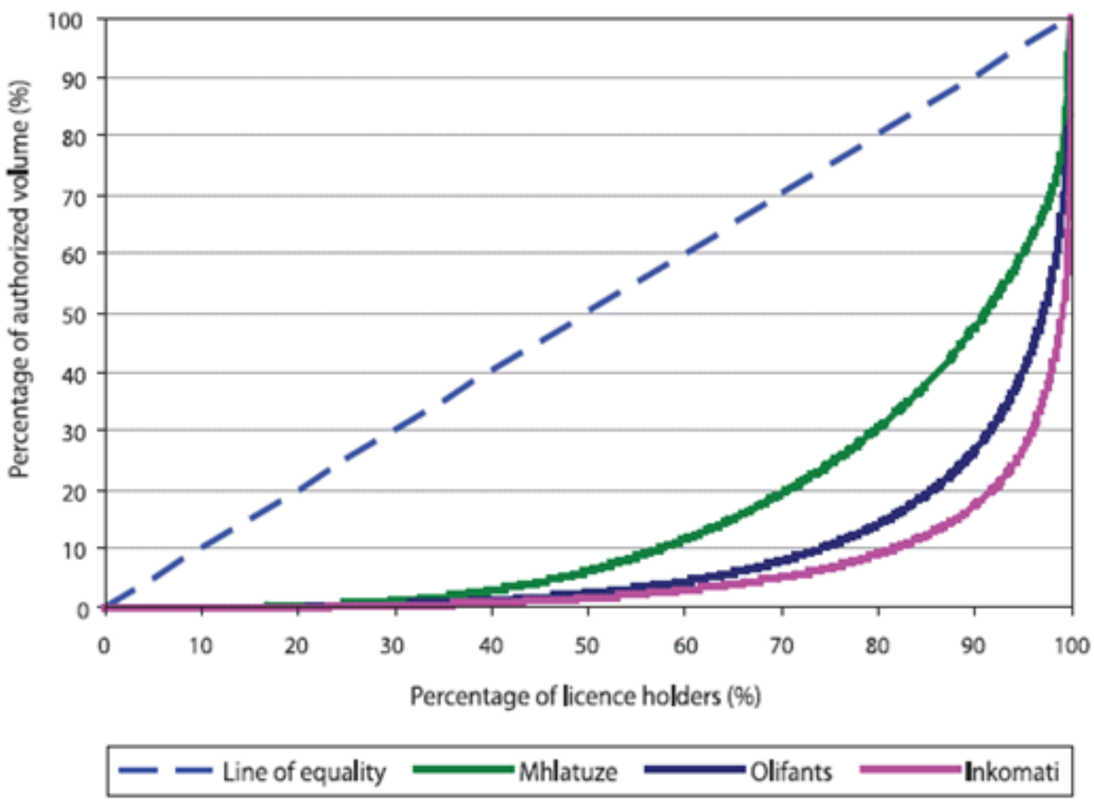


Figure 4.3: Distribution of registered water use for Mhlatuze, Olifants and Inkomati catchments (Source: Cullis & van Koppen, 2007).

The highest water users remain the agricultural sector, which exports a great deal of its products, and thus disproportionally benefiting individuals from the utilisation of water as a national resource. According to DWAF (2013a), the agricultural sector uses about 62% of the water resources in South Africa. The major economic activity of the sector continues to be dominated by large commercial farms, mostly owned by white farmers, and cooperates, as the major water resource beneficiaries as was the case even in the apartheid era. By inference, since the South African water economy remains largely untransformed (with limited black players), water resource use and its economic benefits remains dominated by the previously privileged members of society, almost 20 years since the passing of the National Water Act, 38 of 1998.

4.4. Current water resources management policy

After the elections in 1994, the task for South Africa's new democratic government, post-1994, was to implement policy reform to ensure equitable access and sustainability of water resources as a socio-economic and environmental priority (DWAF, 1997). Water resources management policy was one of the central priorities for the first democratically elected government (DWAF, 1997). In the context of water resources management, the policy reform task goes beyond the common challenge of managing water supply and demand, under what could be normal conditions, as is experienced in many other countries globally. Notwithstanding current challenges to equity and equitable access and use of water, South Africa has progressed significantly since the times of the Water Act of 1956 (RSA, 1956). Current water resources management policy prioritises reform and redress. The policy is built on two core principles (RSA, 1998; DWAF, 1997):

- to promote equity and equitable access as the means to address the needs of those who were historically denied access to water; and
- to achieve optimum sustainable societal benefits by ensuring that the country's limited water resources are used to improve the quality of life for all South Africans.

Figure *4.4*: So illustrates a schematic representation of South Africa's water resources management policy post-1994. For the purposes of this thesis however, the focus is on the national water resources policy management, (white blocks), with elements of the proposed policy positions in the National Water Policy Review and the Draft National Water and Sanitation Master Plan (NW&SMP), which is currently under consideration (green blocks).

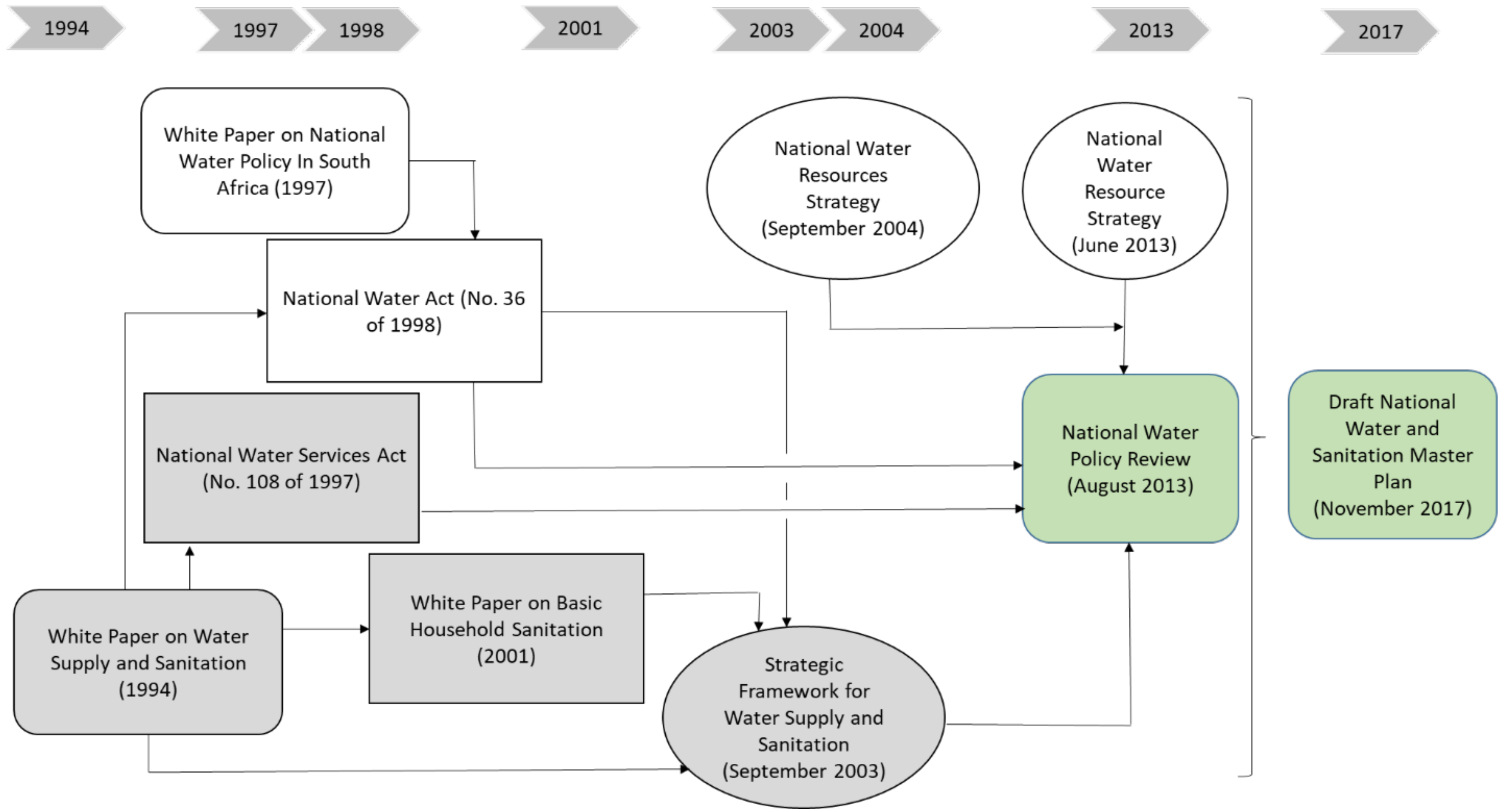


Figure 4.4: South African water policy, legislation and strategies post-1994 (Source: adapted from Wilkinson et al., 2018).

The post-apartheid regime’s water policies mainly endeavoured to correct the socio-economic access rights and associated injustices of the past, while pursuing national water security, equity and sustainability. The post-apartheid water resources management policy reform proposal took two distinct directions with one focusing on water services and sanitation and the other on water resources management. The new water resources management policy proposals followed the development of the White Paper on a National Water Policy in South Africa (water resources) as well as the Water Supply and Sanitation White Paper (water services) (DWAF, 1994). These policies were further legislated into law, specifically through the National Water Act 36 of 1998 (RSA, 1998) and the Water Services Act 108 of 1997 (RSA, 1997), implemented through the Strategic Framework for Water Services (DWAF, 2003) and the National Water Resources Strategy (NWRS2) (DWA, 2013a) as the respective strategic implementation frameworks.

4.4.1. White paper on a national water policy for South Africa (1997)

The White Paper on a National Water Policy for South Africa, as approved by parliament in 1997, sets out the fundamental principles and objectives for the new national water legislation in the new South Africa. One of the key parts of the policy was the recognition of the government’s role as custodian of the ‘public trust’ to manage water resources in the best interests of the public (DWAF, 1997). The government policy position was one that prioritised the public’s rights to fair access to water resources. This recognition meant that the government was obligated to regulate water use for the benefit of all South Africans in a manner that ensured fair access to scarce water resources and their benefits. In the White Paper on National Water Policy for South Africa (DWAF, 1997), the government committed to carrying out its public trust obligations to water resources management in a manner that:

- guarantees access to sufficient water for basic domestic needs;
- makes sure that the requirements of the environment are met;
- takes into account the interconnected nature of the water cycle - a process on which the sustainability and renewability of the resource depends;
- makes provision for the transfer of water between catchments;
- respects South Africa's obligations to its neighbours; and
- fulfils its commitment as custodian of the nation's water.

In this regard, the White Paper on a National Water Policy for South Africa envisioned a country where people have "opportunities to develop their skills and opportunities to use them productively to work and earn an income to meet their basic needs" and ultimately "a country where people can live at peace with one another, in dignity and security" in a sustainable manner (i.e. socially acceptable, economically viable and environment friendly) (DWAF, 1997, p.15). The policy effectively argued that water should be a central resource to the achieving of the national vision of a prosperous and sustainable South Africa by ensuring equitable and sustainable access to water resources (DWAF, 1997). Within the provisions of water as a public good held in a public trust, the White Paper on a National Water Policy for South Africa proposed at least 28 water policy principles and objectives, focusing on the legal aspects of water management, water resource management priorities, water resource management approaches, water governance institutions, and certain specific aspects relating to water services (see **Appendix 5**).

While pursuing equity and equitable access for all South Africans, the White Paper on a National Water Policy for South Africa also recognised that “It is not practical nor possible to divide up South Africa’s water resources so that each person has access to the same amount of water” (DWAF, 1997, p. 20). The policy argued that due to the uneven distribution of rainfall, rivers and storage capacity versus the mismatch in the distribution of the population concentrated mainly in urban areas, achieving direct equity to scarce water resources would not be possible. Furthermore, to meet equity targets in water access, land access would also have to be equally distributed as one of the areas where significant gains could be made for equitable allocation of water resources.

The White Paper therefore argued that, where possible, water and land would be redistributed, but in the main, water resource would be managed in a manner that ensured that the benefits accrued from the national water resources would be directly or indirectly equitably distributed for all. In practice, however, the operationalisation of such a policy position is extremely difficult. Unless government irrigation schemes directly benefit citizens, it would be virtually impossible to ensure equity, particularly when land and agricultural production is privately owned. For example, a great share of agricultural produce (especially irrigated fresh produce) is exported. Therefore, there is limited direct or indirect equity that could be derived from privately exported agricultural produce. Indirect benefit could be realised through employment opportunities, especially in the key water-using sectors like agriculture. However, in light of the unemployment rate, estimated at 30,1% during the first quarter of 2020 (Stats SA, 2020), as well as low wages, especially among farm workers, it can be argued that even the indirect benefits of access to water resources remains difficult to achieve.

4.4.2. National Water Act, 38 of 1998

Following the approval of the White Paper on a National Water Policy for South Africa (DWAF, 1997), the government developed the national water bill in the form of the National Water Act 38 of 1998 (RSA, 1998). The purpose of the National Water Act 38 of 1998 is to provide for the legal framework to facilitate the "protection, use, development, conservation, management and control of water resources" in consideration of sustainability and equity as the central guiding principles (RSA, 1998, Chapter 1). The mandate of the legislation emerged from the need to develop an instrument that would repeal past discriminatory laws and facilitate water resources management reform. The National Water Act of 1998 (RSA, 1998), as the foundational legislation for water resources management policy in South Africa, prescribes the development of a national water resources strategy and catchment management strategy to guide and facilitate water resources management. The legislation also prescribes some of the critical planning conditions and sets the tone and guiding frame for water management including the following:

- Water is a scarce and unevenly distributed national resource which occurs in many different forms which are all part of a unitary, interdependent cycle;
- While water is a natural resource that belongs to all people, the discriminatory laws and practices of the past have prevented equal access to water, and use of water resources;

- The National Government's overall authority and responsibility for the governance of national water resources, including the equitable allocation of water for beneficial use, the redistribution of water, and international water matters;
- The aim is to achieve the sustainable use of water for the benefit of all users;
- The protection of the quality of water resources is necessary to ensure sustainability of the nation's water resources in the interests of all water users; and
- The need for the integrated management of all aspects of water resources and, where appropriate, the delegation of management functions to a regional or catchment level to enable everyone to participate.

4.4.3. National water resources management strategy, second edition (2013)

Within the confines of this study, which focuses on national water resources management policy, it is important to look specifically at the current implementation strategy for water resources management policy (DWA, 2013a). As a legally prescribed instrument for the implementation of water resources management legislation in South Africa, the NWRS2 is legally binding. The NWRS2 covers elements of the first version of the national water resource management strategy (NWRS1) (DWAF, 2004a), because it was effectively built based on the progress and implementation gaps identified from the first strategy (DWA, 2013a) (**Table 4.2**).

Table 4.2: Implementation analysis of the NWRS1 (Source: DWA, 2013a).

NWRS1 Achievements	Outstanding Challenges
• Development of new water resources and water supply infrastructure and an investment in improved dam safety for State dams • Water Reconciliation Strategies in major urban areas and improved insights into reliable future water demands and supplies • A significant proportion of reserve determinations have been done with different level of confidence. • Incentive-based regulation through Blue and Green Drop assessments • Improved sector collaboration and participation • A Learning Academy to improve skills and capacity within the sector • Two Catchment Management Agencies established • Support given to numerous resource-poor farmers • Water sharing agreements and Institutional arrangements in place in all trans-boundary basins	• Achievement of water conservation and demand management targets • Streamlined water allocation reform to redress past racial and gender imbalances in access to water for productive uses and to address poverty and inequality • Implementation of environmental flow monitoring • Establishment of water management institutions and the decentralisation of water resources management • Strengthening of regulation of water resources and water quality • Improvement of technical and management skills to implement developmental water management. • Improvement in the integration of monitoring and information management • Reduction in the backlog of infrastructure maintenance

The NWRS2 presents a new set of strategic thematic areas of focus, guiding objectives and vision in a manner that attempts to align water resources management to the new and emerging national development goals, as set out in the National Development Plan (NDP) (NPC, 2012). Among other variables, most of the national development goals identified in the NDP depend, to a great extent, on water security (DWA, 2013a). The NDP determined that water was one of the strategic resources needed to power the South African economy and facilitate the achievement of national goals. The national development goals identified in the NDP (NPC, 2012) include:

- Creating jobs and ensuring sustainable livelihoods;
- Ensuring equal opportunities, inclusion and redress;
- Expand strategic infrastructure;
- Ensuring integrated and inclusive rural and urban economies;
- Supporting environmental sustainability;
- Provide quality health care;
- Building a capable and developmental State, and
- Promoting health and ensuring social protection,

The strategic goals of the NWRS2 are further informed by specific issues and challenges directly affecting water resources management in South Africa as indicated earlier in this chapter. The NWRS2 summarily presented the issues in **Table 4.3** as the major challenges that informed its strategic interventions.

Table 4.3: The water context as a background to the strategic goals of the NWRS2 (Source: DWA, 2013a).

Issue	Status Quo
Water scarcity	South Africa has low levels of rainfall with high variability and high levels of evaporation due to the hot climate and increasing challenges from water pollution. South Africa is the 30th driest country in the world and has less water per person than countries widely considered to be much drier, such as Namibia and Botswana
Water runoff	The variable rainfall distribution and characteristics give rise to the uneven run-off and distribution of water resources across the country, with more than 60% of the river flow arising from only 20% of the land area. Water runoff is thus highly variable and unevenly spread in space and time.
Water resource infrastructure	There is well-developed infrastructure, with more than 4 395 registered dams in South Africa, including a number of large-scale inter-basin water transfer schemes. However, many parts of the country have either reached or are fast approaching the point at which all of the financially viable freshwater resources are fully utilised and where building new dams will not address the challenges. There are also backlogs in the maintenance and rehabilitation of water infrastructure
Floods and droughts	Despite good infrastructure, floods and droughts are part of the normal water cycle and water restrictions and flood management are a critical part of the water business.
Water demand	Many parts of the country are fast approaching the point at which all of the easily accessible freshwater resources are fully utilised. It is imperative that all South Africans recognise this situation so that the necessary steps are taken to assess current and future demands for water
Water planning and shortages	For water planning, the DWS plans with available water and uses a 98% assurance of supply, which means that water can be abstracted at the determined yield, 98 out of 100 years, on average. There is about 10 000 million m3 per year available with this level of assurance from a total mean annual runoff of 49 000 million m3 (thus, only approximately 20% of run-off is available as assured yield). Often where there are water deficits or where the system is considered to be ‘in balance’, the probability is that water shortages are experienced more than 2 out of 100 years. Water shortages have become part of life in South Africa and will be more frequent unless the strategies put forward are timely implemented
Mean annual runoff and	Most of the economically available yield from surface water resources over large parts of the country has been fully developed and utilised. More than two thirds of the country’s mean annual runoff is already

ecological Reserve	stored in dams. Where additional water is still available, e.g. uThukela, Mzimvubu and Phongolo basins, it is located in relatively remote areas far from existing centres of demand.
Volume of surface water yield	Surface water from dams and direct abstraction from rivers accounts for 9 500 million m3/a, with a significant volume of the surface water yield (3 000 million m3/a) moved via inter-basin transfers to areas in the country where requirements exceed supply. The Mzimvubu to Keiskamma is currently the only Water Management Area (WMA) that is not subject to inter-basin transfers
Ground water potential	The most recent estimate of sustainable potential yield of groundwater resources at high assurance is 7 500 million m3/a, while current groundwater use is estimated at around 2 000 million m3/a. Allowing for an underestimation on groundwater use, about 3 500 million m3/a could be available for further development
Water quality challenges	The main contributors to water quality problems are mining (acidity and increased metals content), urban development (salinity, nutrients and microbiological), industries (chemicals and toxins) and agriculture (sediment, nutrients, agro-chemicals and salinity through irrigation return flows). Untreated or poorly treated wastewater is severely affecting the quality of water in many areas
Water resources quality	Of the 223 river ecosystem types, 60% are threatened, with 25% of these critically endangered. Less than 15% of river ecosystems are located within protected areas, many of which are threatened and degraded by upstream human activities. Of the 792 wetland ecosystems, 65% have been identified as threatened and 48% as critically endangered. Acid mine drainage (AMD) has also been reported from a number of areas in South Africa, including the Witwatersrand Gold Fields, the Mpumalanga and KwaZulu-Natal Coal Fields and the O'Kiep Copper District
Inefficient use of water resources	South Africa faces high levels of water wastage and inefficient use. In municipalities, non-revenue water sits at more than 37% on average, and in many irrigation and municipal supply schemes it is estimated losses of up to 60%
Shared water basins	South Africa shares four major river systems with six neighbouring states (Botswana, Lesotho, Mozambique, Namibia, Eswatini and Zimbabwe). International agreements on water sharing are in place in all of these river basins, in line with the revised Southern African Development Community (SADC) protocol on shared watercourses

In the NWRS2, the strategic actions are divided into two connected core areas. First are the actions that are directed primarily to the management of water resources (referred to in **Figure *4.5*** as Strategic Themes), e.g. Water resources protection, managing water resources for climate change etc. Second, are the execution enablers, which are meant to help facilitate the execution of the strategic themes, e.g. institutional arrangements, financing, monitoring and information management, etc.

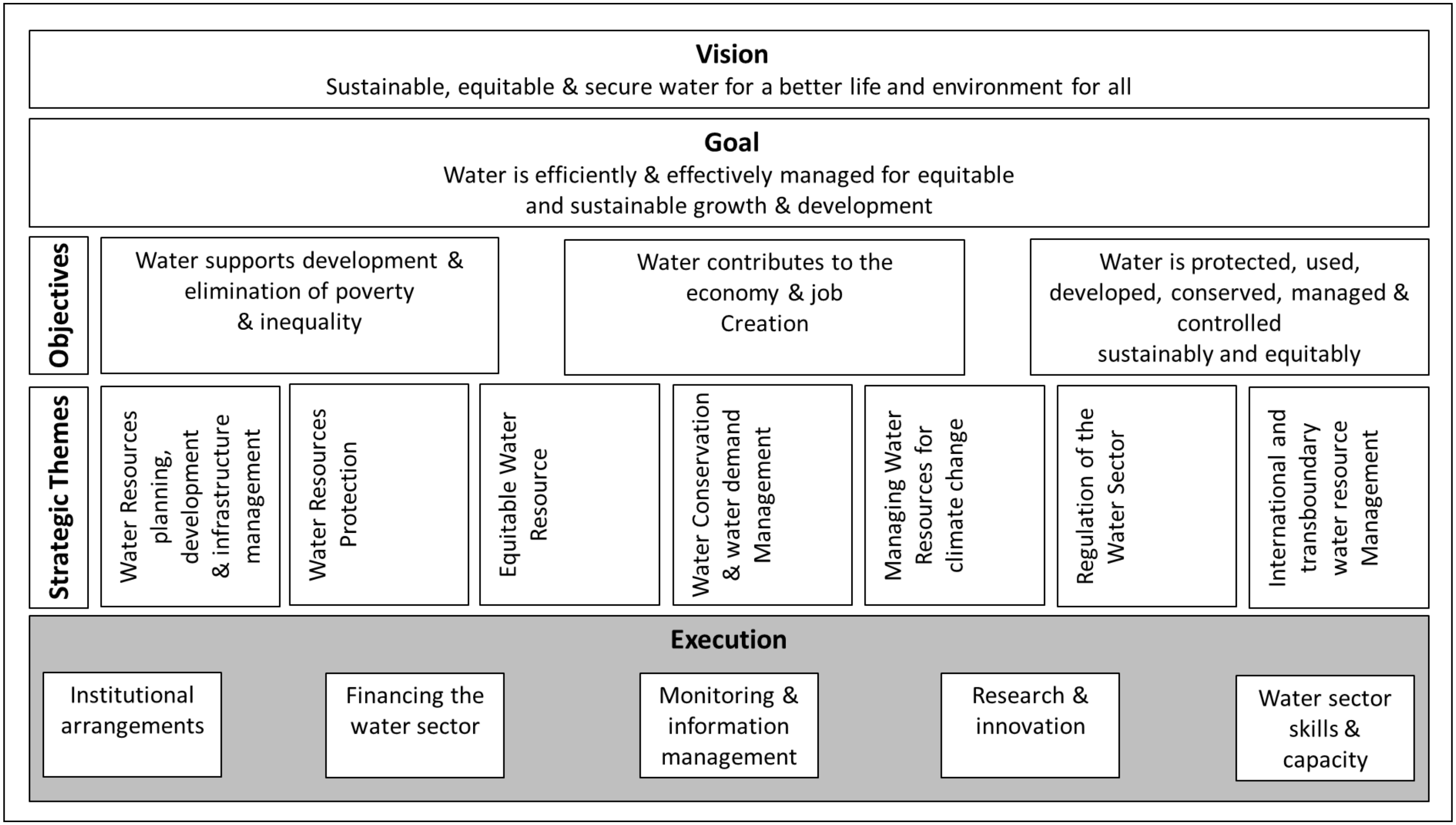


Figure 4.5: Overview of the NWRS2 from vision to execution (Source: adapted from DWA, 2013a).

The NWRS2 sets out the vision, principles, goals and strategic actions for achieving effective developmental water management, as a responsibility of the State and its partners. Importantly, the execution of the NWRS2 occurs in the context of an integrated economy that exhibits great interdependencies and interconnectedness between different environmental, economic, socio-cultural and political variables. These variables may be internal or external to the boundaries of the water resources policy management system of interest and thus either within or outside the direct control of water managers. Specifically, most of the strategic themes identified in the WRMS2 have direct or indirect internal and external drivers, which could potentially induce positive or negative effects to the performance of the water resources management policy.

Moreover, and in consideration of the historical context of discriminatory water resources management policy in South Africa, the National Water Act, 38 of 1998 prescribed the establishment of suitable institutions that have appropriate community, racial and gender representation as custodians of water resource in South Africa. The WRMS 1 proposed new water governance institutions that continue to be refined through the WRMS2. In a context of scarce water resources, these institutions needed to focus on demand management, water efficiency, and collective frameworks allowing for burden-sharing and trade-offs among stakeholder interests (van der Brugge & Rotmans, 2006). This strategic shift effectively meant the birth of new water governance structures and associated institutions as the policy instruments to facilitate effective IWRM (Lach et al., 2005). These include the Department of Water Affairs (DWA) (as the leading line-ministry), as well as other government ministries with major impacting activities on water resources such as the Department of Agriculture, Forestry and Fisheries (DAFF) and the Department of Minerals and Energy (DME); existing catchment management agencies, water services authorities, water boards, water users, communities, civil society, as well as the private sector. See **Figure 4.6** for the institutional arrangement for water governance institutions in South Africa.

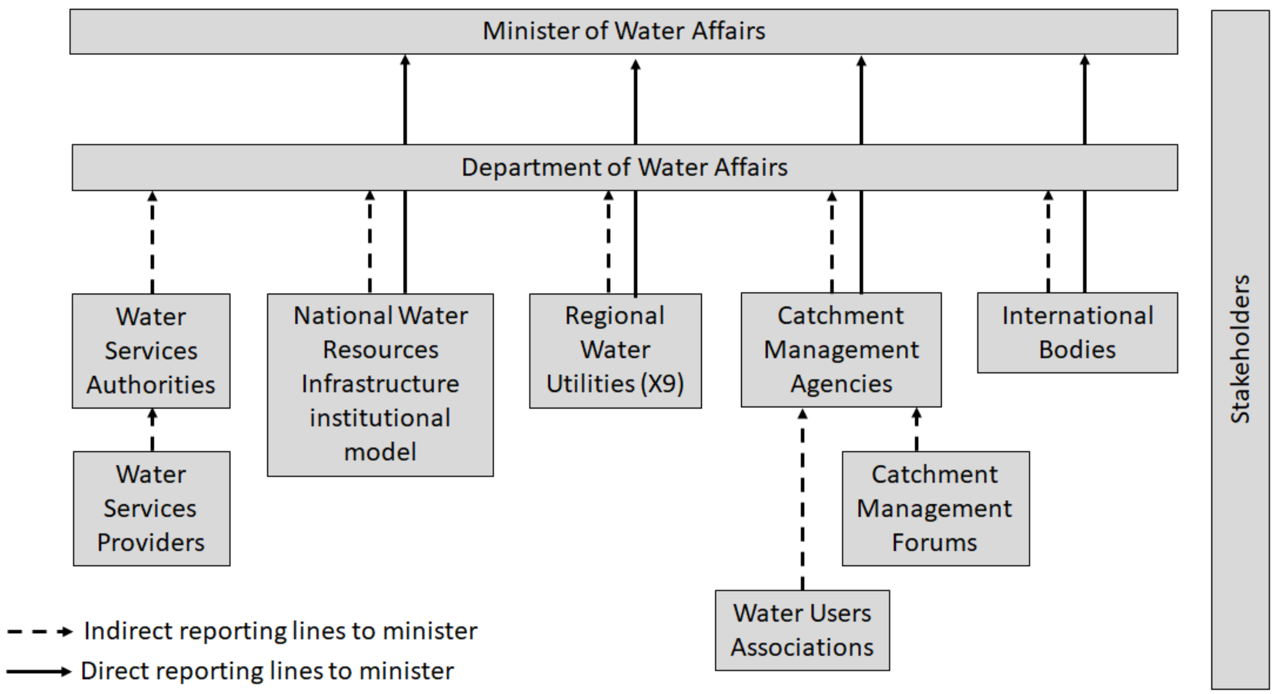


Figure 4.6: Institutional arrangements for water management in South Africa (Source: adapted from DWA, 2013a).

Water governance institutions, as presented in **Figure 4.6**, are stipulated in the National Water Act, 38 of 1998 and explained further in the NWRS2 (DWA, 2013a). The institutions covered in the NWRS2 reflect the entire water value chain responsible for water resources management such as the Department of Water Affairs, Catchment Management Agencies (CMAs) and International bodies, rather than water resources management institutions *per se*. A central part to the current institutional policy for water resources is the establishment of CMAs as part of the decentralised water resources governance strategy of the State. According to the NWRS2 (DWA, 2013a), CMAs are responsible for water resources management at the regional or catchment level - ensuring that water resources are managed in accordance with national policies, guidelines and standards set out for their jurisdiction. In fulfilling their role, CMAs must actively involve local communities and other stakeholders through Catchment Committees, Catchment Management Forums (CMFs) and Water User Associations (WUAs) (DWA, 2013a). The role of CMAs includes managing water use authorisation, water resources protection; planning compliance monitoring and enforcement; coordinating conservation and demand management programmes; and water quality management. Other duties include the establishment and oversight of WUAs and CMFs, in order to facilitate water resources planning, information management and managing issues related to billing and the collection of water use charges. In cases where the CMA is not yet established, the National Water Act provides for the Minister of Water Affairs to act as a CMA, through the auspices of his ministry. The new water resources management institutions are included in the establishment of 19 CMAs, in accordance with 15 Water Management Areas (WMAs) as presented in **Figure 4.7** and as determined in the NWRS1.

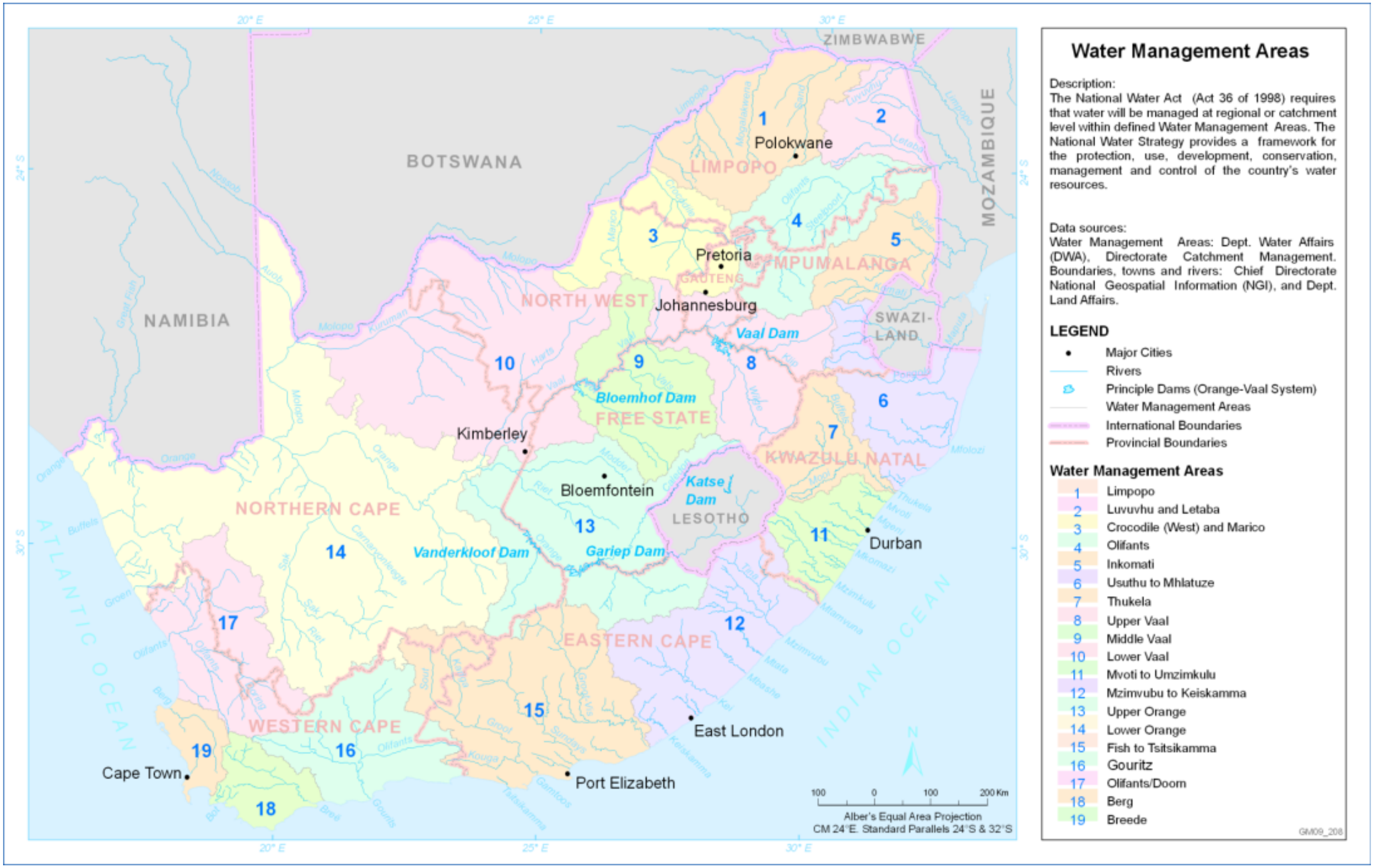


Figure 4.7: Water Management Areas (Numbered 1 to 19) (Source: DWAF, 2004c).

The environmental boundaries of the naturally occurring Water Management Areas (WMAs) were effectively used to determine the initial 19 CMAs. According to DWAF (2004a), the institutional reasoning for the initial proposal of the 19 CMAs were based on the following reasoning;

- the institutional efficiency of creating a large number of catchment management agencies, each managing a relatively small area, compared with a small number of agencies, each managing a larger area;
- the potential for a catchment management agency to become financially self-sufficient from water use charges;
- the location of centres of economic activity;
- social development patterns;
- the location of centres of water-related expertise from which the agency may source assistance;
- the distribution of water resources infrastructure.

However, the slow and problematic nature of the process of establishing the CMAs has persisted since the determination of the initial 19 Water Management Areas (WMAs) in 1999. This became one of the main the reasons for the need to consolidate them from 19 to nine (DWA, 2013a). As presented in **Figure 4.8**, the nine CMAs include Limpopo, Olifants, Inkomati-Usuthu, Pongola-Umzimkulu, Vaal, Orange, Mzimvubu-Tsitsikamma, Breede-Gouritz and Berg-Olifants (DWA, 2013a).

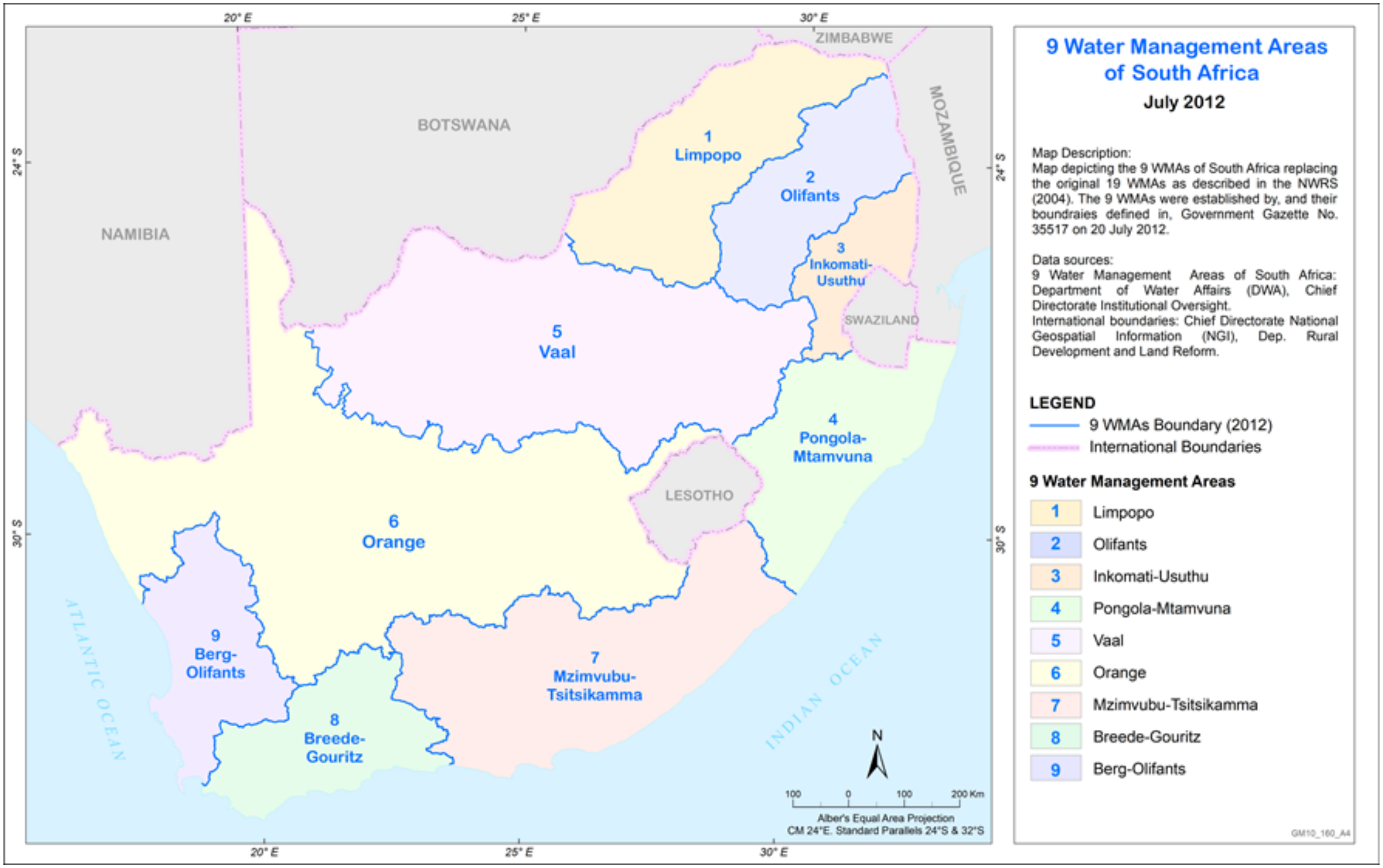


Figure 4.8: Revised Water Management Areas for South Africa (Source: DWA, 2012).

According to the NWRS2 (DWA, 2013a), the revised boundaries of the revised WMAs still took into considered catchment and aquifer boundaries as well as financial viability concerns, coherence of interests of participating stakeholders, and equity considerations. The NWRS2 further argued that the advantages of reducing the number of WMAs from 19 to nine included the following:

- Managing integrated water systems, which were previously split across the WMAs, would be easier;
- Scarce technical skills could be better distributed between institutions;
- Stronger revenue streams would give rise to more sustainable water resources management institutions;
- Establishment of the CMAs could be achieved in a shorter time; and
- Larger CMAs could more easily cooperate and coordinate on regional, provincial and international levels, as a result of being more substantial,

While the number of WMAs was reduced, for what could be justifiable reasons, there is great risk associated with the increased land size of the CMAs in terms of local management and participation as one of the key reasons for the decentralisation of water governance. Importantly this is a key limitation when considering adaptive policy management approaches which greatly rely on effective decentralised governance structures to ensure real-time adaptive management decision-making and execution. However, while South Africa has been hailed as one of the positive exceptions in Southern Africa for successful water decentralisation processes and performance in pursuit of IWRM (Swatuk, 2005) some serious governance flows have also been noted with great concern. Brown's (2011) exploration of the institutionalisation of participatory water resource management in post-apartheid South Africa are quite compelling. Using the case of one of the operational Catchment Management Agency (CMA), the Inkomati-Usuthu CMA, Brown (2011) found that there might be fundamental weaknesses in the adopted participatory water governance model related to limited local ownership of decision-making processes. While the goal of the decentralised IWRM model adopted for CMAs in the management of Water Mangers Areas (WMAs) is to strengthen local participation in decision making towards equity, economic efficiency and sustainability, in the South African context, the decentralisation processes might have created exaggerated opportunities for powerful vocal groups to co-opt processes and dominate CMAs and water users associations (WUAs). In consequence, the lack of contextualisation of IWRM for South Africa might risk perpetuating historical inequalities to accessing especially water for economic activity. As such, Brown (2011) strongly argued that the role of the State must be reinforced at the lowest level of IWRM structures, to ensure compliance with the national policy governance vision of equity and sustainability.

4.5. Future water resources management policy considerations for South Africa

In 2013, the DWA commissioned a review of the national water resources management policy (DWA, 2013b). The goal of the policy review was to determine any unintended oversights or gaps in the policy in order to provide for the necessary amendments. The review covered both water services and water resources management policies. In terms of WRM, the policy review specifically looked at the White Paper on Water Policy for South Africa (DWAF, 1997). Accordingly, only the elements of the review directly related to water resources management, as provided for in the White Pater on Water Policy for South Africa, were highlighted.

At a higher strategic level the policy review (DWA, 2013b) found that there was a need for a holistic management of the entire water value chain, for which the current legislation does not allow. The current water legislation in South Africa does not provide for a sole mandate for the management of the entire water value chain. Instead the National Water Act provides for water resources management as a national mandate tasked to the DWA, while the Water Services Act provides water supply and sanitation services responsibility to local government. The review found that there is a lack of alignment between the Water Services Act, Act 108 of 1997 (RSA, 1997) and the National Water Act, Act 36 of 1998 (RSA, 1998), as well as their implementation strategies, the Strategic Framework for Water Services (DWAF, 2003) and the National Water Resources Strategy (DWA, 2013a), respectively. As a result, although national government has over-sight over local government responsibilities, the separation of power for the management, development, control and protection of water resources and the provision of water supply and sanitation services, creates great inconsistencies in the management of the entire water value chain. Therefore, the policy review recommended that the two policy issues and the associated legislation and implementation strategies be merged and aligned in order to provide for a sole mandate to the Minister and the DWS for the management of the entire water value chain.

At the technical water resources management policy level, the national water policy review noted numerous challenges and recommended specific new policy positions to accelerate policy effectiveness and efficiency (**Table 4.4**).

Table 4.4: Revised water resource policy positions for South Africa (Source: based on the DWA, 2013b).

Current Water Resource Policy Issues	Proposed Water Resource Policy Positions
Applicability of the Use-it or Lose-it Principle A large number of water use allocations are still authorised under Existing Lawful Use (ELU). As such, water which is not productively used remains held and often traded amongst the minority group in the country. Currently the Use-it or Lose-it Principle in the legislation excludes ELU	• Any authorised water use, including ELU, which is not utilised for a period specified by the Minister, should be reallocated to the public trust managed by the Minister as custodian of the nation's water resources • The Minister will re-allocate this water to address social and economic equity (this aligns the ELU to the provisions of the National Water ACT • The Minister will mandate timeframes and methodology by which all ELU entitlements will cease to be recognised and users must have applied for a water use licence
Water Trading between Authorised Water Users Current legislation on trading of authorised water does not support the equitable allocation of the source in that ELU can be traded between users thus mainly benefiting previously advantaged water users	• There shall be no form of temporary or permanent trading between authorised water users. It will be obligatory for any holder of an entitlement to use water, which is no longer utilised, to surrender such use to the public trust for which the State is the custodian • The Minister's discretion to approve water use will be guided by the needs and requirements of the transformation and development objectives of the State • This position strengthens the use-it or lose-it principle
Prioritising Social and Economic Equity in the Reallocation of Water The legislation currently does not prioritise equity and redress. Instead, equity and redress are	• Decision making in reallocation of water will have equity as the primary consideration • Priority will be given to water use authorisation applications that meet the equity requirement, as provided in the regulatory instruments • Priority in reallocations should be afforded to black women and men, including coloureds and Indians, all

no more prioritised than any of the other factors currently considered during an authorisation application. Current legislation rather seeks to protect ELU.	of whom were citizens of South Africa and were disenfranchised before 1994 and therefore had unfair constrained water access • The Minister has discretion to determine priority considerations for reallocation of water
Multiple Water Use Approach in Planning Infrastructure Bulk water infrastructure development currently prioritises specific individual sectors thus risking the segregation of other users such as communities and rural households	• A multiple water use approach will be implemented, which incorporates all water uses in an area including water supply, must be adopted in planning of bulk water infrastructure. This approach will also have equity and transformation as a priority • A participatory planning approach will be adopted to avoid conflicts over allocations for different purposes or users
Economic Regulation There is currently no regulation of the entire water value chain	• Economic regulation will be applied throughout the water value chain • Scope and functions of economic regulation will encompass the setting of the rules to control, monitor, enforce and/or change tariffs/charge, tariff/charge determination structures, and service standards for the water sector whilst recognising and supporting government policy and broader social, environmental and economic imperatives and the function of technical regulation of water infrastructure. • To avoid any conflict of interest, real or perceived, water use tariffs will be determined annually by DWA, in consultation with National Treasury

To address implementation challenges and associated inconsistencies and overlaps, among others, the policy review recommended that water resources and water services policies be merged and aligned (DWA, 2013b). In this regard, a draft National Water and Sanitation Master Plan (NW&SMP) (DWS, 2018) has been developed and is currently undergoing the policy approval processes of the State. The NW&SMP offers five key objectives for water and sanitation management in South Africa:

- Resilient and fit-for-use water supply;
- Universal water and sanitation provision;

- Equitable sharing and allocation of water resources;
- Effective infrastructure management, operation and maintenance; and
- Reduction in future water demand.

The NW&SMP proposes the development of a National Water and Sanitation Resources and Services Strategy (NWSRSS), which combines water resources and water services into a single strategic management document. The NWSRSS will be reviewed and updated every five years. The NWSRSS is the implementation plan however will be managed as a living plan to be updated annually, using an adaptive management approach (DWS, 2018). This presents a great opportunity to strengthen the water resources policy M&E capacity to ensure the generation of credible and comprehensive evidence required to manage water resources efficiently especially in the face of uncertainty highly emergent management conditions. For the purposes of this research, water resources management policy is viewed within the current status quo of the separate water services and water resources management policies and their implementation strategies.

4.6. Conclusion

A greater part of the national water resources policy management challenges emerge as a legacy of the past apartheid's racially discriminatory policies that continues to persist today and are exacerbated by other new problems associated with democratic South Africa. The majority of South Africans remain marginalised in terms of access to water resources. The historical discrimination (limiting access to production resources such as water and land) greatly contributed to the current inequality challenges to accessing water resources for productive use or its economic benefits. As such, South African water resources policy management is informed by a policy reform and redress agenda that prioritises the correction of the past apartheid government injustices. Indeed there are other contributing factors such as the lack of implementation of water resources management policies, procrastination by policy makers to monitor and review policies as well as general poor planning. These are equally of greater interest and focus for current water resources policy management efforts.

In light of the social, economic, political, environmental challenges presented by the legacy of past discriminatory water policies of the apartheid government on the current affairs, water resources policy management success is vital to the developmental agenda of the State. This task however remains an extremely difficult task especially in a context of scarce water resources and the economic imperatives where redress could potentially undermine the viability of the economy as it is currently constituted. In the context of this study, despite a good understanding of current water resources management challenges, policy complexity and uncertainty make it extremely difficult to pin down the solutions with the most promise for accelerated policy success and impact. An evidence-based adaptive and integrated strategy that employs a mix of strategies is suggested as one that could be the most appropriate strategy in this context. Alongside noticeable on-going efforts to improve water resources management policies in South Africa, this study emphasises the value of continuous learning to inform adaptive policy efficiency through a systems thinking infused M&E strategy.

CHAPTER 5 : SOURCES AND IMPLICATIONS OF UNCERTAINTY FOR EVIDENCE-BASED WATER RESOURCES POLICY MANAGEMENT

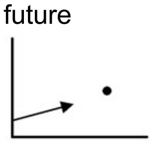
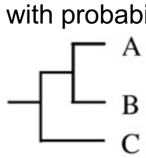
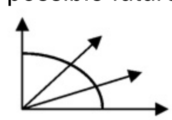
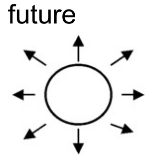
5.1. Introduction

In the context of this research, the pursuit of water security and equity brings us closer to the key uncertainties that could potentially affect the success and effectiveness of water resources management policies. Water in South Africa is determined as a central resource to the country's developmental State agenda which implies greater environmental, economic, socio-cultural and political systems' dependencies with the water resources policy management system. Uncertainty in policy making tends to be exacerbated by the complexity presented by other interdependent policy systems, and requires a systems-wide understanding to guide comprehensive and effective policy decisions (Williams & van't Hof, 2016). This chapter endeavours to identify the key sources of uncertainty for water resources management in South Africa, with the view to demonstrate the complexity of the policy management task. The chapter also explores the implications of uncertainty and complexity for evidence-based adaptive water resources policy management and in particular M&E as an approach to facilitate the generation of policy planning and performance management evidence.

5.2. Sources of uncertainty for water resources policy management in South Africa

Although there is a general appreciation of uncertainty, from a practical point of view, there is limited understanding of the different types and relative magnitudes of uncertainty in most policymaking situations. Walker et al. (2003) identify at least four levels of uncertainty in policy systems. These includes uncertainties related to the policy context, the policy system model, the system outcomes, as well as the weights stakeholders place on policy outcomes (see **Table 5.1**).

Table 5.1: The progressive transition of levels of uncertainty from determinism to total ignorance (Source: Walker et al., 2003).

		Level 1	Level 2	Level 3	Level 4	
				Deep Uncertainty		
	Context	A clear enough future 	Alternative futures with probabilities 	A multiplicity of possible futures 	Unknown future 	
Determinism	**System model**	A single system model	A single system model with a probabilistic parameterization	Several system models, with different structures	Unknown system model; we know we do not know	**Total Ignorance**
	System outcomes	A point estimate and confidence interval for each outcome	Several set of point estimates and confidence intervals for outcomes, with a probability attached to each set	A known range of outcomes	Unknown outcomes; we know we do not know	
	Weights on outcomes	A single estimate of weights	Several sets of weights, with a probability attached to each set	A known range of weights	Unknown weights; we know we do not know	

Levels 1 and 2 fall to the determinism side of the uncertainty scale, which the authors define as the type of uncertainty that can be modelled and demonstrates reasonable capacity to be incorporated in probabilistic predictions (Makridakis et al., 2009; Walker et al., 2010; Walker et al., 2003). On the other hand, Level 3 and 4 represent 'deep uncertainty', or what is often referred to as the 'unknown unknowns', which is a type of uncertainty that cannot be reduced by gathering more information (Makridakis et al., 2009; Taleb, 2007; Walker et al., 2010). Unique, high impact events, such as climate change-induced extreme weather events with major impact on public policy, are typical examples of deep uncertainty. Such events can only be explained in retrospect, rather than through modelling and probabilistic predictions (Taleb, 2007; Walker et al., 2003). In this regard, according to Walker et al. (2003), 'deep uncertainty' remains a condition/state where policy makers and analysts find themselves in total ignorance with only the knowledge that they do not know. Different environmental, social, economic and political uncertainties, as presented in this section, become relevant for an efficient and comprehensive evidence-based water resources policy management system. A systems-wide interactive understanding of such uncertainties and the related emerging complexities would be key to ensure the advancement of innovative approaches for evidence-based adaptive and integrated water resources policy management.

5.1.1. Climate change, climate variability and the hydrological system

In the Fifth Assessment Report (AR5), the United Nations Intergovernmental Panel on Climate Change asserts that, with the current concentration of greenhouse gases in the atmosphere, global warming will persist even if carbon dioxide emissions are significantly reduced or even stopped (United Nations Intergovernmental Panel on Climate Change [IPCC], 2014a). The IPCC (2014a) further asserts that global warming is likely to intensify climate variability, thus presenting greater uncertainty for policy makers to act decisively and appropriately. Water resources policy makers should develop their water policies or water plans based on the latest scientific evidence. This will assist them to be able to formulate relevant water policies that have implementable solution with better prospects for success. Making efficient water resources policy management decisions will be further challenged by climate variability, with the possible and likely increased frequency of extreme weather events, such as drought and floods (IPCC, 2014a; Schulze, 2005a). Given these uncertainties, and indeed the limits of what is known about the impact of climate change on water resources, it is extremely difficult to develop appropriate and well-targeted water resources management policies that are appropriately tailored to respond to current and future growth conditions, driven by population and economic growth demands. In South Africa, climate change increases the pressure on water resources in a country already experiencing water scarcity especially in view of a water resources management policy stance that pursues redress toward equitable and sustainable access to the resource. This is further exacerbated by the uncertainty related to the degree, magnitude or sign and spatial extent of precipitation change and the consequences on the hydrological system (Hewitson et al., 2005; Schulze, 2005a). According to Ziervogel et al. (2014) the uncertainties associated with climate change impact are driven by the;

- lack of climate scenario products;
- under-synthesized and contradictory climate information;
- incomplete impacts modelling approaches;
- inadequate socio-economic and vulnerability assessments;

- a lack of cross-sectoral integration in impacts and adaptation assessments, and
- poor traceability between impacts assessments and climate scenarios on which they are based.

While regional climate change projections can be readily produced at a range of spatial and temporal detail, down to the point scale, at best climate change forecasts are probable indicators of change with great uncertainty still embedded in the outcomes (Hewitson et al., 2005). With Global Climate Models (GCMs) only able to predict general directions of the change, the magnitude of uncertainty for climate change therefore widens as the scale is reduced down from the global to the local scale, with mixed signals and generally low degrees of accuracy on changes in variability (Hewitson et al., 2005). Within the realm of climate change and climate variability research, the challenge is to focus on understanding projected precipitation, which is generally a secondary process in GCMs and is represented with relatively lower confidence (than temperature) going into the future (Mitchell, 2002).

Orlowsky and Seneviratne (2012) note that precipitation exhibits higher spatial and seasonal dependence and is more uncertain than temperature projections. The degree, magnitude or sign and spatial extent of projected precipitation changes are dependent on the integrity of the Global Circulation Model (GCM) employed, the parameterization schemes used and their interaction with model dynamics (Hewitson & Crane, 2006). For example as noted by Crétat et al. (2011) changes in the parameterization schemes of a single regional climate model produced contrasting rainfall biases over Southern Africa, thus justifying the using of multiple ensemble downscaling models to better describe uncertainty of future rainfall changes. Current climate change scenarios suggest that South

Africa will become drier towards the western half with greatly increased variability and extreme events (floods and drought) towards the eastern parts (Department of Environmental Affairs [DEA], 2013a). Using four climate scenarios at national scale to describe South Africa's future climate up to year 2050 and beyond, the DEA found evidence of the different degrees of change and impacts likelihood into the future (DEA, 2013a). **Table 5.2** shows rainfall projections for each of South Africa's six hydrological zones, which are representative of the nine water catchment areas in the country.

Table 5.2: Rainfall projections for the six hydrological zones in South Africa (Source: DEA, 2013a).

Scenario	Limpopo/ Olifants/Inkomati- Usuthu	Pongola- Umzimkhulu	Vaal	Orange	Mzimvubu- Tsitsikamma	Breede-Gouritz/ Berg-Olifants
1. Warmer <3°C above 1961–2000) and Wetter	Increased rainfall in spring and summer	Increased rainfall in spring	Increased rainfall in spring and summer	Increased rainfall in all seasons	Increased rainfall in all seasons	Decreased rainfall in autumn and increased in winter and spring
2. Warmer <3°C above 1961–2000) and Drier	Decreased rainfall in summer, spring and autumn	Decreased rainfall in spring and strongly decreased in summer and autumn	Decreased rainfall in summer and spring and strongly decreased in autumn	Decreased rainfall in summer, autumn and spring	Decreased rainfall in all seasons, strongly decreased in summer and autumn	Decreased rainfall in all seasons, strongly decreased in the west
3. Hotter >3°C above 1961–2000) and Wetter	Strongly increased rainfall in spring and summer	Strongly increased rainfall in spring	Increased rainfall in spring and summer	Increased rainfall in all seasons	Strongly increased rainfall in all seasons	Decreased rainfall in autumn, and increased in winter and spring
4. Hotter >3°C above 1961–2000) and Drier	Strongly Decreased rainfall in summer, spring and autumn	Decreased rainfall in spring and Strongly decreased summer and autumn	Decreased rainfall in summer and spring and strongly decreased Autumn	Decreased rainfall in summer, autumn and spring	Decreased rainfall in all seasons, Strongly decreased in summer and autumn	Decreased rainfall in all seasons, strongly decreased in the west

The DEA (2013a) argues that strong international mitigation responses would be helpful to reducing the likelihood of scenarios 3 and 4, and instead increase the likelihood of scenarios 1 and 2. However, slow mitigation efforts and indeed South Africa continued emissions' contribution mainly through coal-generated electricity, represents increased risk for the realisation of scenarios 3 and 4 with great negative implications on water resources and sustainable development.

Moreover, even with strong international mitigation responses, the CDKN assert that significant socio-economic implications would still be expected especially for vulnerable groups and communities under both wetter and drier climate futures (CDKN, 2012). The impact will be mainly felt through the challenge of increased non-linear confidence on rainfall extremes (flooding and drought) and changes in the direction, amplitude and variability of rainfall ultimately with negative outcomes for the availability of water resources (CDKN, 2012). For instance, it could be argued that even more rainfall but erratically distributed would lead to less water available. With limited comprehensive socio-economic and environmental observational data in Africa, it remains difficult to account for climate change contribution for changes in water availability, especially considering the role of multiple other factors such as land use change and water withdrawals (Neumann et al., 2007). Furthermore, climate change impacts on groundwater will vary across climatic zones.

There is agreement between climate change and water resources management scholars that 'perturbations' in climate parameters, particularly rainfall, are largely amplified or intensified by the hydrological system and that if climate changes manifest according to projections, it would add further concern to the management of south Africa's already high risk and stressed water sector (Schulze, 2005b). According to Schulze (2005b), natural and anthropogenic landscapes display considerable heterogeneity that influences different hydrological responses and the rates at which they occur. Schulze (2005b) identifies the following causative attributes (with many feedbacks occurring across overlapping spatial and temporal scales) with regard to the complexity of hydrological responses to climate change:

- **topography,** e.g. altitude, aspect, slope, position in the landscape (be it upland, midslope or footslope);
- **soils,** e.g. their infiltrability, transmissivity or water holding capacity, dependent inter alia on geology and topographic position;
- **rainfall,** e.g. its frequency of occurrence, persistence of wet or dry days, duration, intensity, seasonality or total amount;
- **evaporation**, dependent on atmospheric demand (solar radiation, water vapour deficit and wind) in interplay with soil and vegetation characteristics;
- **land use,** accounting for factors such as the leaf area index (LAI) and photosynthetic/stomatal characteristics of actively photosynthesising plants, canopy interception of rainfall, canopy height, structure and root distribution, as well as the degree of imperviousness, and
- the effects of **tillage practice** and **drainage**.

Schulze (2005b) asserts that the natural and anthropogenic environment in which hydrological responses occur is very complex and any changes in the major triggers of hydrological processes (i.e. rainfall, and its characteristics such as magnitude, intensity, duration, persistence or seasonality), will not respond in a linear manner, once certain thresholds have been exceeded. Consequently, these factors amplify or intensify hydrological responses, therefore rendering hydrological systems especially sensitive to changes in climate parameters, particularly rainfall. There are questions however that relates directly to local solutions. Within the agricultural system for example, it is necessary to know how much water can be used in each irrigation area in relation to the river basin and catchment area, when the water would be available and how much of it can be stored for use during drought period (de Souza et al., 2015). It is also necessary to quantify the long-term variability of water resources and its links with other water dependent socio-economic development systems such as, human consumption, energy or biodiversity needs.

While there are great uncertainties associated with the degree, spatial and temporal variability of predicted climate change, the IPCC (2014b) categorically concludes that climate change is real. As such, South Africa should start adapting its water resources management policies and practices or sustained agricultural productivity, even in the context of high uncertainty, especially concerning precipitation (Hawkins & Sutton, 2011). Muller et al. (2009) make an even more compelling justification for this, arguing that,

> Managing complex water resources would therefore be a challenge in a society that is relatively stable from a social and economic point of view. South Africa, however, is a society in rapid change. The physical distribution of its people, their social structure and the economies in which they engage are all evolving rapidly. In addition, the nature of the resource may itself be changing in response to the dynamics of a globally

> changing climate. In these circumstances, the challenge of adapting or aligning the nation to its water resource endowments will be greater than in a less dynamic environment. (p. 30)

While there are benefits offered by the national integrated approach through the national policy frameworks for water management, the development of sound sectorial-level water resources policy management instruments is equally key. This would help to ensure better alignment of the specific sectors with national benefits for sustainable water resources management. The South African agricultural sector for example is one of the major users of water - about 62% of the national freshwater supplies (DWA, 2013a). Consequently, water resources management ‘successes’ in the agriculture sector could bear great national benefits.

Importantly, successful sectorial-level water resources policy management would require specific and relevant demand and supply water management evidence to inform appropriate policy design and practice. However, the current evidence for climate change and variability, and its implications for the water sector, comes with great uncertainty, making it extremely difficult for water resources policy managers and their counterparts in the different water using sectors, to act with confidence. Effectively, adaptation decisions for climate change and climate variability, including water management, will therefore have to be made in the context of deep uncertainty especially regarding regional and local changes in precipitation (Hawkins and Sutton’s, 2011).

Attempting to address the highly variable, turbulent, and uncertain characteristics of the threat posed by climate change and climate variability to water resources becomes extremely difficult. As a result of increased variability and climate change, historical evidence about average rainfall and inflows into water storage dams has increasingly become an unreliable guide to predicting future patterns (Head, 2010). Water resources policy management and outcomes' targeting have become extremely complex potentially intractable given increasing uncertainties related to and climate change and climate variability and especially relating to precipitation (Hawkins & Sutton (2011). Indeed, as a compromise towards policy efficiency, there is a need for the supply of the best-available forecasting information, combined with evidence from both the supply- and demand-sides, as a means to inform integrated water management strategies and policies. However, even the best-available forecasting information would certainly not be sufficient to eliminate deep uncertainty and the complexity associated with managing the resource but could rather be justifiable as credible effort towards efficient evidence-based water resources policy management.

While mitigating climate change is a global multinational effort, there is scope to increase South Africa's capacity to cope with climate change and climate variability through evidence-based adaptive policy management. Concurrently, there are considerable differences of note between what could be considered relatively stable policy areas (such as education and healthcare services) versus those with high risk or radical uncertainty such as policy fields marked by challenges of value-conflict or rapid change (Head, 2010). The latter include policies related to issues such as water resources management and climate change adaptation for instance, which are dominated by great uncertainty and limited evidence and experience to inform sound policy decisions. Climate change and climate variability related uncertainties will persist long into the mid-century and beyond (Wolski, 2017), thus the need for systematic policy management approaches (development, implementation, monitoring and evaluation) that embraces rather than avoids uncertainty. Here, various adaptation strategies characterized by economic efficiency and equity, risk reduction, robustness, resiliency, and reliability must be considered (Schulze, 2005b).

Overall, climate change challenges are unlikely to be resolved in the near future which presents major problems for policy makers currently attempting to guide both short and long-term adaptation decisions. In terms of policy planning and management, it becomes necessary to understand climate change projections as valuable information inputs for decision-making rather than solid predictions of change (Hewitson et al., 2005; Maier et al., 2016; Ziervogel et al., 2014). Moving forward therefore requires embracing uncertainty as a fundamental variable of water resources management. Consequently, policy makers must find justifiable policy options in pursuit of sustainable water resource management even under deeply uncertain knowledge inputs for both water supply and demand.

5.1.2. Increasing demand against limited water supply

Limited current water storage capacity and the limited potential to expand storage infrastructure, largely owing to limited financial capital and construction sites for dams, as well as challenges related to limited and unreliable rainfall, makes the task to achieve equity even greater. Using the 2016 database of registered dams in South Africa, surface water storage capacity ranges from as high as 5385.1 m^3/inhabitant in the Free State province to as low as 33.5 m^3/inhabitant in the Gauteng province (See **Figure 5.1**). Certainly, this is not a function of any management inefficiencies, but rather the limitations presented by availability of dam construction sites closest to the densely populated areas in South Africa. In this regard, it is also important to note that while there are areas that receive more than the average annual rainfall, at least 21% of the land area in South Africa receives less than 200mm rainfall per year (World Wide Fund - South Africa [WWF-SA], 2016). As such, complex and expensive water transfer programmes between water catchment areas, such as the Lesotho Highlands Project, which supplies water to the Gauteng province, remain one of the key water resources management strategies for South Africa.

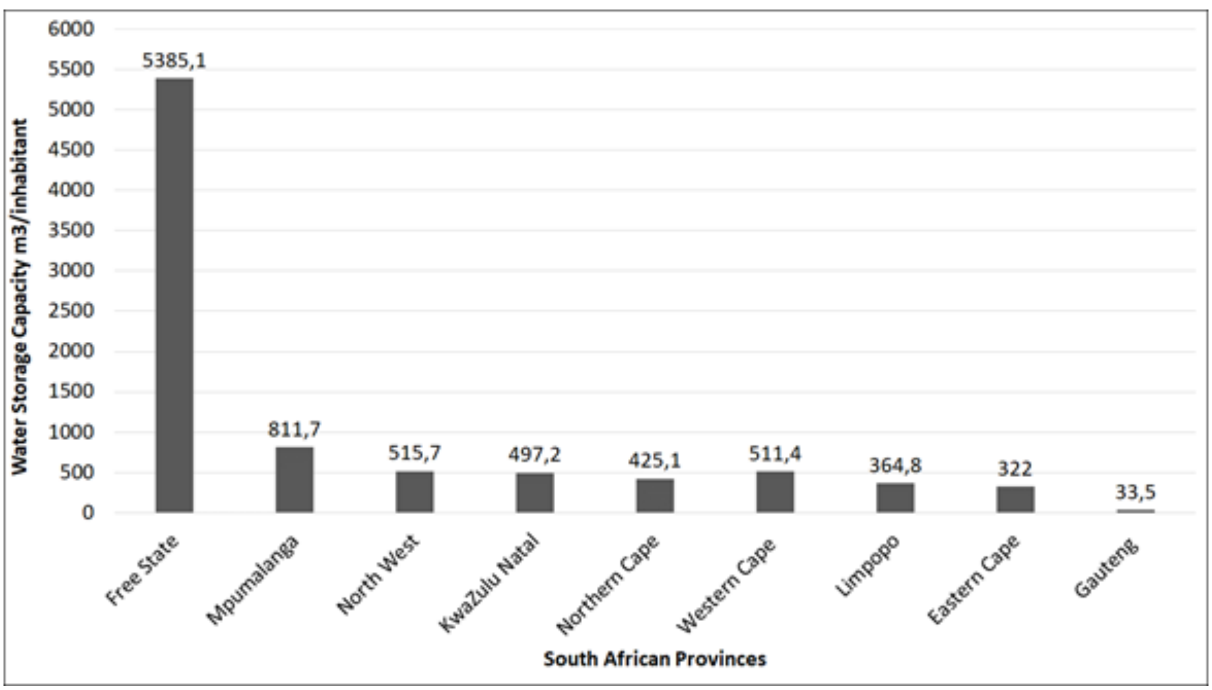


Figure 5.1: South Africa's water storage capacity per person by province (Source: Mwendera & Atyosi, 2018).

Concurrently, the potential for water scarcity increases with water demand (Fujihara et al., 2008), for example due to population growth and related irrigation expansion requirements for food production. The demand for water resources continues to increase at a high rate following accelerated population growth, higher living standards, and a greater drive for economic growth in South Africa. As demonstrated in **Figure *5.2*:**, it is estimated that the South African population grew by 39.2% between the 1996 census and the 2018 mid-year population estimates (from 40 583 572 to about 57 725 600 million people) with a trend that shows continued growth (Stats SA, 2018b, 2012).

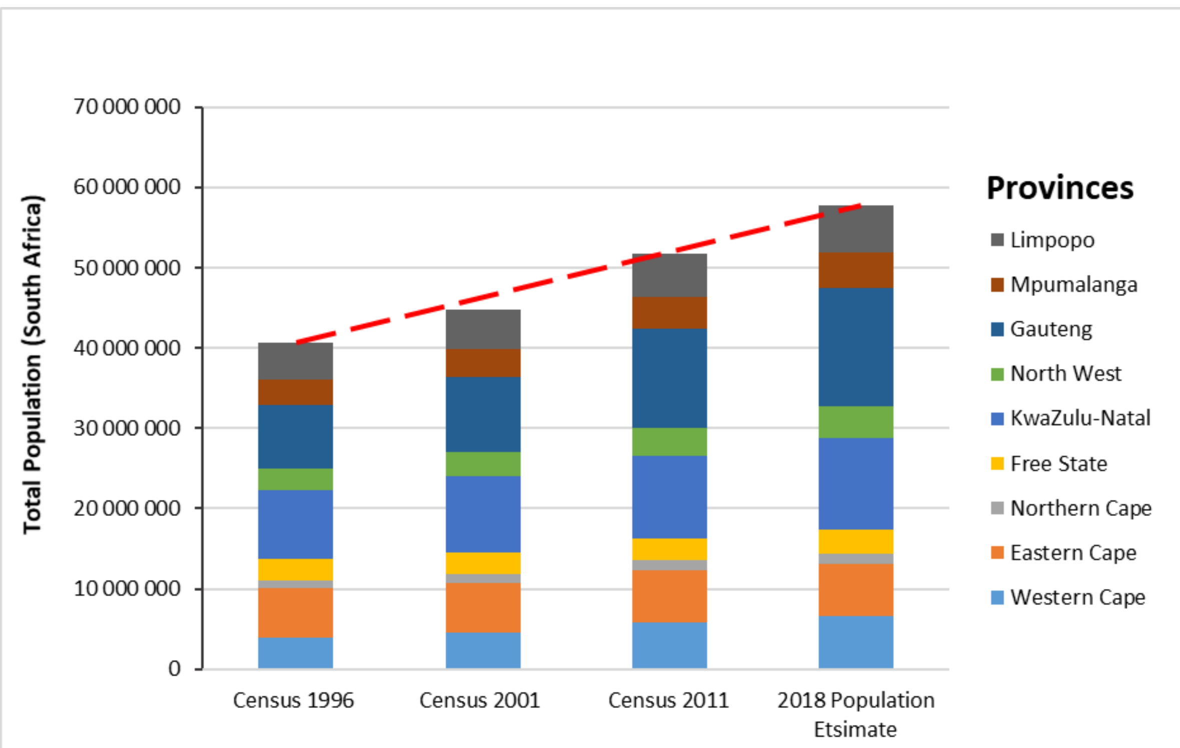


Figure 5.2: South African population growth between 1996 and 2018 (Source: Based on Stats SA, 2018b, 2012).

Globally, the withdrawal and net consumption of water is expected to grow substantially until mid-21st century, following an increase in population, quality of life, food production and demand (Mitchell, 2002). According to WWF-SA (2016), a similar trend is also expected in South Africa where national demand is projected to increase by just over 30% (to 17 700 million m^3) by 2030, which is arguably beyond the limit of what can be safely allocated. Moreover, spatial distribution of demand for water resources, especially for major users such as irrigated agriculture, domestic and other key economic sectors like mining, often does not align with existing water availability and supply systems. For example, the Western Cape province, one of the countries agricultural bread-basket areas of the country, has water storage capacity of 411.4 m^3/inhabitant and while hosting three out of eight metropolitan cities in the country (Johannesburg, Pretoria and Ekurhuleni) and with a population of 14 278 700 people (about 25.3% of the national population), the Gauteng province, which is the economic hub of South Africa, only has water storage capacity of 33.5 m^3/inhabitant(Mwendera & Atyosi, 2018; Pallett, 1997). This effectively means that water availability in many areas across South Africa depends on water resources located elsewhere, thus making water resources management in South Africa an interconnected task, not just between users within a catchment area, but also between catchments. Transboundary water management also becomes a highly relevant issue for water demand. With South Africa sharing four of its major river systems with six neighbouring countries (Lesotho, Zimbabwe, Botswana, Namibia, Mozambique and Eswatini), located upstream as well as downstream, the need for international cooperation in managing water as a transboundary resource is pivotal (Mwendera & Atyosi, 2018; Pallett, 1997). Therefore, effective and efficient management of water resources in South Africa must not only focus narrowly on the country's water demands and challenges, but also be cognisant of those of the neighbouring countries.

Furthermore, the South African government has committed to reserving water supplies to support environmental needs. In this regard, an ecological reserve has been set at an average of about 20% of mean annual runoff. It has been argued, however that at 20%, the ecological reserve could be too high for some of the already overburdened river basins (DWAF, 2004b). With the backdrop of a changing climate and the increased likelihood for reduced rainfall, versus increasing demands for water driven by population increase and a rapidly urbanising and industrialising economy, commitments to environmental water are bound to be challenged. Especially in cases where the environmental water needs are perceived to be highly prioritised over those of the poor or other water using sectors with greater potential for wider and equitable societal gains.

While the water resources policy management instruments in South Africa provides for potential access to water for all, in practice actual access and active use especially for economic purposes, remains a privilege for those who have extraction capacity (financial and physical infrastructure) and more than just the legal rights for use. As such, according to Muller et al. (2009), much of the potential economic and social development opportunities offered by the water sector have not been fully exploited due to limited financial capacity to afford irrigation equipment and electricity to draw water for example. As such, the difference between allocated water and actual use remains the missing link in the actual estimation of the risk of water scarcity in South Africa. Consequently, any positive shifts in people's socio-economic status could result in a rapid increase in water demand. As such, the full extent and implications for a 100% exploitation of water resources, both domestic and economic activities, is a development scenario that is yet to be determined.

5.1.3. Transboundary water interdependencies

The interconnectedness nature of Southern African watercourses necessitates cooperation between South Africa and its neighbouring countries. In **Table 5.3**, Pallett (1997) presents some of the major water transfer schemes in Southern Africa that directly or indirectly involve South Africa. As demonstrated in **Table 5.3**, there are at least 17 significant watercourses that South Africa shares with its neighbours both up-and down-stream. This emphasizes the need for international collaborative governance of the resource in recognition of international water needs over and above national needs.

Table 5.3: Major water transfer schemes involving South Africa and other neighbouring states (Source: adapted from Pallett, 1997).

Name of water transfer scheme	River basin involved	Countries directly involved	Other basin states indirectly involved
Komati Scheme	Inkomati - Limpopo	South Africa	Eswatini, Mozambique, Botswana, Zimbabwe
Usuthu Scheme	Maputo - Limpopo	South Africa	Eswatini, Mozambique, Botswana, Zimbabwe
Usuthu - Vaal Scheme	Maputo - Orange	South Africa	Eswatini, Mozambique, Lesotho, Namibia
Grootdraai Emergency Augmentation	Orange - Limpopo	South Africa	Mozambique, Botswana, Lesotho, Namibia, Zimbabwe
Vaal - Crocodile	Orange - Limpopo	South Africa	Mozambique, Botswana, Lesotho, Namibia, Zimbabwe
Tugela - Vaal Scheme	Tugela - Orange	South Africa	Lesotho, Namibia
Orange River Project	Orange - Great Fish	South Africa	Lesotho, Namibia
Orange - Riet	Orange	South Africa	Lesotho, Namibia
Caledon - Modder	Orange	South Africa	Lesotho, Namibia
Orange - Vaal	Orange	South Africa	Lesotho, Namibia
Lesotho Highlands Water Project	Orange	Lesotho, South Africa	Namibia
Vaal - Gamagara Scheme	Orange	South Africa	Lesotho, Namibia
Springbok Water Scheme	Orange	South Africa	Lesotho, Namibia
Vioolsdrift - Noordoewer	Orange	South Africa, Namibia	Lesotho
Molatedi Dam	Limpopo	South Africa, Botswana	Zimbabwe, Mozambique
North - South Carrier	Limpopo	Botswana	South Africa, Mozambique, Zimbabwe
Zambezi	Zambezi - Orange	Zimbabwe, Botswana, South Africa	Angola, Lesotho, Mozambique, Namibia, Tanzania, Zambia, Malawi

South Africa is a signatory of the United Nations Convention on the Law of the Non-navigational Uses of International Watercourses. The convention provides that “watercourse states shall in their respective territories utilize an international watercourse in an equitable and reasonable manner" (United Nations [UN], 1997, p 48), as well as to ensure that parties "participate in the use, development and protection of an international watercourse in an equitable and reasonable manner" (UN, 1997, p. 48). South Africa is also a signatory of the Revised Protocol on Shared Watercourses for SADC (Southern African Development Community), where the overall objective is "to foster closer cooperation for judicious, sustainable and coordinated management, protection and utilisation of shared watercourses and advance the SADC agenda of regional integration and poverty alleviation" (Southern African Development Community [SADC], 2000, p. 2).

Notwithstanding requirements for national sovereignty and economic disparities, the protocol prioritizes regional interests rather than national self-sufficiency through transboundary agreements for integrated water management and sharing. Importantly, the sharing of water across borders implies international water needs considerations in national water resources policy planning. Population and economic growth and the subsequent increase in water demand from the countries that share watercourses with South Africa, either upstream or downstream, must therefore be accounted for in South African water resources management policy. As South Africa pursues equitable and sustainability access for its citizens, similar developments have been noted across the SADC region, with all member states pursuing their own development goals. This includes a strong drive to increase irrigated land in pursuit of food and nutrition security and other economic gains. For example, in the past 10 years, Eswatini has seen the introduction of over 17 500 ha of new irrigated sugarcane following the construction of the Maguga and Lubovane dams (Eswatini Water and Agricultural Development Enterprise [ESWADE], 2016). These regional developments are particularly significant for South African water resource management especially with relation to the connectedness nature of the two countries' watercourses. Water, as a transboundary resource, does, largely, deepen uncertainty for policy management especially in cases where regional integration, collaboration and coordination are poor.

5.1.4. System's interconnectedness and interdependencies

The concept of water security places water resources management at the centre of social and economic development and is therefore a part of other interrelated socio-economic development policy systems. As an instrument of governance, 'policy' can in itself also present some elements of uncertainty. The National Planning Commission (NPC) for example argues that through better use of existing water resources and the development of new water schemes, irrigated agriculture can be further expanded by an additional 500 000 hectares (NPC, 2012). In an earlier policy document released by the Department of Economic Development (DED), the government targets to engage at least 300 000 new households in smallholder irrigation schemes (Department of Economic Development [DED, 2011). Importantly, this raises key questions on how these policy goals will be achieved and most importantly, where the water will come from, as these are not addressed in either of the two policy documents (van Koppen & Schreiner, 2014). While it could be argued that the distinction between water resources management policy and water services is clear, the separation creates a knowledge gap due to inconsistences and challenges in the flow of information between water resources and water services managers as interconnected through the availability of water resources. Such lack of clarity and coherence in policy creates more information gaps than it seeks to answer or guide.

Figure *5.3* shows that water resources management is primarily a function of demand and supply. Water resources support numerous livelihoods and economic activities that in turn place great pressure on the resource. However, water resources policy managers can only influence water utilisation through allocations and associated water saving strategies and incentives. Beyond water allocation, decision makers from other sectors take responsibility in leading decisions that negatively or positively affect the performance outcomes of policy decisions pursued at the level of water resources policy managers. Although there are political, economic, and social issues directly managed within the water sector, often, wider societal, economic, and environmental development decisions, that have a greater impact on water resources, occur outside the primary scope of conventional water resources policy managers (Gallopín, 2012; WWAP, 2009). In fact, as demonstrated in **Figure *5.3***, such external decisions could significantly alter the drivers or pressures affecting water resources availability, further affecting water resources policy performance. Regrettably, amongst water resources policy makers, the comprehension of the connections and interdependencies of the water resources policy management system with such other social, economic, and environmental management issues outside the sphere of water resources policy management is limited.

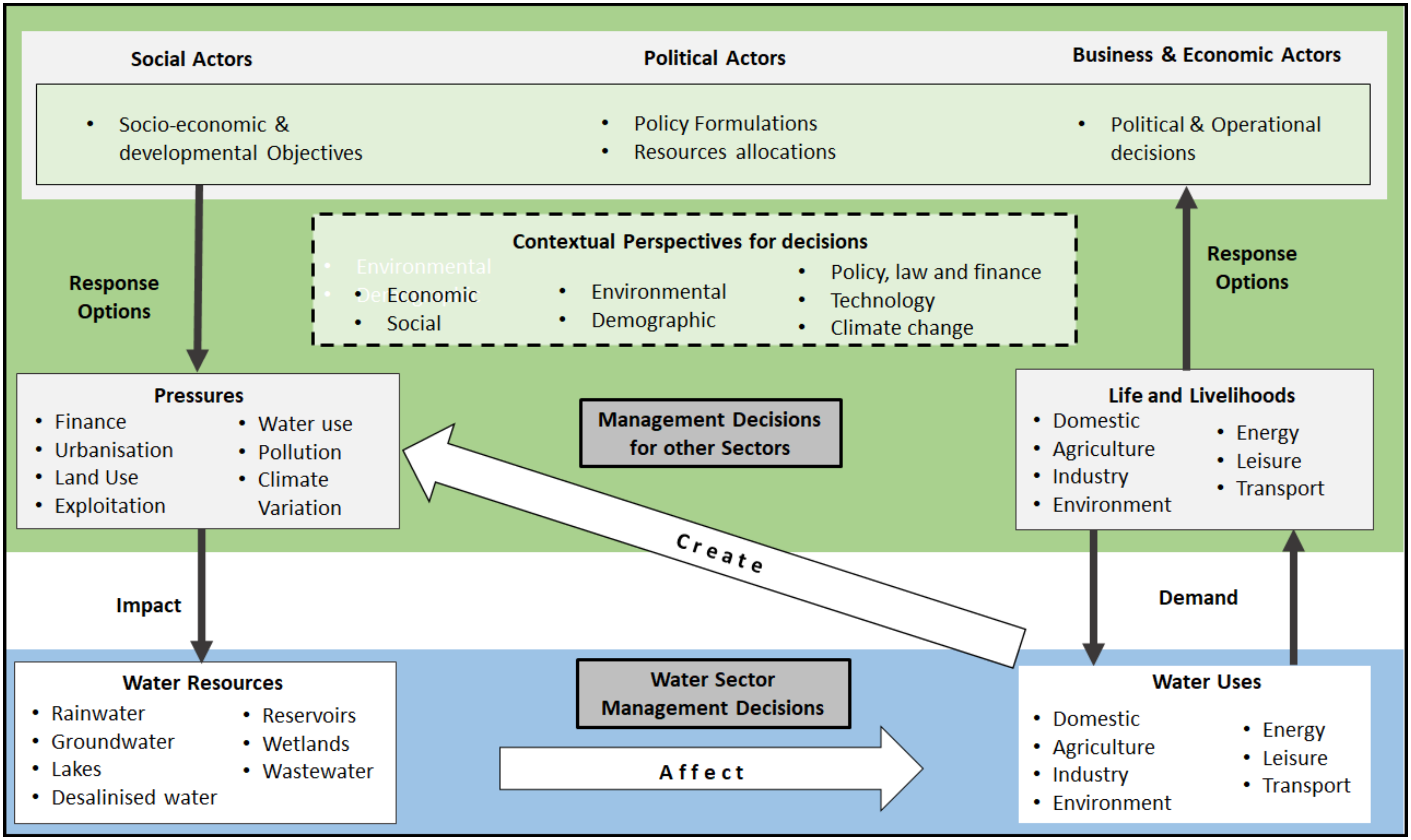


Figure 5.3: Decision-making affecting water resources management (Source: adapted from WWAP, 2009).

Not all the direct or indirect drivers highlighted here present major uncertainties to managing the resource. It is rather the interconnectedness and interdependencies between the different variables that presents a greater potential for deeply uncertain water resources policy planning and performance outcomes. Viewing them holistically as part of the comprehensive picture is necessary for the efficient management of the water resources policy management system. Efficient evidence-based water resources policy management decisions would therefore require that water resources policy makers and evaluators are cognisant of the larger picture of all the drivers and the subsequent impact of the different causal links between the water resources policy management system and other systems. Water resources policy managers are arguably reasonably aware of the major drivers directly within the water resources management portfolio such as rainfall, water storage capacity or water demand. It is the external policy systems' forces outside their direct control however, which pose serious complexity and uncertainty (WWAP, 2009).

5.1.5. Evolving water governance systems and Stakeholder divergence

Traditionally, water resources management was the responsibility of technical experts (civil engineers and hydrologists); mainly within the policy domain of physical infrastructure development in the form of planning and construction of large water storages dams and distribution canals and systems (Head, 2010, Turton et al., 2007). Here, key challenges were limited to financing water storage infrastructure and limited construction sites for dams (Turton et al., 2007). In recent years traditional water management has been confronted by a new set of complex issues relating to water scarcity, environmental and resource sustainability and high access competition driven by the conflicting demands of agriculture, industrial development and population growth (Blomquist et al., 2004; Colebatch, 2006). As demonstrated in **Figure *5.4*:**, water management has become more decentralised with a wider institutional governance system to support collaborative management. Water management has rapidly moved from the first order focus of infrastructure development, to water as an economic resource, and currently to viewing water as a social and economic resource (Turton et al., 2007). Importantly, this shift implied a greater need to engage a wider stakeholder base for water governance through the institutionalisation of integrated water resources management (Turton et al., 2007). The second order focus reflects an appreciation of the IWRM principles, particularly when water scarcity calls for multiple water users to collaborate between scales and spheres in the management of water resources (van Koppen & Schreiner, 2014).

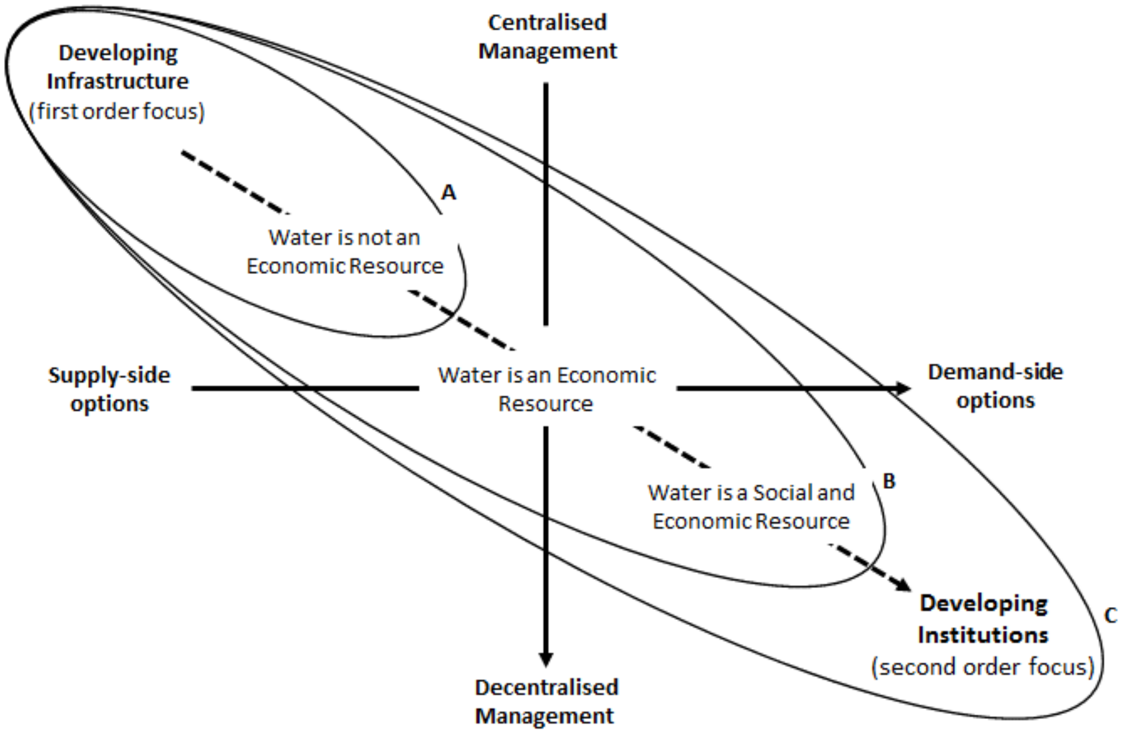


Figure 5.4: Conceptual model illustrating the general trend of change as water resource managers adapt to include a wider range of drivers and issues (Source: adapted from Turton et al., 2007).

Water scarcity and associated uncertainties are effectively at the centre of the need for cooperative behaviour and networked policy institutions. Among others, the new direction for water management strategies needed to focus on demand-management, water efficiency, and collective frameworks allowing for benefit and burden sharing and trade-offs among stakeholder interests (van der Brugge & Rotmans, 2006). This strategic shift effectively meant the birth of new water governance structures and associated policy institutions in the form of IWRM (Lach et al., 2005). The water resources policy management challenge has broadened over time from being largely a hydrology and infrastructure construction issue, towards broader and diverse issues of environmental sustainability, water regulation, competing water uses, and complex debates over appropriate trade-offs between ecological, residential, agricultural and industrial uses of water (Head, 2010; Gallopín, 2009). Importantly, such a system of interrelated, interdependent and complex policy problems also raises issues of competing aspirations, values and perspectives among the different stakeholders and social groupings that could adversely affect the possibility of agreed policy solutions (Head & Alford, 2015).

As such, while the lack of knowledge is central to the concept of uncertainty, it is but one aspect of it. Complexity emerges when a policy intervention is characterized by a high degree of social conflict about how to address a public problem and high uncertainty, which is often associated with policy interventions that are technically and socially complicated to manage (Patton, 2011). Often, there is disagreement about what is known, or even knowable (Head, 2008; Walker et al., 2010), or there may be dissatisfaction with existing knowledge when reflected against different values, perspectives, experience and expertise of the policy stakeholders involved (Davies, 2004; Head & Alford, 2015; Nutley et al., 2003). According to Patton (2011), it is the interaction between uncertainty and stakeholder disagreement that deteriorates management control even for aspects where the policy could be manageable. Accordingly, high uncertainty about how to produce a certain result fuels disagreements that further intensify and expand the parameters of uncertainty (Patton, 2011, p. 90).

Head (2008) argues that high levels of uncertainty may not be sufficient to tip an issue over to the 'wicked' classification of policies. Instead, as demonstrated in **Figure *5.5*:**, wickedness emerges from the convergence of uncertainty, complexity (interconnectedness, interdependencies and the interaction outcomes thereof) and the divergence of stakeholder values on how to manage a particular policy problem (Head, 2008; Head, 2010; Head & Alford, 2015). Rittel and Webber (1973) define 'wicked' public policy problems as those characterised by a great degree of complexity, unpredictability and open-ended goals that are generally intractable, incomprehensible and resistant to solution, while exhibiting great potential for unforeseen consequences and risks. Interestingly, the key elements of wicked policy problems have increasingly become staple characteristics of modern social, economic, and environmental development global policy systems (Head & Alford, 2015).

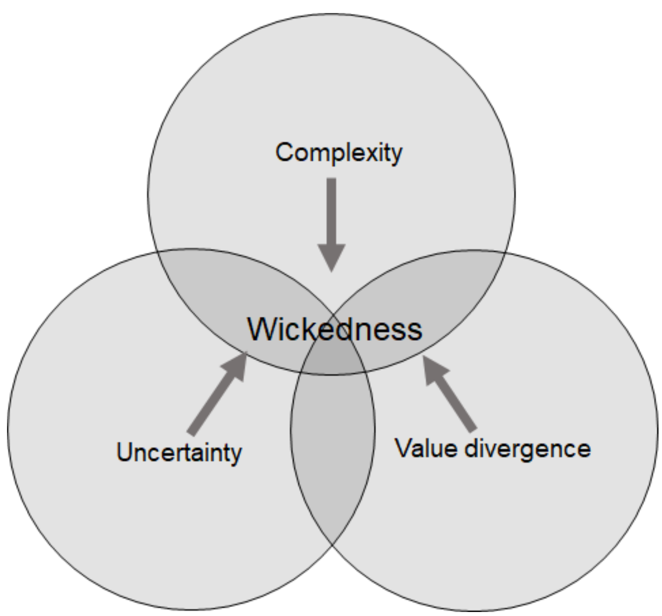


Figure 5.5: 'Wicked' as a combination of complexity, uncertainty and stakeholder divergence (Source: Head, 2008).

Head (2008) argues that, while complexity, uncertainty, and divergence are key constituent features of wicked problems, when isolated, these dimensions may not necessarily constitute ‘wickedness’. According to Head (2008), wicked problems would be those rating highly across the three dimensions rather than in one or two. For example, the difficulty in the precise estimation of policy variables and outcomes is in itself not enough to trigger wickedness, nor are disagreement among stakeholders. Instead, as demonstrated in **Figure 5.5:**, it is when a policy system simultaneously demonstrates uncertainty, complexity and some significant stakeholder disagreements that a policy issue may be considered to have reached a wicked threshold (Head, 2008).

The analysis of wicked policy issues resonates with the challenge presented by water resources policy management in South Africa. The task is great and the pathways to achieving the goals are hardly straightforward with numerous conflicting voices on the solutions. Failure of the water resources management policy would also have dire consequences, in the short to long term, on society, economic development and the environment with greater risk for political instability. This creates a serious dilemma for policy makers who must satisfy not only the evidence-based policy direction but also economic, social and/or politically negotiated policy positions, as is the case for South African water resources management policy. In fact, Head (2008) argues that the dilemma presented by wicked problems cannot be resolved by simply closing the evidence-gaps with empirical knowledge about a particular issue. Disagreements between different policy stakeholders, policy makers and analysts may present new uncertainties in the form of subjective policy views or positions that go beyond those emerging from gaps in the knowledge (Schon & Rein, 1995). Such a divergence of stakeholder values bears greater consequences for major policy management decisions. Disagreement between and among different policy stakeholders, policy makers and analysts, regarding different positions on the credibility of different aspects of a particular problem and proposed policy solutions, governance structures, etc. creates uncertainty about the best decisions options to take.

5.3. Implications of uncertainty for policy evaluation

As demonstrated in **Figure *5.6***, at the one extreme, there are policies that demonstrate great technical complications interventions, such as the development of water storage and transfer management infrastructure, thus requiring technical consensus on what should be done. At the other extreme end, could also be policies that are socially complicated (e.g., equitable water allocations and reform in South Africa) such that there is a need for social consensus among stakeholders. Yet still there may be policies such as water resources policy management in South Africa, that demonstrate a combination of both extremes with greater complexity, uncertainty, and stakeholder divergence of the most appropriate way-forward. The latter would therefore be classified as policies implemented within the zone of complicity with greater potential to tip-over to a state of chaos.

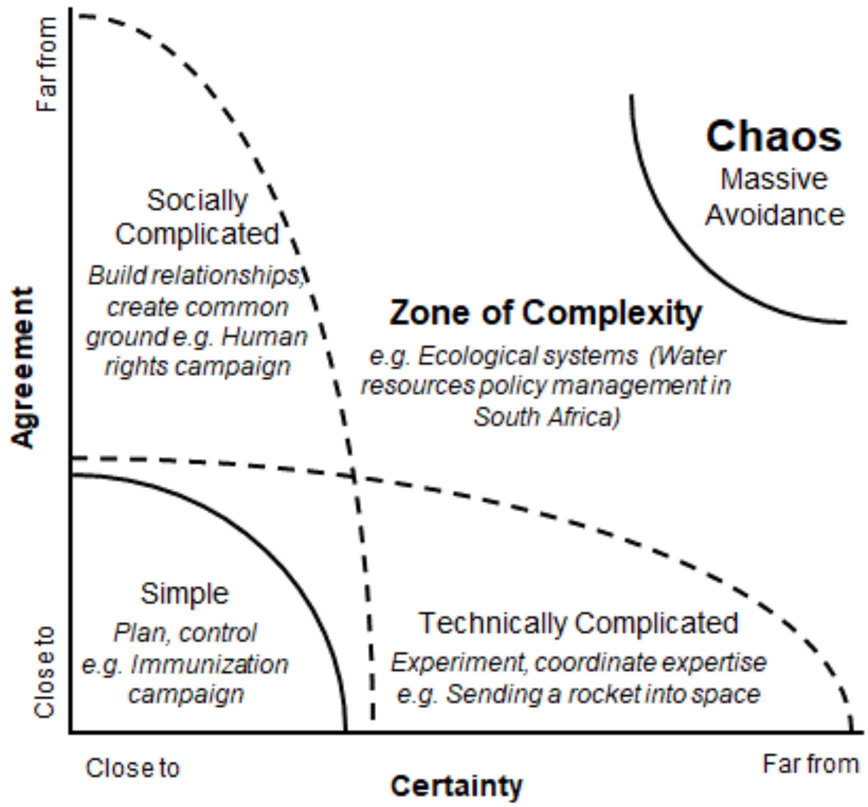


Figure 5.6: Zone of complexity for policy management (Source: Patton, 2011).

According to Patton (2011), complex policy systems present the following interdependent characteristics:

- **Emergence:** the emergence of issues that go beyond, outside of, and are oblivious to any notion of shared intentionality. Mainly as a function of interdependent systems and interactions;
- **Nonlinearity:** Sensitivity to initial conditions; small actions can stimulate large highly improbable, unpredictable and unexpected reactions;
- **Dynamic interactions:** Interactions within, between, and among subsystems and parts within systems are volatile, turbulent, cascading rapidly and unpredictably;

- **Uncertainty:** Under conditions of complexity, processes and outcomes are unpredictable, uncontrollable, and unknowable in advance;
- **Co-evolutionary:** As interacting and adaptive agents self-organise, ongoing connections emerge that become co-evolutionary as the agents evolve together (coevolve) within and as part of the whole system, over time;
- **Adaptation:** Interacting elements and agents respond and adapt to each other so that what emerges and evolves is a function of ongoing adaptation among both interacting elements and the responsive relationships interacting agents have with their environment.

Deep uncertainty and complexity make the facilitation of effective evidence-based adaptive and integrated water resources policy management, extremely difficult. Here policy makers and evaluators are challenged to employ agile and responsive policy innovations towards evidence-based management decisions. Patton (2011) argues that developmental evaluation could assist in ensuring that the generation of policy planning and management evidence is as contemporaneous as possible to the management process to guarantee real life learning and adapting. Evaluating complex systems, therefore, implies that evaluators and policy managers should endeavor to understand and manage both known and controllable as well as the unknown and uncontrollable behavioral characteristics of the system. The appropriate approach in this regard is to be intentional about learning and adapting, rather than expressing a misguided sense of control of the system and risk missing any potential learning and improving opportunities.

The challenge of deep uncertainty has become increasingly common with most social, economic, political and environmental public problems of the 21st century, including water resources policy management (Borowski & Kastens, 2009; Engle et al., 2011; Head, 2008; Head & Alford, 2015; Kwakkel, Walker, Haasnoot, 2016; Williams & van't Hof, 2016). Most policy systems tend to shift towards known uncertainty, as policy makers and analysts begin to improve their knowledge and understanding of certain aspects of the system (Makridakis et al., 2009). This is effectively a stage where the behaviour of different aspects of a system is better understood by the planners, thus improving the opportunities for reliable, evidence-based policy planning and performance management decisions. In evaluation terms, at this stage, it would be possible to develop a reliable programme ToC, or performance logical framework, with a high degree of confidence on the chances that the system will behave within the confines of the perceived logic. Even then, the variables involved in a system may be unstable such that a programme still behaves differently, depending on context.

In fact, even a fairly understood system, may produce outcomes that are out of the boundaries of the perceived performance logic. Importantly, policies that may be categorised as stable in one context, may exhibit deeply uncertain performance dynamics in another. Policy design and evaluation efforts must therefore be always cognisant of this risk in order to be appreciative of the tailored needs for different contexts. There are 'wicked' policy systems, however, that are resistant to this kind of shift - towards known uncertainty. According to Rittel and Webber (1973), such wicked policy systems can generally be identified through the characteristics presented in **Table 5.4**.

Table 5.4: Characteristics of wicked public problems (Source: Based on Rittel & Webber, 1973).

Characteristics	Description
Wicked problems have no definitive formulation	There is always more than one explanation for a wicked problem, with the appropriateness of the explanation depending on individual perspectives. The problem may not be defined the same way by different actors or in different contexts.
There is no stopping rule	It is difficult to claim success with wicked problems because the problem extends to other problems. The search for solutions never stops.
Solutions to wicked problems can be good or bad, but not true or false	The approach to solve wicked problems should be tractable ways to improve a situation rather than solve it. Choosing a policy intervention may be largely a matter of judgement.
There is no immediate and/or ultimate test of a solution that could solve a wicked problem	Although history may provide a guide, there is no template to follow. Solutions are made up on the go as there may be unexpected consequences over time, making it difficult to measure the effectiveness interventions
Every solution is a one-shot operation	There are no opportunities for trial-and-error with each attempt presenting significant consequences that may not be undone
There are no exhaustively describable set of solutions	There are numerous possible solutions making it difficult to determine the most effective
Every wicked problem is essentially unique	A wicked problem is substantially without precedence; experience does not provide solutions
Every wicked problem is a symptom of another problem.	Wicked problems are entwined with other socio-economic, political and environmental problems. They demonstrate complex interconnectedness with greater potential for unpredictable outcomes
The existence of a discrepancy representing a wicked problem can be explained in numerous ways	Wicked problems involve many stakeholders, who have divergent views about what the problem and its causes might be.
The planner has no right to be wrong.	Planners are held liable for the consequences (large impact is hard to justify) of any actions they take

Policy interventions, designed to address rapidly changing and complex problems, such as those encountered in water resources management, more than likely do not follow a linear ToC. Instead, several external, unexpected, and unanticipated developments could affect the policy impact pathways. This increases the chances of policy failure and/or unintended policy outcomes not being detected early enough, especially if the policy M&E process only focuses on internal indicators, rather than on a comprehensive (internal and external) outlook. As noted by Kusek and Rist (2004), although results-based M&E is a powerful public management tool to help policy makers track progress and demonstrate impact (without the identification of appropriate outcome and impact indicators as a *priori*), it is highly possible that the design, implementation and performance measurement of projects, programmes or polices may be misguided. Kusek and Rist (2004) define outcome indicators as the:

> Quantitative or qualitative variables that provide simple and reliable means to measure achievement, to reflect the change connected to an intervention, or to help assess the performance of an organisation against the stated outcome. (p. 65)

In line with this definition, without clear and appropriate performance indicators, it becomes increasingly difficult to measure and tell a reliable story about the results chain of an intervention or policy. This could be especially true for designing appropriate and relevant water resources management policies that respond to highly uncertain and transient targets such as drought, flooding, political instability, population growth or migration.

M&E is one of the key adaptive policy tools that are central to the generation of credible policy design and performance evidence (Swanson et al., 2010). This is only possible however through the guidance of accurate causal linkages between the policy problem, the interventions and the eventual outcome or impact of the interventions (Cloete & de Coning, 2018). The perceived causal relationship is commonly referred to as the Theory of

Change (ToC), which is the theory that underlies the policy intervention. The ToC can also be presented through a logical framework of the policy intervention, highlighting the logic through which specific actions will be able to produce specific outputs, outcomes, and the eventual impact (Cloete & de Coning, 2018; Wildschut, 2014). According to Cloete and de Coning (2018), a ToC typically comprises, one or more alternative or competing sets of logical sequences of linked theoretical and practical assumptions, which explain why a particular policy intervention is necessary and how it should be implemented to ensure it successfully achieves its intended outcomes. Furthermore, in analysing predictable versus unpredictable futures, Cloete and de Coning (2018) argue that there are two competing contexts to change: first, is a policy context where change is fixed, known, predictable, controlled, and rational, thus resulting in conventional, deterministic, linear, and simple mechanistic outcomes. Second, is a policy where the future is perpetually under construction such that the magnitude of change is uncontrollable, unknown, and even unknowable, resulting in multiple unexpected and unintended outcomes.

This study argues that uncertainty and complexity can seriously disrupt any perceived policy causality-effect to a state that is uncontrollable and with greater risk for multiple other unexpected and unintended outcomes, which may be positive of negative. As illustrated in **Figure *5.7***, the challenge for traditional ToC, especially in deeply uncertain and complex policy management conditions, in that there is greater emphasis on the foreseen policy performance dynamics. As such, the policy ToC may risk becoming rigid in the way previously unconsidered emerging variables are treated thus possibly limiting the value of learning and adapting that could be potentially exposed through such external policy design and performance variables.

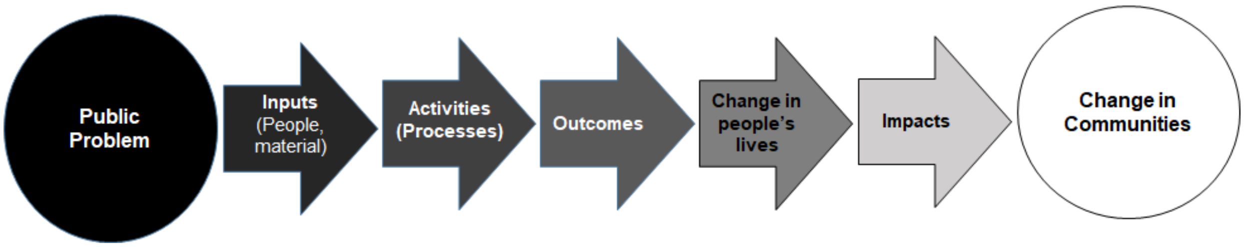


Figure 5.7: Linear Logic Model (Source: based on Westley, Zimmerman & Patton, 2006).

Over and above establishing the emerging outcomes or accrued benefits of a particular policy intervention, one of the key challenges for policy evaluators is also to establish an improved understanding of how the policy outcomes or accrued benefits were produced (Chen & Rossi, 1983). Chen and Rossi (1983) refer to this challenge as black-box evaluations, where the process of transformation in a programme is concealed through a lack of effort and focus in understanding the relationship between the different policy components that are responsible for policy performance or non-performance. As such, the evaluation results may risk mistakenly suggesting that a particular policy activity be up scaled or completely abandoned, without any proper comprehensive understanding of the policy performance mechanics that help to produce or make a policy to fail to produce certain policy outcomes. These challenges might be exacerbated in cases where wicked policies are the subjects of an evaluation due to the interdependent nature of the intervention with other policy systems that may dampen and/ or amplify some aspects of the policy performance dynamics. As illustrated in **Figure *5.8***, according to Walker et al. (2003), model structure uncertainty (uncertainty about the form of the model itself, Figure

5.8c) may produce competing interpretations of the cause-effect relationships, and consequently, it is possible that neither of these interpretations is correct.

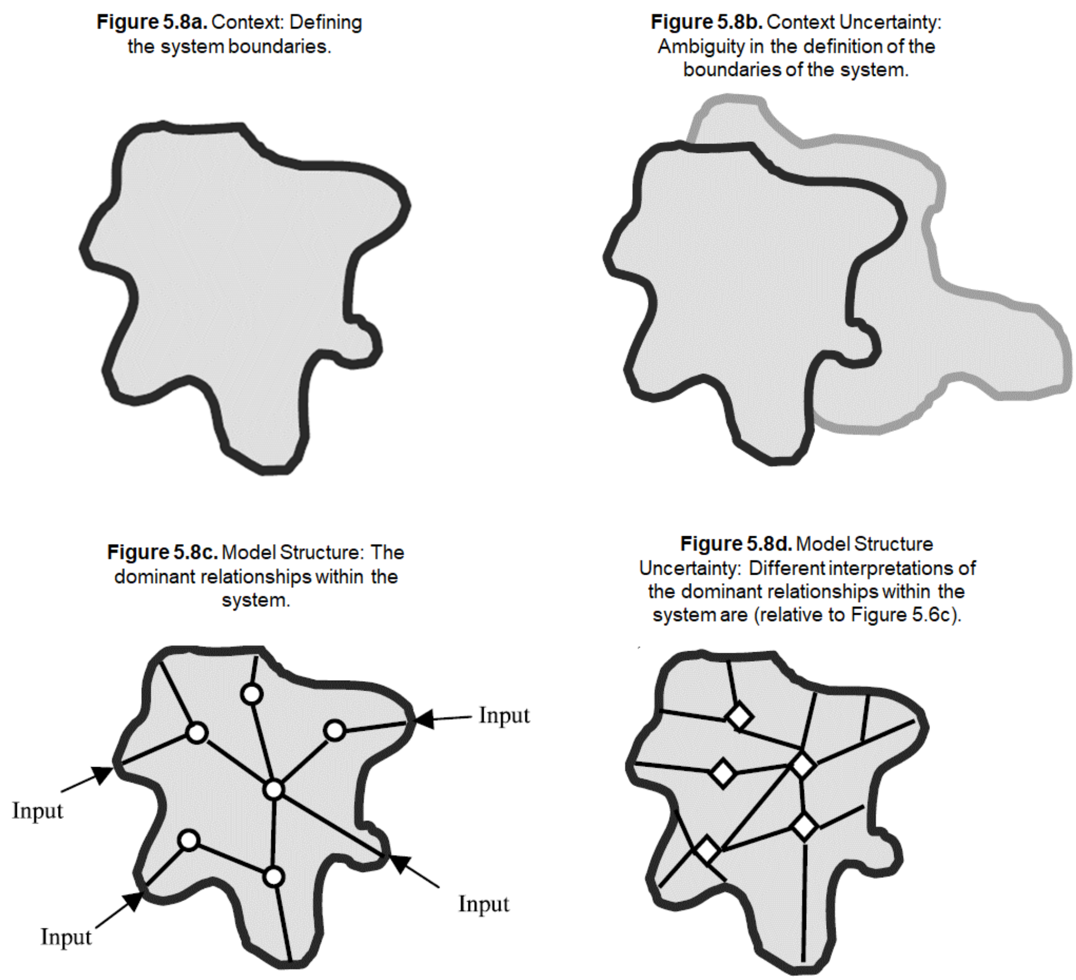


Figure 5.8: Context and model structure of uncertainty (Source: Walker et al. 2003).

Amplifying potential mis-conception or at best not optimal-conception of policy evaluation, traditional methods tend to aggregate uncertainty as a marginal issue - only evaluating the impacts of ‘known uncertainties’ for which estimates or probability distributions are available (van Asselt and Rotmans, 2002). In developing the policy ToC or logical framework, policy planners and evaluators often treat uncontrollable external variables, as risks to the predetermined performance logic with very little effort made to integrate and address such issues where possible. In a system of interconnected and highly interdependent systems, the generation of evidence is especially complex as solutions in one system could be addressed by managing and addressing issues presented by variables in another. Such policy systems are often interconnected and interdependent with other related systems, resulting in greater complexity and more uncertainty through which policy decisions must still navigate. The wider system-view simply cannot be ignored; instead, there must be intentionality to comprehensively pursue such external variables such that they are catered for in the planning, monitoring and policy evaluation processes.

In **Table 5.5**, Westley et al (2006) presents a distinction between the focus of traditional evaluation approaches and complexity-based developmental evaluation as the bases to argue the need to evolve evaluation studies towards continuously adding value to the evidence-based policy management process especially for policies implemented in a context plagued with deep uncertainty and complexity.

Table 5.5: Distinctive emphasis between traditional and complex-based/developmental evaluations (Source: adapted from Westley et al, 2006).

Traditional Evaluations	Complexity-based/Developmental Evaluations
Render definitive judgments of success or failure	Provide feedback, generate learnings, support direction or affirm changes in direction
Measure success against predetermined goals	Develop new measures and monitoring mechanisms as goals emerge & evolve
Position the evaluator outside to assure independence and objectivity	Position evaluation as an internal, team function integrated into action and ongoing interpretive processes
Design the evaluation based on linear cause-effect logic models	Design the evaluation to capture system dynamics, interdependencies, and emergent interconnections
Aim to produce generalisable findings across time and space	Aim to produce context-specific understandings that inform ongoing innovation
Accountability focused on and directed to external authorities and funders	Accountability centred on the innovators' deep sense of fundamental values and commitments
Accountability to control and locate blame for failures	Learning to respond to lack of control and stay in touch with what's unfolding And thereby respond strategically
Evaluator determines the design based on the evaluator's perspective about what is important. The evaluator controls the evaluation	Evaluator collaborates with those engaged in the change effort to design an evaluation process that matches philosophically and organisationally
Evaluation engenders fear of failure	Evaluation supports hunger for learning

Patton's (2011) work on 'developmental evaluation' is a direct response to the limits of traditional evaluation towards meeting the challenges presented by complex non-linear dynamics that cut across systems. Developmental evaluation builds on traditional evaluation methods that explore merit and worth, and processes and outcomes, to address formative and summative questions. It differs in emphasis, however, in that it is embedded in the policy implementation process in a manner that facilitates real-time learning and adaptive decision-making.

Patton (2011) suggests the strengthening of logical models in a manner that embraces the complexity and nonlinearity in the policy performance dynamics as the most appropriate for complex and deeply uncertain management condition. In line with Rittel and Webber's (1973) argument that wicked policies do not have a stopping rule, Patton's (2014) further suggested feedback measuring related to measuring policy effectiveness and stakeholder satisfaction through continuous learning and improving. This instead of rigid evaluations that are biased to tracking policy performance only against the predetermined policy goals often driven by externally accountability processes rather than perhaps for both external and internal perspectives of accounting and learning respectively. In this way, there is an improved chance that performance successes can be improved, and failures or risks detected early because of the comprehensive understanding of the wider policy performance dynamics. He categorizes three key areas of focus; the policy design **structure**, the implementation **process** as well as the policy **outcomes** as the value chain for policy effectiveness and where evaluative measurements to understand the policy should be focused (See **Figure *5.9***).

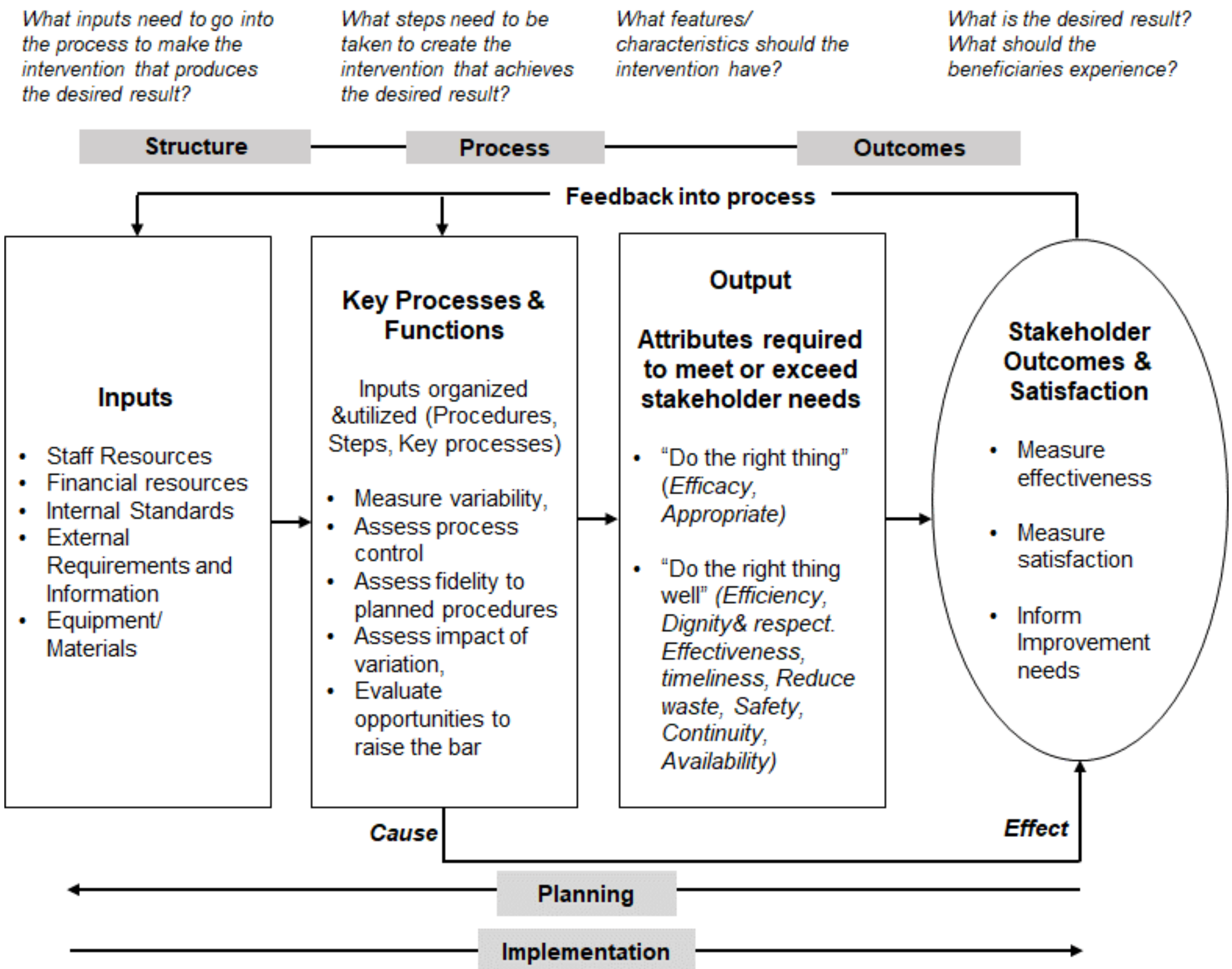


Figure 5.9: Feedback systems logic model (Source: adapted from Patton, 2014).

5.4. Conclusion

The consideration of uncertainties presented in this chapter and specifically related to water resources, reveals variables of note to inform water resources policy planning and evaluation efforts to strengthen performance efficiency. South African policy makers and evaluators alike must acknowledge that numerous internal and external environmental, economic, socio-cultural, and political uncertainties exist and may be central to the potential successor failure or the efficiency of the water resources policy management. With this recognition, M&E could play an important role in designing innovative and robust policies to respond to the deep uncertainty conundrum that is characteristic of water resources policy management in South Africa.

Deep uncertainty and complexity make the facilitation of effective evidence-based adaptive and integrated water resources policy management, extremely difficult. Here policy makers and evaluators are challenged to employ agile and responsive policy innovations towards evidence-based management decisions. Patton (2011) argues that developmental evaluation could assist in ensuring that the generation of policy planning and management evidence is as contemporaneous as possible to the management process to guarantee real life learning and adapting. Evaluating complex systems, therefore, implies that evaluators and policy managers should endeavor to understand and manage both known and controllable as well as the unknown and uncontrollable behavioral characteristics of the system. The appropriate approach in this regard is to be intentional about learning and adapting, rather than expressing a misguided sense of control of the system and risk missing any potential learning and improving opportunities. There could be cases however, where employing strategies that strengthen the utilisation of evaluation results could yield better results to support policy effectiveness and improve the appreciation of empirical evidence in water resources policy making. Nonetheless, this thesis also acknowledges that managing uncertainty and complexity goes beyond strengthening policy management evidence but should also include a greater appreciation of the social, economic, and political context through which a policy is implemented.

The efficiency of adaptive and integrated water resources policy management strategies designed for help navigate deeply uncertain and complex policy management conditions could be improved if the policy implementation realities that risk failure could be anticipated or detected early. Importantly, in adaptive policy management, such flexibility does not necessarily represent a lack of decisiveness on the part of the responsible policy managers, but rather an honest admission and awareness of the policy management uncertainties, complexities, and performance opportunities to embrace through a systems perspective to policy design, M&E and ultimately continuous learning and adapting. Such policy flexibility could therefore facilitate real-time or the early inclusion of new or altered strategies to ensure performance resilience. As a result, potential policy solutions generally lie in systems thinking approach, rather than isolated policy solutions that might run a greater risk of producing negative and unintended policy outcomes.

Although this chapter puts an emphasis on the sources of uncertainty on water resources management, it is fair to acknowledge the many innovative efforts made by different stakeholders to address some of the challenges of scarce water resources and increasing demand in South Africa. These include for example, water recycling, green infrastructure development, storm water capturing, low-flow technologies, switching to drought-tolerant crops and varieties, the adoption of water-saving irrigation systems, removing alien species, protection of wetlands and engaging multiple stakeholders to support the scaling of some of the innovations and local successes.

CHAPTER 6 : A CONTRIBUTION TO THE ADVANCEMENT OF ADAPTIVE AND INTEGRATED WATER RESOURCES POLICY MANAGEMENT IN SOUTH AFRICA

6.1. Introduction

This chapter considers the adoption of adaptive policy management approaches over and above current water resources policy management efforts in South Africa, which emphasise Integrated Water Resources Management (IWRM). The aim is to investigate the potential value and implementation challenges that could hinder of enable the adoption of adaptive policy management in an extra management layer for effective and efficient water resources policy management in a context of rapidly changing and uncertain policy management conditions in South Africa. Engle et al. (2011) refers to this approach to water resources management as Adaptive and Integrated and Water Resources Management (AIWRM) (see **Section 3.4**). Through the interviews conducted with key study informants, the study shows how a South African specific policy management focus might assist in the successful adoption and implementation of an adaptive and integrated approach to water resources policy management. The key informants interviewed in this regard included individuals with expertise in a variety of areas, including water resources policy management, water resources research, as well as water engineering; public policy analysis and management; development policy management; policy monitoring and evaluation; and water sociology.

The argument presented in this chapter follows the narrative that the generation of planning and water resources policy management performance evidence is of no value unless the adopted management strategy is intentional about learning and acting from evidence. Adaptive policy management is identified as part of a continuum of adaptive policy planning strategies that demonstrate different levels of robustness, flexibility and responsive capacities to policy uncertainty (in terms of both vulnerability and opportunity). In their review of planning approaches for adaptive policy management, Walker et al. (2013), identify several adaptive policy planning approaches: assumption-based planning, robust decision-making, adaptation tipping points, adaptive policy pathways, and dynamic adaptive policy pathways. These approaches demonstrate overlapping similarities with differing degrees of dynamism in terms of their potential to facilitate adaptive policy management. **Table 6.1** presents an overview of the different approaches for developing adaptive policies, their defining elements, the degree of uncertainty they address (from characterised uncertainty towards deep uncertainty and recognized ignorance) along with their level of dynamism.

Table 6.1: Overview of approaches for developing adaptive policies (Source: based on Walker et al., 2013).

Adaptive planning approach	Key management elements	Degree of uncertainty addressed	Dynamic nature of policy	Application/potential in South African water resources management policy
Adaptation Tipping Points	Specifies the conditions and time frame for which new or additional management strategy is needed by identifying vulnerabilities in the system and where actions must first be taken	Deep uncertainty	Static *	Could be applicable for some technical water resources management policy aspects. May not be useful for qualitative policy management aspects.
Assumption-Based Planning	Analyses critical assumptions of an existing plan, but not used to cope with changing policy implementation conditions	Well characterised uncertainty	Static Robust **	Generally the most used. However, once determined it is difficult to deviate from the developed policy management plans.
Robust Decision Making	Aims at developing a static rather than a dynamic policy	Well characterised uncertainty	Static Robust	Could be limited in a context of rapid change and deep uncertainty, as is the case in South Africa.
Adaptive Policy Making	Emphasises the importance of monitoring and adapting to changes over time to prevent the basic plan from failing	Anticipated uncertainty with some capacity to deal with deep uncertainty	Static Robust with potential for Dynamic	The approach most emphasised in South African policy theory but hardly adhered to in practice.
Adaptation Pathways	Builds on adaptation tipping points towards a more dynamic approach	Anticipated uncertainty with some capacity to deal with deep uncertainty	Dynamic ***	Assumes structured dosages of policy actions with specific outputs and outcomes, which is hardly the case in a chaotic context.
Dynamic Adaptive Policy Pathways	Includes adaptation pathways and adaptive policy making (contingency planning) components, which are helpful to identifying policy options and vulnerabilities, thus suited for rapidly changing policy conditions. Allows for anticipatory reactions triggered by sign posts and tipping point rather than in retrospect.	Deep uncertainty	Dynamic and anticipatory	Could potentially add great value to water resources management policy in South Africa if there is some intentionality to create the necessary institutional and economic capacity to learn and act.

** Timing of the policy actions not being explicitly considered*
*** Adaptation is primarily anticipatory in character*
**** Adaptation is anticipatory, concurrent, and reactive*

In practice, the different adaptive planning approaches presented in **Table 6.1** are at best integrated, such that each may not be exclusively implemented without elements of another (Walker et al., 2013). Adaptive policy management, as presented in this thesis, at least draws on all the different approaches. In this thesis, the different adaptive policy management approaches are understood to be related with overlapping adaptive policy management principles. Adaptive policy management principles, in this regard, relates to the robustness necessary to enhance adaptation through effective policy governance that is facilitated through appropriately structured institutions. The theoretical appreciation of adaptive policy management is confronted with different challenges when applied in practice, depending on the policy problem in question, the management context, as well as the resources and capacity available. In South Africa, there is a need to explore some key considerations in the application of adaptive policy approaches as an extra policy management layer that can be embedded onto current IWRM efforts, to strengthen water resources policy management performance.

This this chapter attempts to contextually understand and contribute to an improved understanding of the challenges and opportunities that the adoption and implementation of adaptive policy management could be confronted with in an applied context of water resources policy management in South Africa. The contribution could be invaluable to water resources policy management by helping to determine the key issues that might be improved upon or adapted, to ensure that the approach stands a fair chance of achieving its theoretical assertions.

6.2. Designing and implementing adaptive policies

In a context of rapid and deeply uncertain policy management changes, an adaptive policy management approach, which employs an anticipatory or reactive strategy, could be useful, instead of a 'wait and see attitude' approach. Under such policy management conditions, considerations for the underlying trends and potential future scenarios, constructed through various methods of 'prospective' analysis, which make use of, becomes a serious alternative (Head, 2010; Schwartz, 1991). Head (2010) argues that these techniques go beyond what is usually included in 'evidence-based' analysis. In this regard, it must be noted that 'evidence,' as objectively determined, is not enough to facilitate a specific decision. Instead, other factors such as stakeholder judgement, resources, values, habits and tradition, experience and expertise along with various political considerations, aftermath of, becomes of greater relevance for policy decisions (Davies, 2004). Politics, for instance, could distort the rationality of policy decisions by either pursuing a particular political agenda regardless of the evidence pointers It. could be argued that this is the case for water resources policy management in South Africa. The volatility and deep uncertainty associated with the driving factors, both on the supply and demand sides of water resources management in South Africa, makes it extremely unhelpful to employ a rigid policy management approach and expect positive results. The water resources management policy reform agenda often seems extremely difficult to execute given the country's racially discriminatory past, but is in fact even more necessary for national peace and sustainability. Although evidence for policy execution may suggest failure of a particular aspect of water resources management policy, it might not automatically imply a direct policy action in-line with the technical evidence as necessary.

In this thesis, a case is made for alternative policy making processes that strengthen normal evidence-based policymaking, and contribute to support and facilitate learning and adaptation in a practical context.

As demonstrated in **Figure *6.1***, in terms of implementation, it is helpful to look at adaptive policy management as a dynamic adaptive planning approach with two main phases (Williams & Brown, 2014). The first phase is a *Design or Deliberative phase.* This includes the development of a dynamic adaptive plan, a monitoring system, along with the design of various pre- and post-implementation actions as part of the planning process.

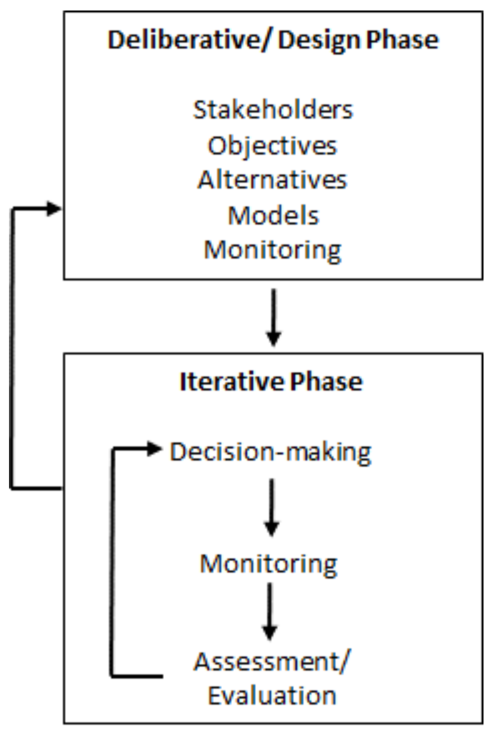


Figure 6.1: Two-phase learning in adaptive management (Source: Williams & Brown, 2014).

One of the key differentiators between traditional policy management and adaptive policy management is in the *design* or *deliberative phase* of the adaptive policy management process. The success of adaptive policy management also depends, to a great extent, on the comprehensiveness and robustness of the plan that emerges from the design/ deliberative phase. This includes clear consideration of issues such as the intended goals of the policy; key factors that could potentially affect performance and their interactions; plausible futures of key factors; policy options and indicators of success; as well as the alternative adjustments that can be triggered by different factors to ensure continuous performance (Swanson et al., 2010). Importantly, achieving such a comprehensive policy planning and performance situation would require a combination of reliable research evidence, and active participation and deliberations of multiple stakeholders with the relevant capacities (Swanson et al., 2010; Walker et al., 2003; Walker et al., 2013). Programme evaluation, in this regard, is applied to the selected policy management approach. This implies that M&E efforts are only as good as the policy management plan put in place. During this phase, the different elements of the adaptive policy management plan are developed and refined. In South Africa, great emphasis is placed on planning. In fact, the development of the national water resource strategy has been legally determined to be conducted at five-year intervals. Importantly, this may limit adaptive water resources policy management decisions outside this stipulated timeframes, but also increase the risk of a legalistic approach to policy strategic planning, even when there could be no justification from evidence to improve or change the adopted strategy. Poor policy implementation, however, remains the greatest challenge in South Africa, making it difficult to determine with certainty if the adopted policy strategy is sound or not. For example, a number of water resources policy management decisions had to be revised or improved through their implementation efforts. The second phase to adaptive policy management is embedded on the first and referred to as the *Iterative or Implementation phase*. This phase is part of the evaluation cycle (**Figure 6.1**), during which the dynamic adaptive plan and its key elements are implemented, as part of a cycle of decision-making, monitoring, evaluation, and feedback that informs the deliberative /design phase.

Overall, the two phases of adaptive policy management demonstrate cyclical characteristics, as new emerging lessons are built-into the policy planning for implementation at various points over time (Walker et al., 2001). In **Figure *6.2***, Kwakkel et al. (2010) present least five steps in the design and implementation of adaptive policies. The contribution by Kwakkel et al. (2010) could be understood as elaborate steps of the deliberative/ design and Iterative or Implementation phases of adaptive policy making determined Williams and Brown (2014).

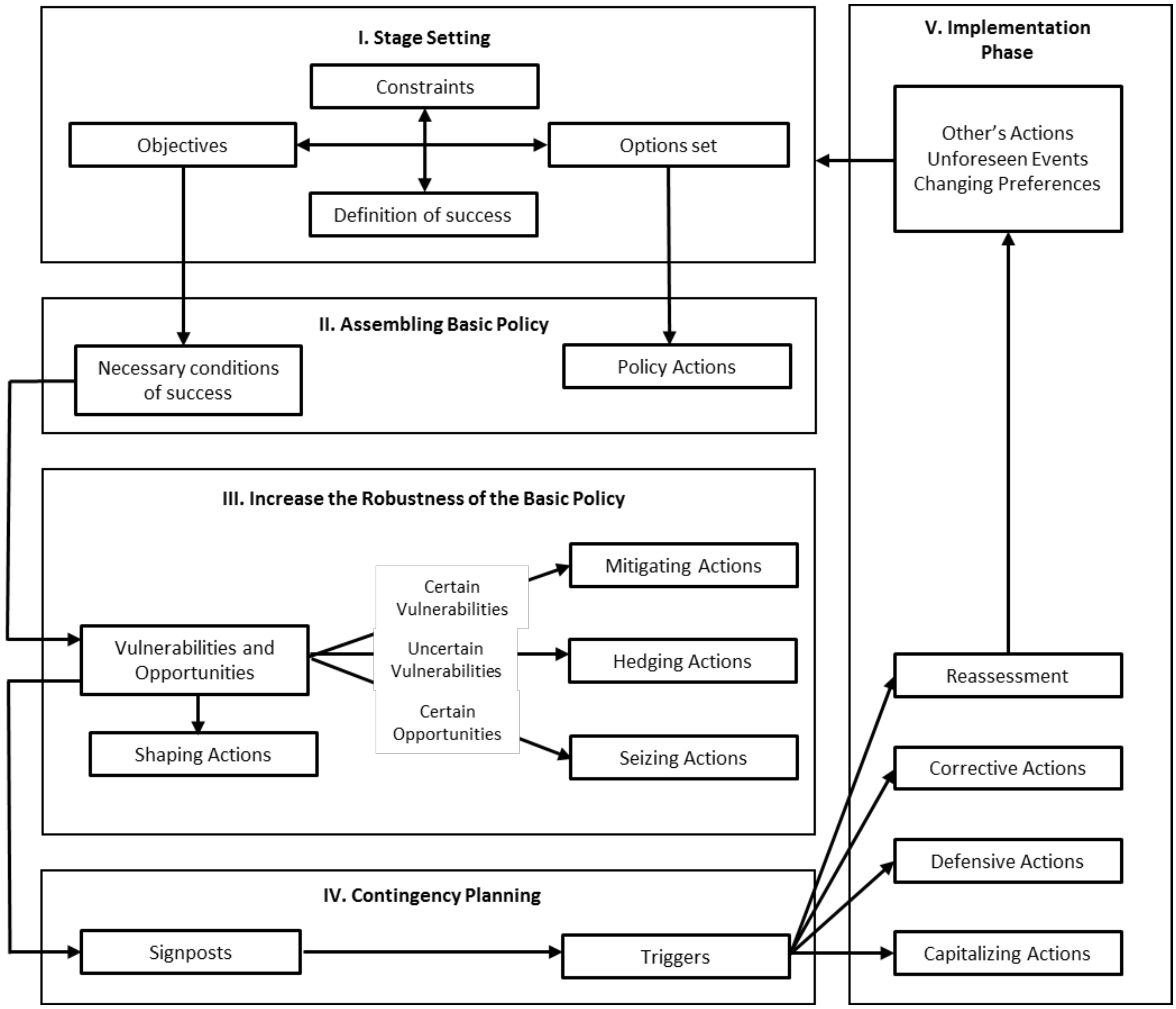


Figure 6.2: Five steps in designing and implementing adaptive policy (Source: Kwakkel et al., 2010).

As demonstrated in **Figure *6.2***, the differentiator between traditional policy management and adaptive policy management is effectively in the design or deliberative phase of the adaptive policy management process. Unlike in traditional policy management, for adaptive policy management this phase goes beyond developing the basic policy plan (i.e. identifying policy objectives, defining conditions of success, identifying potential constraints as well as policy options and the necessary policy actions) to also consider preplanning key policy elements relating to (1) increasing the robustness of the basic policy by considering certain and uncertain policy vulnerabilities and opportunities, and identifying and prebuilding appropriate actions, and (2) developing a policy contingency plan by identifying certain signposts of interest to watch over the course of implementing the policy and specific triggers that could help facilitate specific policy actions that could become necessary depending on the policy performance behaviour. As such and unlike in traditional policy management, Walker, Rahman and Cave (2001), contend that adaptive policy management as a generic and structured approach becomes useful for designing dynamic and robust policies in which, adaptation against rapidly changing and/or uncertain conditions, is readily built-in at the onset of the policy formulation stages rather than in retrospect.

Once the initial design or deliberative phase is concluded, the Implementation or Iterative phase kicks-in. During implementation signpost information related to the policy triggers is collected, and specific policy actions are started, altered, expanded, or stopped Accordingly as noted by Kwakkel et al. (2010), as long as the original policy objectives and constraints remain in place, the responses to a trigger event would be about making adjustments to the basic policy thus preserving its benefits or meeting outside challenges. These are the defensive or corrective policy actions. To ensure the effective and efficient facilitation of an adaptive policy there is need to ensure that a comprehensive policy monitoring system is established to help identify opportunities that trigger different policy actions as well as to identify obvious policy failure that trigger policy reassessment actions leading to substantial changes or even abandoning the original policy actions. Importantly, the added value offered by the adaptive policy management process is that even in cases where certain policy actions must be completely abandoned, there are numerous experiences and lessons that can be of great benefit to the next adaptive policy management cycle (Kwakkel et al., 2010; Swanson et al. 2009).

Unlike traditional policy management for adaptive policy management, this phase goes beyond developing the basic policy plan (i.e. identifying policy objectives, defining conditions of success, identifying potential constraints as well as policy options and the necessary policy actions). According to Kwakkel et al. (2010), this step also considers some deliberate efforts to pre-plan key policy elements relating to,

- increasing the robustness of the basic policy by considering certain and uncertain policy vulnerabilities and opportunities and identifying and prebuilding appropriate actions, and;
- developing a policy contingency plan by identifying certain signposts of interest to watch over the course of implementing the policy and specific triggers that could help facilitate specific necessary policy actions.

The detailed consideration of these two elements effectively helps policy makers build the necessary flexibility into the adaptive plan, as well as provides the opportunity to consider in advance the potential actions to be triggered as and when necessary. As such, and unlike in traditional policy management, Walker et al. (2001) contend that adaptive policy management, as a generic and structured approach for designing dynamic robust plans, must be built-in at the onset of policy formulation rather than as an ad hoc implementation.

During the policy implementation process, signpost information related to the policy triggers is collected, and specific policy actions are started, altered, expanded, or stopped (Kwakkel et al., 2010). Accordingly, as long as the original policy objectives and constraints remain in place, the responses to a trigger event would include adjusting the basic policy, thus preserving its benefits or meeting outside challenges. These are defensive or corrective policy actions. To ensure the effective and efficient facilitation of an adaptive policy, one must ensure that a comprehensive policy monitoring system is established to identify opportunities that trigger different policy actions. These can work together to identify obvious policy failures that should then trigger policy reassessment actions leading to substantial changes or even the abandoning of the original policy actions (Swanson et al., 2010; Walker et al., 2013; Kwakkel et al., 2010; Williams & Brown, 2014). Importantly, the added value offered by the adaptive policy management process is that, even in cases where certain policy actions must be completely abandoned, there are numerous previous experiences and lessons that can be of great benefit to the next adaptive policy management cycle (Borowski & Kastens, 2009; Hamarat et al., 2014; NRC, 2004; Rondinelli, 1993; Swanson et al., 2010; Williams & Brown, 2014). Ultimately, according to Swanson et al. (2010), when effectively and efficiently managed adaptive policy makers can produce and implement policies that:

- are robust and adaptable to a range of anticipated and unanticipated conditions;
- ensure broader stakeholder participation and commitment to policy performance;
- demonstrate enhanced local resilience to unforeseen events;
- build on experience to ensure continuous improvement and performance; and
- are effectively prepared for emergent future conditions.

The key components of the design, or deliberative phase of adaptive policy management, suggests that the adaptive capacity of a policy must, to a certain extent, be pre-planned particularly through the institutional policy design as well as the necessary resources to respond in time. This also implies that it would be difficult to embed adaptive actions on top of traditional policy plans and governance systems or structures (Borowski & Kastens, 2009; Kwakkel et al., 2010; Varady et al., 2016). Walker et al. (2013) refer to such pre-planning as ‘planned adaptation’, resulting from deliberate decisions based on an awareness of policy makers that the policy implementation conditions might change or have changed, and that certain actions are required to return to, maintain, or achieve the desired policy goals. In addition, as part of the drive to design, develop and implement efficient adaptive policy, there is a need to embed learning and immediate action as standard elements of policy management, which is certainly not currently the case in South Africa. Where evidence-based decisions are stalled, policy makers must investigate and learn from the situation, in order to avoid future challenges resulting from similar situations, and risk to be stalled again, despite available evidence pointing thereafter to a better-understood situation. Indeed, there are a number of policy aspects that could be technically determined, such as dam storage capacity versus demand for the resource in a particular location. In such cases, it may be possible to determine with certainty the risks and the alternative policy impact pathways to achieve certain policy outcomes. There are, however, a number of other variables that might not be technically determined to produce any specific outcomes, yet could be estimated using a range of expected outcomes, for which a particular set of policy actions may apply. This could include issues such as climate variability (drought, flooding and seasonal weather variations) and climate change , when overlayed with some context-specific socio-economic variables such as unemployment, poverty, food insecurity, population grown, forced migration, etc., may instead raise some highly unpredictable and unintended policy outcomes where signposts or policy-action triggers may be difficult to determine beforehand. In fact, such conditions could be further exacerbated by the complexity presented by the influence of multi-sector variables that are impacted by or impact water resources.

In recent years, there has been significant advancements made in adaptive policy management specifically through the Dynamic Adaptive Pathways Planning (DAPP) approach (Haasnoot, Warren & Kwakkel, 2019). Among other appropriate policy management contexts, Maru & Smith (2014), note that the DAPP approach is aimed to help policy makers respond better to addressing policies plagued with deep uncertainty around long-term levels of change in adaptation decision-making including an improved causal understanding of how climate change and extreme events lead to impacts and possible adaptation responses (Bloemen et al., 2018). The DAPP approach is designed mainly to respond to climate related risks where multiple long-term possible futures can be avoided by applying multiple flexible path-dependent policy actions (Bloemen et al. 2018; Barnett et al., 2014; Maru & Smith, 2014). The DAPP is effectively a dynamic, long-term transitional process of repeated policy decisions organised and structured through the adaptation pathways approach (Barnett et al., 2014).

As highlighted earlier in this chapter (**Table 6.1),** at least all the different adaptive policy management approaches present some overlapping characteristic elements with one or more of the other approaches. For example, as part of contingency planning in adaptive policy management as asserted by Kwakkel et al. (2010), there is need to identify predetermined signposts and triggers to determine the needs for either capitalising, defensive, or corrective actions or even the need for a reassessing the policy in consideration of new options. Haasnoot et al. (2013), builds further on Kwakkel et al.'s (2010) work on adaptive policy management to add decision-nodes and tipping points with a view to strengthen the dynamism and robustness of the adaptive plan towards sustained effectiveness. According to Lawrence et al. (2019), the essence of the DAPP approach is proactive planning, arguing that this ensures the development of a series of flexible policy performance pathways that are predetermined with initial actions and long-term adaptive options to consider as the future unfolds. The alternatives pathways in this regard do not necessarily have to narrowly formulated as singular paths Wise et al. (2014), but may also include portfolios of actions that are enacted simultaneously (Haasnoot, Warren & Kwakkel, 2019) as demonstrated in the pathway map in

Figure 6.*3*

Figure *6.3*: Example of an Adaptation Pathways Map demonstrating adaptation signals and decision nodes as well a scorecard presenting the costs and benefits of 9 possible policy performance pathways (Source: Haasnoot, Warren & Kwakkel, 2019).

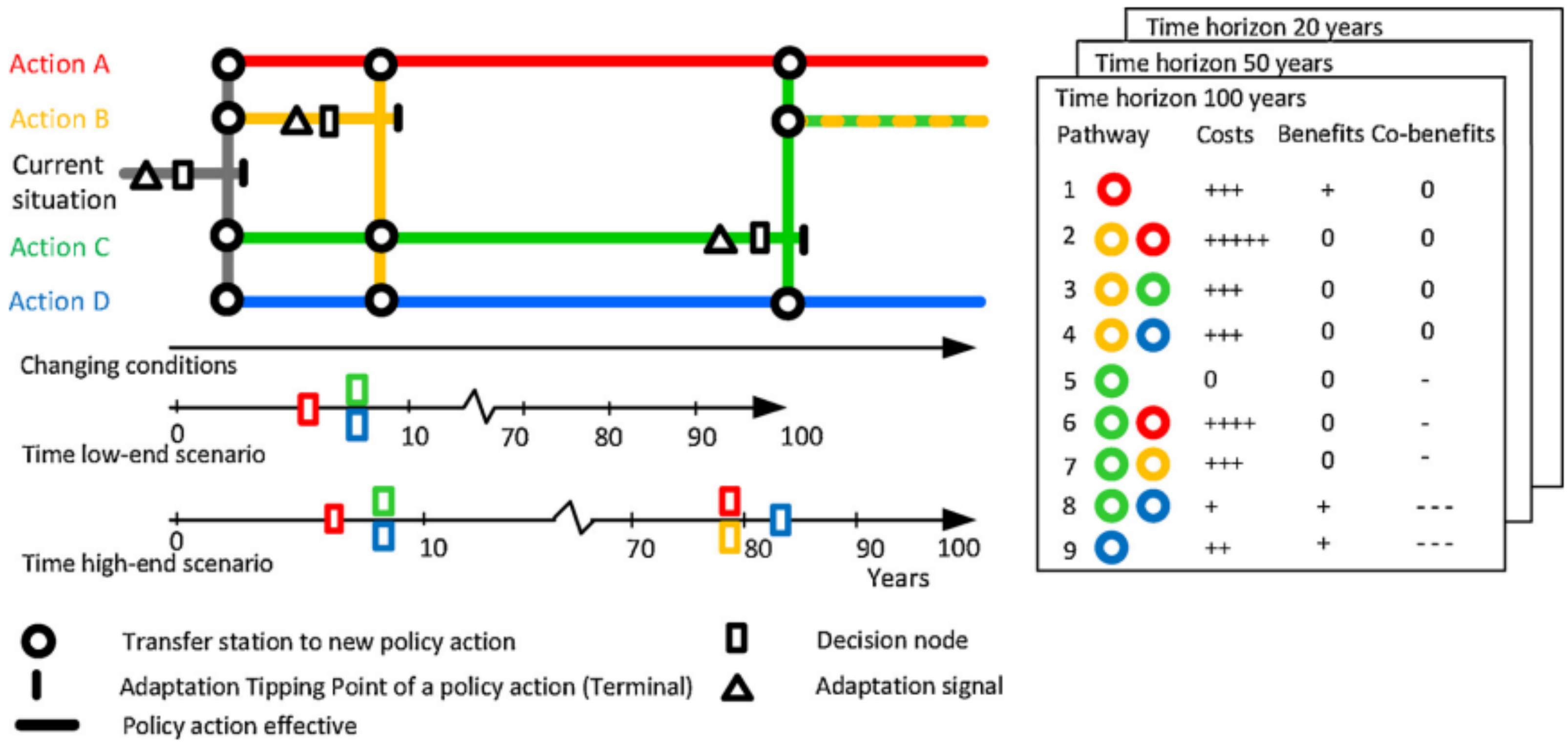


Figure 6.3: Example of an Adaptation Pathways Map demonstrating adaptation signals and decision nodes as well a scorecard presenting the costs and benefits of 9 possible policy performance pathways (Source: Haasnoot, Warren & Kwakkel, 2019).

Using the bright colours to represent the analogy of the underground train system in the City of London, England where a passenger can change from one train route to another to arrive at his/her destination, according to Haasnoot et al. (2013), the Adaptation Pathways Map helps to provide a comprehensive high-level view of policy actions and long-term options organised and structured using multiple predetermined and flexible policy pathways. It is essential to know early-on whether the policy remains on track or not, and if not, what action should be taken? In the Adaptation Pathways Map a decision node represents the latest temporal point where a decision must be taken to ensure sustained policy performance (Haasnoot, van't Kloosterc & van Alphen, 2018). Ideally, a signal should therefore be identified in time before a decision needs to be taken (thus before a decision node). A signal could be represented by some early warning signs or weak indications (demonstrating greater uncertainty) of the change as a sign that an adaptation tipping point may be approaching (Haasnoot et al., 2018). Haasnoot et al. (2018), continues to argue that, while a weak signal is generally surrounded by more uncertainty, decision makers are at least presented with the opportunity to prepare for the potential adaptive action, unlike for strong signals that demonstrate (with greater confidence) that a tipping is likely to occur and thus the risk for adaptive decisions being delayed beyond a particular decision node (Haasnoot et al., 2018; Haasnoot et al., 2013).

Ideally, different follow-up policy actions (i.e. capitalising, defensive or corrective actions) should be taken before an adaptation tipping point is reached (Haasnoot et al., 2013; Kwakkel et al.'s (2010). In resource-constrained economies like in South Africa however, there is a greater likelihood that a decision that is linked with uncertainty would not be prioritised until the current state of the policy management context or the policy itself reaches an adaptation tipping point due to limited resources. Although reduced, Wise et al. (2014), admits the likelihood for maladaptation which would certainly reduce the confidence that policy makers have to enact a particular action. Bloemen et al. (2018) argues that,

> Even in the adaptation pathways approach, it is possible that actions that seem evident now will turn out to be maladaptative as the actual risk situation reveals itself. But by explicitly taking into consideration a bandwidth of possible futures and by identifying long-term options and guaranteeing as much as possible that they are kept open, the risk of maladaptation is reduced. (P. 1086)

In a context of constraint resources, maladaptation could also be associated with a false policy signal in line with the 'lead-time' associated with a particular decision node, such as sea level rise (Haasnoot et al., 2013; Stafford Smith et al., 2011). Importantly, determining a lead-time for a decision node would be even more uncertain in cases of socio-cultural variables such as inequality, social unrest or conflict. As much as climate related risks demonstrate considerable dependencies with water resources policy management as the core public policy issue of interest for this research, there are a number of other embedded challenges that introduce greater policy complexity and uncertainty as informed by South African context-specific socio-economic, environmental, socio-cultural and political developments that may challenge the successful application of some elements of the DAPP approach. For example, a tipping point related to social unrest may not be easily recognisable as compared to sea-level rise. Even when such a signal is identified, the alternative policy actions may not be distinctively identified, just like the selected policy actions may not necessarily follow a particular performance pathway due to the emergent issues and the subsequent policy complexities. In such cases, the pathways' boundaries may be blurred such that elements of the different alternative pathways are simultaneously relevant thus more expensive if the solutions consider the effective policy pathways as those with the multiple policy actions (Wise et al. 2014; Haasnoot, Warren & Kwakkel, 2019). As such, this thesis argues for the need to consider different adaptive policy management approaches as a bucket of adaptive tools rather than one over the other. As such, applying a combination of different adaptive policy management approaches that demonstrate wider responsive capacity to a number of qualitative and quantitative variables associated with different environmental, economic, socio-cultural and political complex problems associated with water equity and water security in South Africa, may offer better opportunities for improved adaptive policy efficiencies, overall.

In this study, the argument is made that improvements on evidence-based water resources policy management may not be any more beneficial to facilitate real-time learning and adapting if they occur outside an unstructured rationale of the policy management approach that is in place, In this regard, the policy position in South Africa certainly suggests a strong drive towards the adoption and implementation of adaptive policy management as an approach for water resources policy management. While adaptive management approaches, it is argued, present great potential value for effective and efficient policy management under rapidly changing, complex and deeply uncertain management conditions, the successful implementation of such an approach faces numerous challenges in practice. Despite the growing appreciation of the potential value of adaptive policy approaches in literature, their uptake and successful implementation remain low and difficult in practice (Allen & Gunderson, 2011; DEA, 2013b; Walker et al., 2013).

Interestingly, Dewey (1927) identified the need for the adoption and implementation of adaptive policies as early as 1927, arguing that there was a need to view policies as experiments allowing for continuous learning and adaptation. Yet, the challenges to design and implement such policies persist today (Allen & Gunderson, 2011). Williams and Brown (2014) suggest that the slow uptake is related to the idea that policy makers often mistakenly believe that they are already using adaptive management. In this regard, Allen and Gunderson (2011) identify at least nine challenges that can lead to the failure of adaptive policies (**Table 6.2**).

Table 6.2: Challenges that can lead to adaptive policy management failure (Source: Allen & Gunderson, 2011).

Pathologies and Challenges	Brief Description
Lack of stakeholder engagement	Lack of stakeholder engagement early in the adaptive management process can risk the rejection of results that vary from stakeholder expectations
Experiments are difficult	The scale of experiments, perceived high costs, delays in system response to policy interventions, and vested interests of stakeholders can lead to failure in designing and implementing necessary policy experiments
Surprises are suppressed	Instead of embracing surprises as opportunities to learn rather than as externalities, policy managers often respond to an uncertain future driven by anthropogenic stress by attempting to anticipate and mitigate surprises
Prescriptions are followed	New knowledge generated by the adaptive management process should be embraced and adaptive management plans should be revisited, dropped, and rewritten as a matter of course. However, prescribed plans may sometimes be followed in the fear of making previous adaptive management plans obsolete
Action procrastination	Learning and discussion often remain the only ingredients for most complex and difficult environmental challenges where policy managers procrastinate on making and acting on tough decisions based on what has been learned
Learning is not used to modify policy and management	Often, even when new important knowledge is generated it is shelved and not acted upon, because the identified management actions are too politically, economically, or logistically difficult to carry out
Avoiding hard truths: decisions makers are risk-averse	Often small-scale management experiments are conducted and these provide some lessons that may not be comprehensive enough to provide the bigger picture information concerning a resource that could help to guide bold management decisions
The process lacks leadership and direction	There is risk that the adaptive management process is hijacked by influential stakeholder groups with opposing interests to the desired learning on how best to manage the system
Focus is on planning, not action	The desire for the development of the perfect adaptation policy may result in a situation where efforts are overinvested on the planning phase, which is often mistaken to be a panacea rather than a process and thus affects implementation

A number of the challenges presented in **Table 6.2** would have to be considered for efficient and successful water resources policy management in South Africa. In addition, and in line with this thesis, it is argued that M&E (M&E) is one of the key elements responsible for the successful facilitation of an evidence-based adaptive approach to policy management. M&E would be particularly important to track implementation actions, to facilitate learning and to guide real-time evidence-based policy decisions and execution. In South Africa however, it is noted that current water resources management policy monitoring generally tends to focus on the technical elements of water resources and related financial and administrative compliance outputs (which can be mainly reduced to numerical values), with a greater focus on regulating policy implementation processes and controlling the financial inputs, in line with the State's performance reporting responsibilities. This could be arguably the most relevant approach for monitoring technical hydrological issues such as rainfall, river-flows, dam construction, dam levels, underground water levels as well as monitoring water quality for surface and underground water (The Food and Agriculture Organisation on the United Nations [FAO], 2016; Mwendera & Atyosi, 2018; Schulze, 2005a, 2005b; Wilkinson, et al., 2018). A successful adaptive water management strategy must instead be knowledge-intensive and comprehensive enough to provide credible evidence that efficiently help to respond to both the emergent endogenous and exogenous changes that interactively determine water resources policy management performance. The development of a comprehensive set of policy design and performance indicators to M&E is therefore a central requirement to facilitate effective evidence-based adaptive approach for efficient water resources management decisions in South Africa. Such a comprehensive set of policy design and performance indicators could also be very useful to strengthen the more transient and emergent areas of water resources management policy monitoring related to uncertain environmental, economic, socio-cultural and political variables affected or affecting water resources policy management. Such information could relate to technical elements of water resources management, and other environmental, economic, socio-cultural, and political variables, relevant for water resources management in the face of uncertainty. This thesis argues that the design of comprehensive M&E efforts that are inclusive of both the hydrological and socio-economics elements of water resources policy management can play an invaluable role in addressing major evidence-based adaptive water resources policy management information needs (Patton, 2011; Williams & Brown, 2014). Such a comprehensive approach to water resources policy M&E could help improve the quality and flow of information between technical water managers, society and decision-makers in government, public sector, and civil society to inform better planning and management actions.

The successful implementation of adaptive policy management can therefore, only be achievable through deliberately planned initiatives rather than ad hoc, instantaneous and autonomous responses (Swanson et al., 2009). This implies the need for the State to institutionalise and intentionally facilitate adaptive policy readiness, which could prove difficult when policy governance institutions are, arguably, designed for stable and stagnant policy management conditions. Furthermore, adaptive policy making requires local actions, which implies the need for a great degree of decentralised capacity to manage such tasks effectively. This thesis focuses at the national level of policy management as the guiding framework for local scale activities. The national and local scales, in this regard, are complementary in that the effectiveness of the national level planning is facilitated at the local level, where success or failure could be practically demonstrated. While the national policy framework assumes a single policy instrument for all in South Africa, some degree of flexibility must be allowed for locally adapted planning and decisions. Consequently, at the foundation of all adaptive policy management is the need for the continuous generation of comprehensive, reliable and credible water resources management policy planning and performance evidence, in order to facilitate effective and efficient adaptive water decisions.

6.3. Key findings on advancing Adaptive and Integrated Water Resources Management (AIWRM) in South Africa

The following section presents the evidence (generated through interviews with the key informants of this study) on the contextual understanding of the challenges and opportunities for the adoption and implementation of adaptive and integrated water resources policy management in South Africa policy. A semi-structured interview schedule (see **Section 2.2.2**), was developed in line with the comprehensive scholarly work on the development of adaptive policies by Swanson et al. (2010), and used to gather data through interviews with key informants. Although there are several literature sources that present overlapping conceptual elements of adaptive policy management approaches (Allen & Gunderson, 2011; Borowski & Kastens, 2009; Butler et al., 2016; Hamarat et al., 2013; Kwakkel, Haasnoot & Walker, 2016), the seven tools for creating adaptive policies developed by Swanson et al. (2010) demonstrate a comprehensive set of different elements. These tools are particularly helpful in that they help to operationalise the adaptive policy-making tasks and present the potential to effectively facilitate the realisation of the desired adaptive policy-making vision of ensuring effective policies as presented in **Figure 6.4**.

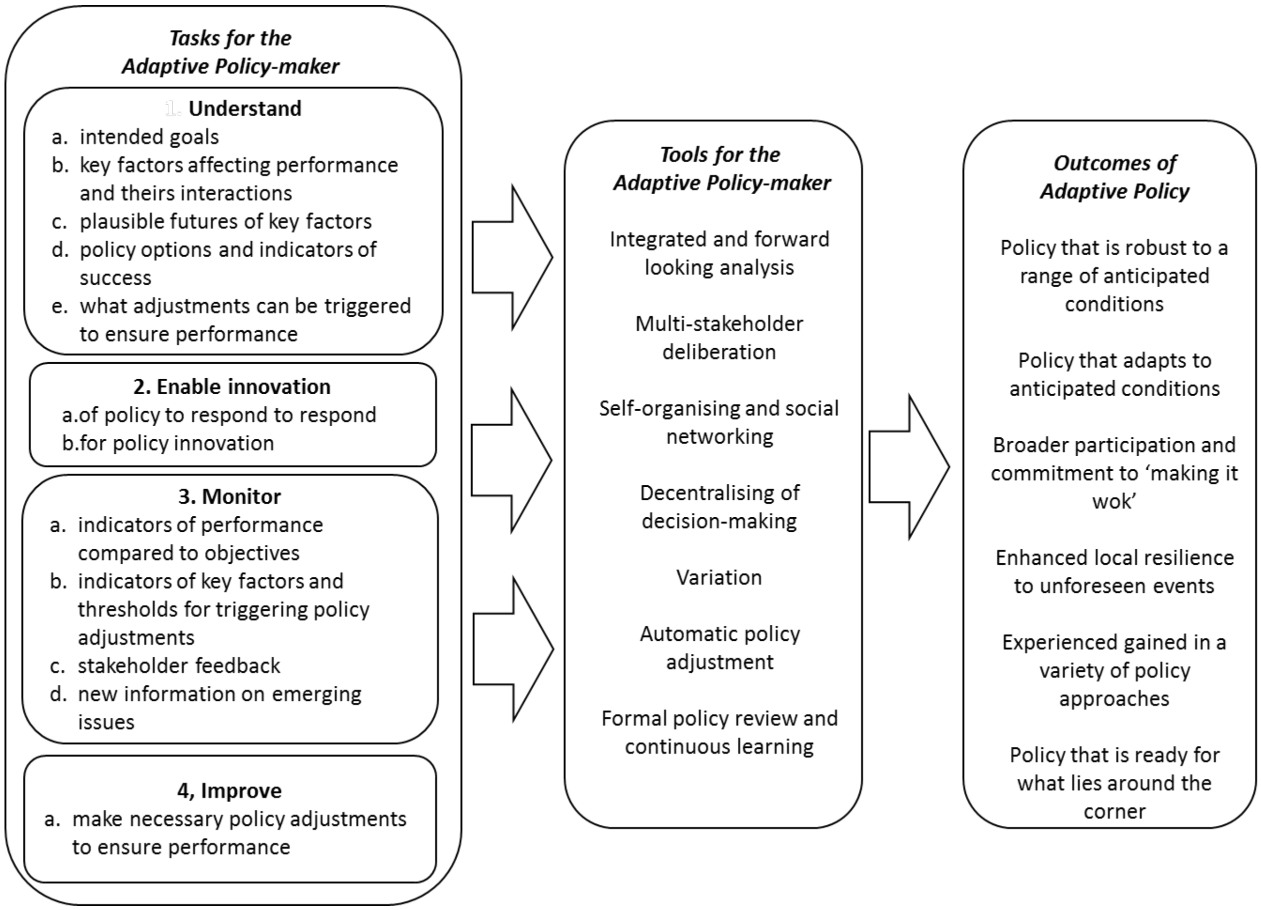


Figure 6.4: Tasks and Tools for the Adaptive Policy-maker (Source: Swanson et al., 2010).

Accordingly as presented in **Figure *6.4***, at different stages of the iterative policy cycle, there are at least four key tasks for policy makers in the design and implementation of adaptive policies. These include establishing a good understanding of the policy environment; enabling policy innovations, ensuring the availability of a variety of policy instruments to employ when needed, and fostering evidence-based learning and diverse experiences across multiple sectors and scales of the state and its organs [81]. The task is also to ensure effective monitoring and evaluation of the implementation to assess effectiveness; as well as to improve policies when they are not performing as required. The seven tools for creating adaptive policies identified in **Figure 6.4** are essentially meant to assist the implementation of these tasks. As such, Swanson et al. (2010) contend that, using integrated and forward-looking analysis; monitoring key performance indicators to trigger built-in policy adjustments; undertaking formal policy review and continuous learning; and using multi-stakeholder deliberation, adaptive policies can help to anticipate and plan for the array of conditions that lie ahead. Swanson et al. (2010) further contend that this can be done by undertaking formal policy reviews and continuous learning; and multi-stakeholder deliberation, as well as directly through enabling self-organization and social networking in a manner that creates the ability of stakeholders to respond to unanticipated events in a variety of innovative ways; decentralizing decision-making closer to local levels; and promoting the implementation of a variety of policies options to address the same issue could help increases the likelihood of achieving desired outcomes.

The interview schedule guided rather than dictated the flow of the interviews. Thus, not all the questions were relevant to each one of the key informants. Each key informant was therefore allowed to narrate the different aspects they deemed relevant to the subject, based on their knowledge, experiences and expertise. Indeed, not all the gathered data was relevant. The context also dictated what might be relevant, so that the conceptual assertions on adaptive management were not considered completely relevant for South Africa. This chapter therefore focuses only on the aspects understood to add value to the question of a contextual understanding of the challenges and opportunities to the adoption and implementation of adaptive policy management for South African water resources management policy.

Generally, based on the interviews conducted for this study, there are three interdependent interactive policy management levels, at which adaptive management decisions could be effected to manage complex and deeply uncertain water resources policy management in South Africa (see **Figure *6.5***). These levels could also help to provide a structured analysis of the challenges and issues to consider in the adoption and implementation of such an approach. These include, the ***technical policy design level***, which establishes the potential policy solutions to a substantial public problem that policy managers seek to address. In this regard, the technical aspects of the policy focus on addressing water resources management challenges in South Africa, which relates to a drive to ensure that national water resources are managed in a sustainable and equitable manner, for the benefit of all. Secondly, there is the ***institutional policy design level*,** which is the aspect of public policy management that emphasises the formal and legal aspects of government structure, institutional arrangements and the related legal powers, and the rules and procedures designed to facilitate water resources policy management in South Africa (Kraft & Furlong, 2004).

According to Klijn and Koppenjan (2006), without institutions virtually every form of collective behaviour and collective action would be impossible. In this regard, institutional/procedural policy arrangements for effective AIWRM emphasise multi-sectorial and multi-disciplinary collaboration. A greater part of multi-sectorial and multi-disciplinary collaboration is the formalisation of water governance institutions at the local, national and international levels. In practice, this level is about establishing clarity as to who is eligible to make water resources policy management decisions, including establishing which actions would be allowable or constrained (Ostrom, 1990). Thirdly, flowing from the technical and institutional policy aspects in place is the ***implementation/Operational level*** of the policy, which deals with the day-to-day execution of water resources policy management and the related legislative and strategic prescripts.

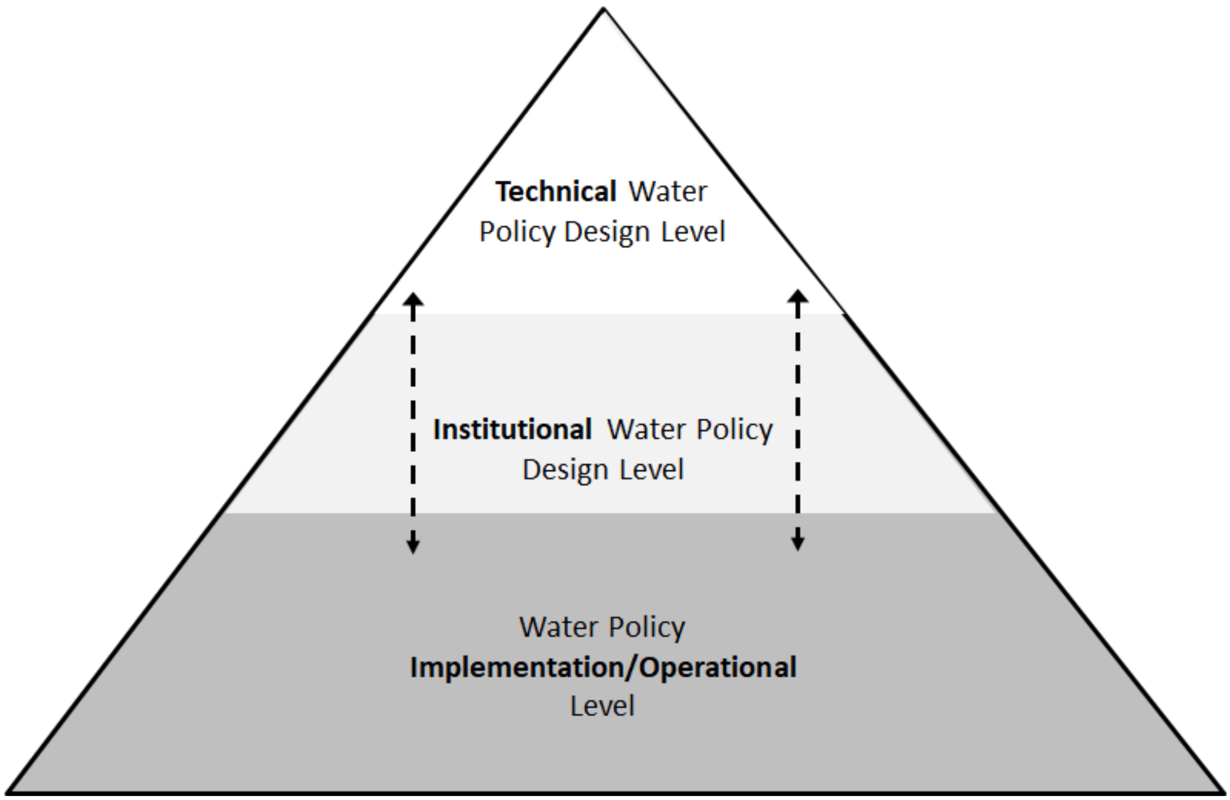


Figure 6.5: Adaptive and integrated water resources policy management levels.

In practice, these policy management levels are interconnected and interdependent. For example, the institutional design level would be informed in part by the technical water resources management policy in place, as well as by the existing institutional architecture of the State and its partners. Consequently, the institutional policy aspects and related issues would influence the State's capacity to execute the water resources policy management strategy in place. Accordingly, evidence-based adaptive decisions, in this case, may include minor or major changes to the policy design or strategy, the policy governance institutional arrangements in place and/ or changes at the operational level of policy implementation. Ultimately, it is at these levels that comprehensive policy performance evidence must be continuously generated and infused into the policy management process to ensure policy efficiency and impact. Ultimately, a policy review may be necessary when any of the policy, institutions or operational levels are not effective, e.g. the specific policy decisions cannot be implemented because the governance institutional arrangements in place are poorly designed, thus triggering a review of the institutional policy prescripts of the legislation.

In the next section, this study elaborates on the different policy management levels (as established through the study interviews) at which adaptive management decisions could be made to help effectively and efficiently facilitate policy success, even in a context of complex and deeply uncertain water resources policy management conditions.

6.3.1. Policy design

Effective adaptive policy management requires a clear intentional approach to deal with uncertainty by purposefully building-in policy dynamism and robustness into water resources policy management processes, rather than being left to *ad hoc* behaviour *(Key informant 4).* Even with limited knowledge inputs, complexity and deep uncertainty, an effort must still be made to develop an adaptable policy plan beforehand. This must be done at least for all the different elements in the policy to guide the basic thinking, assuming the different scenarios that may unfold. There must be clarity of ideas relating to what should be done if this or that scenario becomes a reality. Purposefully building-in policy dynamism and robustness does not necessarily imply that the plan would be rigidly implemented, but that there is at least a plan to deal with different scenarios, while being aware that those may not materialise. This could help foster public confidence, while strategically building-in the required flexibility and adaptive capacity, and ensuring stakeholder buy-in and implementation support of the adaptive policy management strategy. Currently, the planning cycle stipulates a five-year interval and is based on a single scenario, which could be argued to be 'business as usual', and is without clarity and intentionality to address emergent conditions. A good example might be a clear-plan to determine the thresholds of when a new dam should be constructed or dam storage capacity increased based on predetermined population growth or economic water demand thresholds, lead-time from construction to completion, and funding, etc. Thinking through these policy decisions cannot only be relevant when the problems or opportunities eventually emerge. Increased policy flexibility to navigate rapid change and emergent policy management conditions, could arise from ensuring technical, institutional and operational water resources management policy congruence and intentionality, to ensure adaptive efficiency across the board.

Furthermore, effective adaptive policy management adds an extra condition for effective policy performance in that it requires accelerated 'flexibility' as a key condition for management efficiency, in order to allow adaptive decisions to be actioned in time and with ease *(Key Informant 2 and 4).* The lack of preplanning may mean that the speed at which such identified adjustments could be slow to a point where the adaptive window to activate the relevant corrective, defensive or capitalising policy actions opportunities might be missed. Without such flexibility, adaptive management efforts would highly be impaired and unlikely to reach its envisaged benefits. On the contrary, *Key Informant 1* argued that water resources policy management for South Africa already demonstrates sufficient flexibility for adaptive policy management, asserting that:

> *The water legislation presents some basic opportunities that could potentially facilitate the necessary flexibility for the policy to change over time, in response to changing conditions. The National Water Act of 2008 provides that the national water resource strategy be developed every five years. The legislation provides for similar five year planning intervals for the development of the catchment management strategies … however, efforts if any, by the department and minister* [Department of Water and Sanitation] *to utilize these strategic policy improvement opportunities have failed dismally in the past two decades. So, I think that the policy could work, but it is restricted by the people in charge.*

To contextualise *Key Informant 1's* assertions, according to the National Water Act 38 of 1998 (RSA, 1998), the development of an NWRS, as the national level strategic guiding framework as well as the development of Catchment Management Strategies (CMS) to facilitate decentralised water resources management, must be done at intervals of no more than five years. This effectively means that water resources policy should be managed through five-year strategic management cycles, thus allowing for continuous updates in-line with new information and performance evidence to inform the next management cycle. By legislating the development and continuous updating of the NWRS and the CMAs every five years, the National Water Act effectively establishes a window of opportunity to build-in adaptive actions to inform subsequent policy management cycles. While the water legislation allows for learning and adapting opportunities, it is the responsible policy makers that are effectively not taking the offered legislative opportunities to learn and actually ensure that the policy is adaptive in real time.

However, the prescriptive approach on the time interval may limit adaptive opportunities to pursue or correct some aspects of the policy before the legally prescribed timeframe. While *Key Informant 1* argued that the current water legislation provides sufficient opportunities for adaptive management, *Key Informants 2, 4 and 5* argued to the contrary, maintaining that the current legislative provisions may in fact limit efficient adaptive policy management processes. The latter noted that, although commendable, the legislative provisions for the five years strategic planning and management cycles, would not be sufficient to facilitate the accelerated flexibility requirements for effective adaptive water resources policy management. *Key Informant 4* argued that the current legislative provisions only provide for fixed temporal opportunities to adapt the strategy, which implies that it would not be possible to explore any learning and adapting opportunities outside the prescribed planning intervals. The prescriptive time frames could also risk a legalistic approach to updating the policy, even in cases where it is seemingly on course, which in essence could be a waste of resources. A combined approach to this could possibly provide greater value and flexibility by allowing continuous learning, real time adapting, while also providing for mandatory policy review – every five years.

While flexibility is one of the key required conditions for effective adaptive policy management, in hindsight, however, it may also represent opportunistic loopholes that may be exploited for different interests other than those aspired to by the policy. This is a particularly relevant challenge in a country like South Africa, where the stakeholders are racially and economically divided by the discriminatory past policies of the apartheid government. As such, legislating policy prescripts make it possible to force a particular policy reform agenda that holds policy makers and stakeholders legally responsible to act in a particular manner, in pursuit of certain policy goals. In this regard, *Key Informant 4* noted that:

> *In a context of a highly contested public policy issue, particularly within a controversial history of exclusion and racial discrimination in South Africa, to ensure meaningful reform, most policy decisions, of a democratic State, must be legislated to be implemented, otherwise there is a great risk of stakeholder resistance to policy decisions and therefore a greater risk of water resources policy management failure.*

The legislative approach to policy management may seem like a reasonable alternative to managing South Africa's highly contested water resources policy reforms. Importantly, it may also stifle adaptive flexibility and could therefore be counterproductive for policy efficiency and performance. In such cases, policy changes would have to follow a lengthy legislation amendment process to the extent that adaptive opportunities may be missed. In this regard, *Key Informant 4* cautioned that:

> *The risk of legislated policy efforts is that decisions are confined to the provisions of the legislation, where any relevant policy decision outside the legislative provisions can't be enforceable unless the policy is amended. Policy amendment processes in democratic states are very lengthy such that they could possibly stifle adaptive actions. (Key Informant 4).*

In this case, the enforceable elements of water resources management legislation in South Africa are confined through the provision of the National Water Act (RSA, 1998). As provided for currently, water resources policy managers can only make certain strategic policy adjustments (at least every five years through the development of the NWRS and CMSs). Still, these strategies must be compliant with the major provisions of the water resources management legislation. However, in a context where the legislative provisions are too constrained, it will certainly stifle adaptive application, in response to emergent water resources policy management needs, and thus weaken policy efficiency and effectiveness. The findings of the National Water Policy Review conducted in 2013, demonstrate a supporting argument to this point. The national policy review noted several water resources management policy areas that required key strategic policy adjustments, but these would not be immediately implementable within the current rigid policy framework until the policy revised accordingly. Therefore in embracing an adaptive approach to water resources policy management, it would be necessary to build-in some key clauses that allow adaptive flexibility in the current legislation from inception. Otherwise, any other decision outside the provided legislative scope, even if justified and seemingly appropriate, could be challenged in court as unconstitutional *(Key Informant 4).* This effectively justifies increased policy flexibility in order to accommodate timely adaptive actions that can be seen as key embedded principles of adaptive policy management.

To ensure effective AIWRM, multiple sectors and stakeholders, with different expertise, must be involved. Importantly, this requires policy clarity and consensus as conditions to strengthen and facilitate stakeholder collaboration. Water resources policy management must be able to establish clarity for its existence and consensus amongst its stakeholders for collaborative implementation. Policy clarity relates to a well-understood public problem for which specific strategic policy interventions, with clear targets and timeframes, are established to address the problem. However, as established through the interviews for this study, South Africa's water resources management policy lacks this kind of clarity. The lack of policy clarity contributes a great deal to the confusion that leads to major differences in the interpretation of water resources management policy by different stakeholder segments. The policy assertions on 'Water Equity' and 'Equitable Water Access for all' as prescribed in the National Water Act (1998) is such an example, where there is some significant misconceptions and subsequent stakeholder expectations that may not be achievable at least in the short- to medium-term. Some of the informants understood the legislation to represent equal allocation of water resources, whereas others viewed this provision as representing equity in the allocation of the benefits derived from water use, such as employment and food security. *Key Informant 1, for example,* highlighted the need for greater policy clarity as a foundational issue to collaborative stakeholder efforts for effective water resources policy management in South Africa:

> *There is a common assumption that the problem of water resources management policy is about addressing unequal access and I think that is actually the wrong starting point. The formal statement of the objectives of the national water act is to ensure that water is managed in a sustainable and equitable manner, for the benefit of all, which translates to equitable benefits. I think this question of societal versus individual benefits must always be considered. However, I think the original intent of the law, and this is clearly reflected in the legislation, is to achieve equitable optimum benefit from the use of water, rather than equal allocation. However, even equitable allocation, depending on the definition, could seriously reduce the benefits from water for the society, and I think that is perhaps the fundamental point that one has to get right. Therefore, I think that this whole argument of equal access to water*

is based on a fundamental failure to understand the policy, which is to maximise the benefits of water resources for the society. (Key Informant 1)

Moreover, *Key Informant 3* argued to the extreme about the lack of policy clarity, asserting that South Africa does not have a water resources management policy, but rather a set of politically driven aspirations not grounded in reality:

In my opinion South Africa does not have a water resources management policy, what we call policy is not really policy because policy must be goal oriented and it must be grounded in reality. What we have in South Africa is a set of ideologically driven statements - they are aspirations but they are completely disconnected from the reality. (Key Informant 3)

In fact, the key informants interviewed for this study, often displayed strongly divergent views on the current and future thinking specific to the technical aspects of water resources management policy, governance and the implementation thereof. As observed in some of the interviews conducted for this study, there was clear and unhidden dissent between some of the water resources management experts. There were distinctive disagreements for instance between those who promoted the technical hydrological aspects of water resources policy management (e.g. water engineers) over those invested in water governance and related social equity issues, such as the social development experts. On the one hand, as illustrated in Chapter 5, wicked policies such as water resources policy management are synonymous with stakeholder divergence. However, the strongly divergent views of the experts also demonstrates, to some extent, a lack of policy clarity, consensus on the policy goals and the adopted policy management pathways to achieve those goals. Importantly, it would be difficult to facilitate successful adaptive water resources policy management processes in the context of such strong stakeholder divergence. Water resources management policy design efforts must strive for policy clarity as one of the means to facilitate stakeholder consensus and solidarity on the adopted policy management strategy.

Ultimately, the emerging misconceptions represent greater risks for poor stakeholder cooperation as one of the key requirements for effective policy implementation and collaborative governance of the resource by different public, private and social actors. For example, there are highly contested stakeholders perceptions on the national water resources management policy (e.g. either as an opportunity or as a threat), depending on the actors social reality within the historical context of South Africa's racially discriminatory past. As such, a great part of the reform agenda of the policy is about striking a balance in a context of great conflict regarding a scarce resource for which access remains highly skewed. Different stakeholders understand the policy differently, such that it would be necessary to continuously adjust the policy as the policy-makers improve their own understanding of the resource and its stakeholders.

Table 6.3 summarises the key findings (as determined through interviews with key informants) findings related to the contextual elements to consider in designing adaptive water resources policy management in South Africa.

Table 6.3: Summary of findings for improved policy design towards adaptive and integrated water resources management

Sub-theme	Description
Intentionality to address uncertainty	Policy makers acknowledge uncertainty but there is limited intent for purposefully building in policy dynamism and robustness through different policy design features
Policy flexibility	Policy only provides for fixed temporal opportunities to adapt, which may limit learning and adapting outside the legislated time intervals of five years. Legislated policy creates policy rigidity, which could stifle adaptive action in cases where the required policy actions are outside the legislation confines and therefore legally restricted
Policy clarity and stakeholder consensus towards collaboration	There were major divergent values demonstrated by different stakeholders on the pursued policy goals and the most appropriate policy strategies to achieve those goals. Without policy consensus, there is greater risk for poor stakeholder collaboration and solidarity in supporting policy actions

6.3.2. Institutional policy arrangements

In South Africa, water has been declared a national resource and related governance institutions are effectively national institutions, (reporting to the national Minister of Water and Sanitation), with local, national or international jurisdiction (RSA, 1998). One of the major aspects of effective adaptive policy management is the increased speed from learning, through decision-making and to action, which thrives on effective local water governance institutions. The main advantage of establishing locally based water resources governance CMAs and supporting structures is to allow for the for the increased involvement of local users, communities and related institutions in the crafting and execution of locally informed, suited and negotiated water resources management strategies. As the local level water resources policy governance institutions of the State, Catchment Management Agencies (CMAs) are a central part of water resources management in South Africa. CMAs are responsible for water resources management at the regional or catchment level in accordance with national policies, guidelines and standards set out for their jurisdiction including managing Water Users Associations (WUAs), water-use authorisation, protection, planning, compliance monitoring and enforcement, coordinating conservation and demand management programmes, and managing water quality (DWA, 2013a). In fulfilling their role, CMAs must actively involve local communities and other stakeholders through Catchment Management Forums (CMFs) and WUAs (DWA, 2013a). In cases where the CMA is not yet established, the National Water Act provides that, the Minister of Water Affairs will act as a CMA, effectively through the national Department of Water and Sanitation.

The establishment of WMAs however, remains one of the major challenges for water resources policy management in South Africa (Key Informant 1 and 2). The lack of locally representative water governance structures in the form of CMAs (i.e. only two instead of revised and legislated nine), unfortunately aids the utilisation of external consultants by the state in the development of Catchment Management Strategies (CMS) that risks being potentially poorly designed. Moreover, in the absence of fully established CMAs across all the nine Water Management Areas (WMAs), such externally pioneered CMSs are effectively left to individuals and state institutions that had limited influence in their design to lead their implementation. This could potentially limit the recognition and execution of adaptive policy opportunities and actions, due to the challenges presented by externally designed CMSs and their internal governance and implementation limitations. Nonetheless, formalising the establishment of decentralized multi-sectoral and multi-stakeholder water resources management governance institutions remains one of the major challenges for water resources policy management in South Africa *(Key Informant 7 and 9).* Therefore, failure to establish CMAs is representative of a failing water resources management decentralisation strategy with major implications for water resources policy management.

The establishment of CMAs is intended to allow the State to have local-level representation to lead water resources management policy decisions. However, even in cases where CMAs have been established (e.g. the Breede-Gouritz CMA and Inkomati-Usuthu), the national government, through the DWS is still increasingly involved in the local management decisions of governing the resource. In this regard, Key Informant 7, argued for example that:

> *When you talk about water resource management, the principle of managing water at the lowest level possible, in other words decentralized water management, is what the policies have been advancing. What is confusing, though, is that the Department of Water and Sanitation creates Catchment Management Agencies, which are no different from the regional offices of the department in the provinces, in that these Catchment Management Agencies do not have decision-making powers. Water allocation, for example, remains a national Department of Water and Sanitation function, which defeats the purpose of setting up decentralized local water management structures, when they don't have power to decide on stuff like water allocation in the water management areas that they are responsible for. Therefore, I don't see much of a difference between the regional offices and the Catchment Management Agencies, which is quite unfortunate.*

Initially, 19 CMAs were proposed through the first National Water Resource Strategy (NWRS1) based on the 19 naturally occurring environmental boundaries of the Water Management Areas (WMAs) in South Africa (see **Figure 4.7**) (DWAF, 2004a). The 19 CMAs were subsequently revised to nine (see **Figure *4.8***) (DWA, 2013a). Revising the initially proposed CMAs however, doubled their land area of management responsibility – making each of the WMAs arguable too large to be considered local. As noted by *Key Informant 7,*

> *In South Africa, we have cases where two provinces with multiple river basins and catchments are considered a single water management area, which is impractical. So as it is, CMAs simply do not represent 'local'- not from a river basin perspective and not even from a catchment perspective.*

According to Key Informant 1, the heavy involvement of the State at the local level could result from a lack of trust by the national government, either suggesting that local institutions have neither the capacity to comply nor the willingness to help advance the national policy reforms of the State towards the equitable and developmental agenda allocation. Effective AIWRM could benefit from water governance structures built on transparency, trust and sustained participation. Generally, policy governance structures that demonstrate high levels of transparency and trust, also demonstrate greater policy ownership, robust stakeholder participation and sustained collaborative action, which are prerequisite characteristics for effective AIWRM (Deleon & Varda, 2009). Trust, however, is not sufficient in water resources policy management sector in South Africa *(Key Informant 1, 4, 5 and 7)*. As noted by *Key Informant 1:*

Social cohesion remains a challenge in South Africa and trust between the State and the private sector is particularly low. This lack of trust may be related to the transformative agenda of the State that is now dominated by the black previously discriminated against South Africans while the private sector is generally controlled by white South Africans, who continue to enjoy the discriminatory water allocation and other economic benefits of the apartheid era.

In this regard, *Key Informant 1* observed that in practice, water resources policy managers tend to advocate for an approach where some of the key water resources policy management should be managed centrally at the national level, to work. Unfortunately, this approach undermines the authority of the local policy management institutions and by implication limit the turnaround time on any potential decision-making and execution processes, which could limit AIWRM efficiency. *Key Informant 1* however, argued for the contrary:

There is this notion that people will destroy their forest, grazing land or water resources unless there is an involvement of some external force. Often it is when an outside threat gets involved that the management of such (water) resources may be poor. From a resource governance perspective, one of the things I have learnt is that when people are dependent on a resource they make means to ensure that that resource is managed sustainably, because they are entirely dependent on it. Therefore, you have to get together people who understand the local context, and although they might have conflicting interests, they have an interest to resolve those conflicts. When you do that, you find that things work out.

While the argument made by *Key Informant 1* is supported through the current institutional policy provisions of the national water resources management policy (RSA, 1998), there are a number of other social and economic issues in South Africa that could be in conflict with the success potential of these provisions. The policy agenda in South Africa seeks to achieve national water security while ensuring equitable access to water and its social and economic benefits. In a context where the distribution of water use and its benefits in rural South Africa is extremely unequal with 1.2% of the rural households using about 95% of the agricultural/rural water, and 98.8% of the rural population only using the remaining 5% (Cullis & van Koppen, 2007), it could be argued that the responsibility to reform water access cannot be left only to local institutions where there are great power imbalances between for example large corporate and commercial farmers over poor communities, small enterprises and communal farmers. Instead, a more equitable and sustainable management approach could possibly be achieved through a management approach that allows a power balance to negotiate platform for equitable water access and benefit sharing. In the context of great economic and water inequality in South Africa, there could be a justifiable course to the state involvement to facilitate this transformation in water use and benefit sharing. In consequence, the State is involved in the local management of the resource. As noted by *Key Informant 1:*

> *Politicians argue that water allocation is not fair, to which I reply to them - well yes of course it is not fair, because agricultural activity is not fair, land and commercial agriculture is still dominated by a small group. In fact, industrial activity and mining is not fair, does that mean that the water use is unfair? Water use is in fact a secondary element in that, to a great extent, water use effectively follows economic activity. Having said that, I understand the political problem though. Current water*

> *users still reflect a particular constituency that is not just white but it's also big business. It's a constituency that the politicians feel uncomfortable with - because it doesn't seem to be taking benefits to the constituents of the politicians, which is the black majority. As a result, politicians often want to interfere in the management of the resource.*

While local water resources policy management actors may be committed to collaborate and sustainably manage water resources, without addressing the racially discriminatory past in water access, sustainability in South Africa would represent keeping the status core. Contrary to *Key Informant 1's* argument on the interference of politicians and the national government in local water resources policy management, in the South African context, government and political oversight is necessary to make progress in water resources management policy reform. As such, the legislation offers provides power and discretion to the Minister of Water and Sanitation *(Key Informant 8 & 9).* The argument in this regard is that the national government policy-making power present better prospects for national policy reform than what local-level institutions could offer. The design for national water resources management policy and the governance institutional arrangements would however not be enough to ensure the necessary efficient policy implementation. The national government decision-making processes however, are generally more rigid and less flexible which could undermine adaptive policy management efforts. *Key Informant 1 and 7,* argued that for effective and efficient adaptive management, decision making processes must be managed as closely as possible to the source of a problem, which may not be practical when some potentially major adaptive policy management decisions need to be actioned only at the discretion of the national Minister. *Key Informant 4* also noted that policy discretion would be effective only if the Minister in charge has access to real-time information and sound advice about the state of the technical elements of the resource, the institutions responsible, and the day-to-day challenges and opportunities at the operational policy level, which could be quite difficult to achieve. A strong national policy influence is necessary but could be equally limiting for the pursuit of AIWRM principles, which would thrive on decentralised policy governance, while being conscious of the South African historical context. The increased involvement of the State at the local level of water governance, may also risk increased lack of transparency due to the lack of trust between different private stakeholders and the State. Importantly, such interference, with potentially limited comprehension and contextualisation of the local challenges and issues, could risk even greater policy failure.

Key Informants 4 and Key Informant 5, stated that the dominant role/involvement of DWS presents a number of challenges including the employment of homogeneous approaches to the institutional policy arrangements, even for contexts where altered approaches could potentially yield better results. South Africa presents great heterogeneity between different water management areas relating to different environmental, social and economic aspects affecting water resources management. Importantly, such, heterogeneity could imply that no one approach to water resources management procedural policy governance might be fitting in other- and even less likely all- contexts. For example, there may be areas where a stronger hand of the State, to control local institutional behaviour, is justified to support and facilitate policy compliance and to achieve the national reform and developmental agenda. *For example, as argued by Key Informant 1,* sometimes due to limited local decision-making capacity decisions may be misguided and inadequate to a point where the involvement of the national government is simply unavoidable.

> *The trouble with the people of Cape Town is that they think they live in Europe, which generally does not suffer great variability in terms of water availability. As*

such, the approach to water resources management in Cape Town has been excessively influenced by Eurocentric notions that have shown to be inappropriate for the South African situation. This includes, specifically, the local paradigm of scarcity, conservation and ecosystem priority that largely rejects and even seeks to reverse infrastructural interventions. (Key Informant 1)

Consequently, different approaches to procedural policy may be justified for different WMAs to ensure contextually appropriate strategies, increased policy ownership and effective implementation, as argued by *Key Informant 4:*

> *Instead of a rigid top-down policy that applies similar rules, even in different contexts, the government could adopt a flexible policy strategy that builds on the strengths offered by different areas and institutional contexts. In this way, the policy could allow for localised deviations that could occur within a provided scope of decisions allowed to be taken at a catchment or sub-catchment area.*

Furthermore, the current CMAs, institutional design of the (which is reduced from 19 to nine) offer limited solutions as they assume the management responsibility over extremely large WMA' boundaries that create gaps in the efficient management of the resource. Importantly, this has resulted in the emergence of informal self-organising water governance platforms to fill the water governance gaps at the local level. Although informal water governance structures may not be sufficient, they do fill critical institutional gaps in the absence of the formal institutions especially at the local level. In the Gauteng province for example, although there is no active CMA, *Key Informant 1* noted that:

> *The key stakeholders such as Sasol, Eskom, mining companies, Rand Water, agriculture, etc., are able to get together and make key management decisions on the utilisation of water resources. This structure meets twice a year to monitor the resource and take decisions on operational issues … and it is normally coordinated by the department (DWS).*

Interestingly, although informal water governance structures have taken lead and successfully managed a number of common water resource issues for Gauteng province, while the Breede-Gouritz CMA in the Western Cape, (one of the only two established CMAs in South Africa), has not worked as well. According to *Key Informant 2,* a greater part of the institutionalisation issues for water resources policy management in South Africa, could be the artificial separation of water resources and water services into two distinct policy areas when they are actually connected in practice. The management of the Cape Town water crisis helps to demonstrate this point. As the largest water user, the City had to get involved in water resources management issues over and above what is legislatively their mandate – water services. As *Key Informant 2* notes:

> *Look at the role of the city of Cape Town; it's not keeping to water services only it's had to get into water resources management in a major way. So we are paying the price of the artificiality of the White Paper putting these things in different areas.*

In this regard, one of the major challenges cited for the failure in South Africa's procedural policy for water resources management relates to the fact that CMAs are based on WMAs boundaries and not in line with the administrative boundaries of local and provincial governments. As such, the policy misses the benefits that could be derived from the involvement of provincial and local government spheres including, but not limited to, financial and human resources support along with a wider coverage of policy regulation to ensure compliance by all users.

Table 6.4 presents the storyline for institutional policy alignment towards effective AIWRM in South Africa.

Table 6.4: Summary of findings on institutional policy alignment towards efficient AIWRM (Source: based on research interviews).

Sub-theme	Description
Political interference on policy governance	As a result of the racially discriminatory past of water access and continuing inequality for economic and social access, the water resources policy management process has opted for politically guided solutions (that are sometimes deemed as interference) to facilitate water resources management policy reform. Political and policy management actions demonstrate a racial bias in the pursuit of policy reform and equity in the access to water resources and its economic benefits. In a context where past water resources policy management decisions were racially biased it would follow that water resources management policy redress is racially informed. As such, policy management evidence is understood in the context of reform and redress of the country's racially discriminative past
Management discretion over social learning and consensus	The policy offers too much discretional power to the Minister of Water and Sanitation, which may limit wider stakeholder involvement in major policy decisions and thus reduce the necessary buy-in and ownership from policy partners
Power dynamics between policy actors	Water governance includes multiple stakeholders and disciplines but is dominated by the State mainly through the Department of Water and Sanitation at the national level
Trust between policy stakeholders	Due to highly contested issues of scarce water resources between stakeholders, unfavourable policy decisions have created a lack of trust and transparency in the decision-making processes between public, private, social partners and communities.
Stakeholder divergence	There is no consensus on the best way to manage and distribute the resource and its benefits, which creates highly divergent views and hostility between stakeholders on how best to manage and equitably distribute the resource and its benefits
Policy variation and innovation	There is generally a homogeneous approach to decentralized water governance even in cases where there is evident social, economic and ecological heterogeneity, which could benefit from locally tailored approaches to govern the resource

Decentralisation efficiency and effectiveness	Water Management Areas are too large for designated Catchment Management Agencies, which limits management efficiency. Limited implementation of catchment management agencies implies national government dominance also at the local level. Water governance institutions are devolved without power. Even in cases where Catchment Management Agencies are established, numerous major water resources management decisions are still made at the national level e.g. water allocations
Formal versus informal water governance structures	In the absence of formally constituted water governance institutions, there are more informal private water resources governance structures taking charge at the local level with increased risk for diverging from the nationally desired policy goals of water security and equity
Decision-making capacity at the local level	Depending on the complexity of the management challenge, there is increasingly limited decision-making capacity and responsibility at the local water governance levels

6.3.3. Policy implementation

Poor policy implementation continuously negates progress in the performance of water resources management policy. Experience in water resources policy management in the past two decades has demonstrated great failures in the implementation of the very basic aspects of the water resources management legislation in South Africa. For example, compulsory licensing was legislated in 1998 as a process to ensure sustainable and equitable allocation of water rights. As of April 2020, only three compulsory licensing projects had been completed, the Tosca Molopo groundwater aquifer; the Jan Dissels river catchment; and the Umhlathuze river catchment *(Key Informant 5, 8 & 9).* These compulsory licensing projects were implemented as pilot projects involving a relatively small area and amount of overall water resources. Similarly, only two CMAs instead of nine were established since legislation in 1998 (RSA, 1998). Beyond the pilot cases, no other CMAs were established nor have there been any other compulsory licensing processes completed. This is in contravention with the National Water Act, 38 of 1998 (RSA, 1998) and the National Water Resource Strategies (DWAF, 2004a; DWA, 2013a) which provide for the policy implementation. Most importantly, the lack of policy implementation represents lost opportunities to accelerate policy impact or identify failing policy interventions where there is need to improve to ensure policy performance. Despite a number of justifiable reasons to explain this lack of compliance, generally, current water resources management processes in South Africa demonstrate a long-standing culture of non-compliance and a lack accountability, and consequence management *(Key Informant 4).* Water legislation is therefore not adequately used to coerce policy manager to comply.

Without effective policy implementation, effective and efficient learning and improving/ adapting would be limited. Yet, continuous policy changes are proposed and often implemented without comprehensive evidence or lessons from policy implementation outcomes *(Key Informants 9). Key Informant 6* extensively argued this point:

> *You have to fully implement the policy, if you don't implement it, you will never know what works and what doesn’t. That's the biggest problem in South Africa at the moment, that in most cases, there are exceptions, but in most cases, the policy has not been fully implemented.*

Key Informant 5 argued this point further, using the establishment of CMAs as an example to demonstrate poor policy execution.

> *Take CMAs for example, there were 19 CMAs identified for implementation, but only two were established as pilot cases. Then the Department reduced the total number of CMAs from 19 to nine and now the Department is proposing reducing these further back to one national level body to act as one national CMA. The problem is that this is like changing the strategy before it is implemented.*

A great part of the water resources management policy implementation failure, is connected to policy design flaws. According to *Key Informant 4,* aspects of South African water resources management may fail, when tested against the basic conditions of good policy including:

1) Technical feasibility (it must be possible to do it);
2) Financial feasibility (it must be financially affordable to implement the policy, and;
3) Social, environmental, and institutional sustainability in the medium to long-term.

In fact, most of the key informants interviewed for this study noted that South African water resources management policy is theoretically sound but practically difficult to implement. For example, the policy demonstrates challenges of being too costly to implement. *Key Informant 2* also noted that there are shortfalls in the institutional policy arrangements relating to decision-making and policy execution, especially at the local level. He asserts that:

> *When you decentralize a responsibility, you cannot only decentralise the role without capacity. The French have a concept about this called 'subsidiarity' – it featured in our constitution negotiations in South Africa. What the French advised us at the time is that when national functions and powers are given to local government, then the principle of subsidiarity says - you can only devolve powers to the lowest level possible that has the capacity to manage at that level. So here [in South Africa], you have a situation where the water resources management functions were decentralised, but is seems there is no capacity at that level to deal with it. It's like appointing a manager without a budget and without decision-making powers. So*

from a management point of view, it's a recipe for disaster. A good example is what is going on in Cape Town at the moment with the water crisis; the city of Cape Town is now forced to encroach on the management of water resources, which is not their responsibility, because the CMA simply does not have the capacity to manage the situation.

In this regard, poor institutional policy effectiveness also relates to the limited human resource capacity, especially within the DWS (i.e. at the national and regional levels and CMAs structures). This was noted as a major limiting factor in the effective implementation of water resources policy management *(Key Informant 1, 2 & 6).* The State's capacity to implement the policy is therefore a key aspect of this analysis as noted by *Key Informant 6, "as I observe it, there are too few people doing the job and they haven't got the right competencies".*

Key Informant 2 further argued that one possible corrective action to ensure effective policy implementation, especially at the local-level, for DWS to take a very strong developmental State role that is centralist and interventionist in order. As noted by *Key Informant 2:*

The drought in Cape Town is a very good example, where the present capacities in the city of Cape Town and the Breede-Gouritz CMA in particular, cannot cope with the water crisis, such that it is to the detriment of the rest of the country. I think the critical issue here is that once the problem goes beyond a CMA, or when that CMA on its own cannot deal with the situation anymore, then that is a reason for national government's intervention. I don't think the water resources management policy adequately caters for this, but I think this is a very good reason why the national government should intervene. Incidentally, I think that the solutions to water in Cape

Town, for example, may lie outside of the Western Cape, we may need to bring water in from outside the catchment management area. Secondly, even the issue on desalination, for example, is not a city of Cape Town issue only - national government should take an interest. So the ANC (African National Congress) sitting in Pretoria cannot say 'the Western Cape is a European Province let them go dry' because in the end the economic growth issues in Cape Town will also hurt them and the poor.

Furthermore, in a context of limited human and financial resources at national and local levels of water resources policy management, the question arises whether or not there are any opportunities in current water resources management strategies that could be leveraged for adaptive management benefits. In this regard, *Key Informant 5* suggests that:

Instead of a blanket approach where you establish 19 or nine or one CMA, we possibly need to consider an issue based approach to managing water resources. This could be a bottom-up that can be managed as the issues emerge or are anticipated from the local-level instead of a legalistic approach that seeks to establish completely new CMAs across the country [Water Management Areas]. So the coordination could be based on concrete problems that require coordination. For example, an upstream mine, which is polluting the downstream, you need to address the pollution, which may involve the downstream users. This could help cut the cost of water resources management and allow for the channelling of human and financial capital to where it is most needed at a particular point in time. Obviously, you would need to ensure that issues do not escalate out of control by ensuring that M&E becomes a key part of the management process to identify and flag issues of concern to trigger management action as early as possible.

The appreciation of the potential value of adaptive policy management approaches and their adoption for water management does not necessarily equate to effective and efficient policy implementation. In practice, numerous obstacles must be overcome to ensure effective AIWRM. Limited financial capacity could limit adaptive action. A good example could be the 2016-2018 drought in the Western Cape Province that seriously affected the agricultural industry (wine and fresh produce), as well as the residents of the city of Cape Town. In this regard, *Key Informant 1* argued that the City of Cape Town water crisis resulted mainly from the indecisiveness of the national government on water infrastructure to make the necessary investment decisions, even when the evidence showed greater risk of an emergent water crisis, should a prolonged drought be experienced. Still, as asserted by *Key Informant 1:*

> *The real challenge in the Cape Town case was the fact that, although there were signs of a looming future water problem, the uncertainty made it difficult to invest money in to a future problem where there is a probability that that issue may not happen. The investment decision into the development of water storage infrastructure was difficult, especially due to other public problems that required urgent financial prioritisation. So in terms of prioritising, we seem to have a backlog of problems and thus more reactive rather than anticipative in how we manage uncertainty.*

In fact, it was only when the Cape Town water crisis was declared a national disaster that the justification was strong enough to reprioritize resources in order to manage the disaster. While the City of Cape Town water crisis have been highlighted in recent times, water storage and access problems remains a challenge across South Africa. All the interviews conducted for this study also noted major corruption issues, especially in the procurement practices for water-storage infrastructure development as one of the major challenges for the resources policy management. As such, without readily available fiscal capacity, it would be extremely difficult to implement even the basic parts of water resources management policy relating specifically to dam construction and maintenance. In this regard, the involvement of the private sector as a partner to the State could provide a feasible alternative to improve water storage capacity where feasible. *Key Informant 3,* noted that the financial capital required to pursue effective AIWRM on all aspects of the water resources policy management value chain (i.e. from the water source to consumptive and productive use and back to the water resource), could be sustainably raised through effective water-use charges, but also through private equity partners with stricter financial controls and thus better prospects for efficiency.

Table 6.5 presents current policy implementation challenges and opportunities to consider in order supporting continuous learning and policy adaptation.

Table 6.5: Summary of findings on effective policy implementation towards efficient adaptive and integrated water resources management

Sub-theme	Description
Implementation compliance with policy legislated provisions	There exist a culture where the lack of policy compliance related to policy implementation by both the State and water users occurs without consequences
Evidence-based learning and policy interventions	Even in cases where some aspects of water resources management policy are not fully implemented, there are often a number of new proposals for consideration to change and adapt on-going policy decisions virtually without enough evidence to suggest ineffectiveness or any specific inefficiencies to be considered for improvements
Turnaround-time from learning to decision to action	Outside national well-resourced and prioritized pilot cases to guide policy lessons, major water resources policy management decisions are often extremely slow or even not implemented due to a number of reasons. There are also exacerbated by lengthy policy consultation processes and general indecisiveness and lack of execution.
Financial capacity to fund policy actions	Limited water resources policy management funding in general but also due to corrupt procurement practices, makes it difficult to follow-through with timely evidence-based policy decisions
Human capacity to implement policy decisions	There is generally a limited human resource base with the necessary skills and experience to execute water resources policy management decisions especially at the local level

6.4. Conclusion

The current approach in water resources policy management in South Africa supposedly employs some of the elements of adaptive policy that emphasize learning and adapting to facilitate policy improvements changes. In practice, however, as demonstrated in this chapter, South African water resources management policy execution has consistently failed to fully exploit even the basic theoretical provisions of adaptive policy management due to the evident lack of an applied commitment to real-time and continuous evidence-based policy learning, improvements and action).

In this chapter, the theoretical assertions of the potential value of adaptive policy management were tested for practical application in the South African context of water resources policy management through interviews with key informants. Engagements suggest there are great challenges related to the adoption and implementation of the theoretical provisions of adaptive policy management approaches in their standard form. Major adjustments in different aspects of water resources policy management would have to be made to ensure contextual success. These could include,

- specific considerations for the design of the technical water resources management policy provisions in a manner that intentionally pursues better management of uncertainty and rapidly emergent management issues.
- designing institutional policy governance structures that embrace the heterogeneity of conditions presented through different geo-spatial specific issues, rather than employing a blanket approach.
- to design adaptive policy governance mechanisms that have the capacity and power to efficiently handle emerging policy learning evidence and to facilitate real-time or accelerated adaptive policy decisiveness and execution in order to capitalise on emergent opportunities, defend effective policy actions, correct ineffective actions and facilitate new responses to other emergent policy issues and preferences.
- to determine the most effective policy decentralisation strategy to address challenges continually demonstrated at the local level of water resources policy

governance policy as one of the key strategies for effective adaptive policy management without undermining the national policy imperatives;

- a greater commitment to action by facilitating timely, effective and full implementation of policy decisions; and
- to ensure that the adopted policy is well resourced with the necessary human, financial and political capital necessary for full implementation.

Indeed, some of the emerging challenges to adaptive policy management may prove extremely difficult or impossible to implement in the South African context. For example, adaptive policy management would not be any more effective without fully implementing the policy decisions at hand in order to determine what works and what doesn't and where any potential adaptive decisions could be effected. Importantly, there are a number of areas that could potentially produce the desired results if the necessary policy management issues, identified in this chapter are corrected, adjusted or improved. The most effective strategy would be to pursue the theoretical aspects of adaptive policy management that hold greater contextual relevance, rather than to treat adaptive policy management as a panacea for policy management in general without serious contextual considerations, which could stifle the successful application of this approach to policy management in South Africa.

CHAPTER 7 : KEY VARIABLES IDENTIFIED FOR MONITORING AND EVALUATING COMPLEX AND UNCERTAIN WATER RESOURCES POLICY MANAGEMENT PERFORMANCE IN RSA

7.1. Introduction

According to Osborne & Gaebler (1992),

> If you do not measure results, you cannot tell success from failure.
>
> If you cannot see success, you cannot reward it.
>
> If you cannot reward success, you are probably rewarding failure.
>
> If you cannot see success, you cannot learn from it.
>
> If you cannot recognize failure, you cannot correct it. (pp. 147-154)

Osborne & Gaebler's (1992) assertions on policy evaluation, learning and decision making, bring about the question of what counts as credible and comprehensive evidence and therefore how can such evidence be generated to inform the evidence-based adaptive and integrated water resources policy management. Chapter 7 presents an analysis of the data that emerged from the stakeholder workshops hosted as part of this study. Workshops were conducted with experts in the field to use their collective knowledge to identify important variables involved in water resources policy management, which may influence the effectiveness of such policies. Multi-disciplinary and multi-sectoral stakeholders, with expertise in areas such as water resources management, natural resources management, agricultural research and development, environmental management, public policy management, monitoring and evaluation, international development as well as social and economic development, participated in the workshops. With the appreciation that we live in an interdependent world where everything affects everything else, policy makers cannot afford to plan and manage any policy effort in isolation. This chapter seeks to establish the different internal and external variables that together determine the performance behaviour of the internal water resources policy management efforts in South Africa. In this way, the boundary of variables included or excluded in the policy planning and performance management processes, could be systematically determined.

Systems' thinking was used to help stakeholders reflect on water resources policy management given the local context presented in Chapter 4. Systems' thinking is based on the premise that understanding the system of interest (in this case water resources policy management in South Africa) is necessary in order to establish potential interactive behaviour with connected and interdependent systems. According to, Skyttner (2005), systems thinking helps establish a comprehensive appreciation of the performance complexities that emerge from the interaction of the water resources policy management system with related external environmental, economic, socio-cultural and political subsystems in a manner that is holistic rather than reductionist. Mapping the system was helpful to clarify how each of the variables involved directly and indirectly interact to determine the wider system performance outcomes. Importantly, it would be possible to develop, from the variables identified in this chapter, a fairly comprehensive list of indicators of policy performance. Such indicators could form an important part of a M&E framework that would improve the evidence base upon which water policies could be based.

7.2. Mapping the water resources policy management system in South Africa

Multiple variables involved in the water resources policy management system were identified through an iterative guidance of multi-disciplinary and multi-sectoral stakeholders to determine the applied understanding of the systems' interactions. The analysis looked at the internal and external variables outside the primary control of water resources policy managers in order to determine how these variables interactively impact water resources policy management performance and, ultimately, how these variables could be better managed and evaluated for effective and efficient policy performance. This helped to assimilate the complexity and uncertain nature of the system, through determining the reach and potential of the system variables that should be included in a comprehensive M&E framework for evidence-based adaptive and integrated water resources management.

The different variables that constitute the water resources policy management system were systematically mapped in accordance with their connectedness to other embedded economic, environmental, political and social-cultural systems. Once the first round of the mapping process was done, the emerging water resources policy management system was fed back to a few of the stakeholders (individually and together) for validation and further improvements. The smaller group of stakeholders included a systems mapping expert and eight other experts on water, climate change and development policy, who had demonstrated greater insights and commitment to the study during the stakeholder workshops. The mapping process employed multiple stakeholder perspectives, expertise and experiences in order to establish an integrated and contextual appreciation of the different variables that interactively determine the performance of the water resources policy management system in South Africa. The mapping process was effectively used to help elicit and synthesize multiple stakeholder knowledge inputs towards an integrated understanding of the South African water resources policy management system. Ultimately, the mapping process was used to identify webs of variables that play a significant role in the performance of water resources policy management outcomes. Ultimately, the emerging systems' map provided the opportunity to mine significant policy insights to guide actionable recommendations and improve the performance of the system.

7.2.1. High level mapping of water resources policy system in South Africa

The first research workshop held as part of this study helped to identify a high-level overview of the water resources policy management system for South Africa. A high-level perspective of the water resources policy management system emerged with at least three key components including: (1) water supply management; (2) water demand management and; (3) water equity related mainly to access to the resource either directly or indirectly, as the ultimate goals of water resources policy management in South Africa (see **Figure *7.1***). In this thesis, water supply and demand are understood to represent the policy means that could be leveraged to help achieve water equity. Although there are policy management issues that specifically apply to each one of these areas of water resources management policy, considering water equity as a common ambition, all the other components are closely interwoven, including other environmental, economic, socio-cultural and political variables.

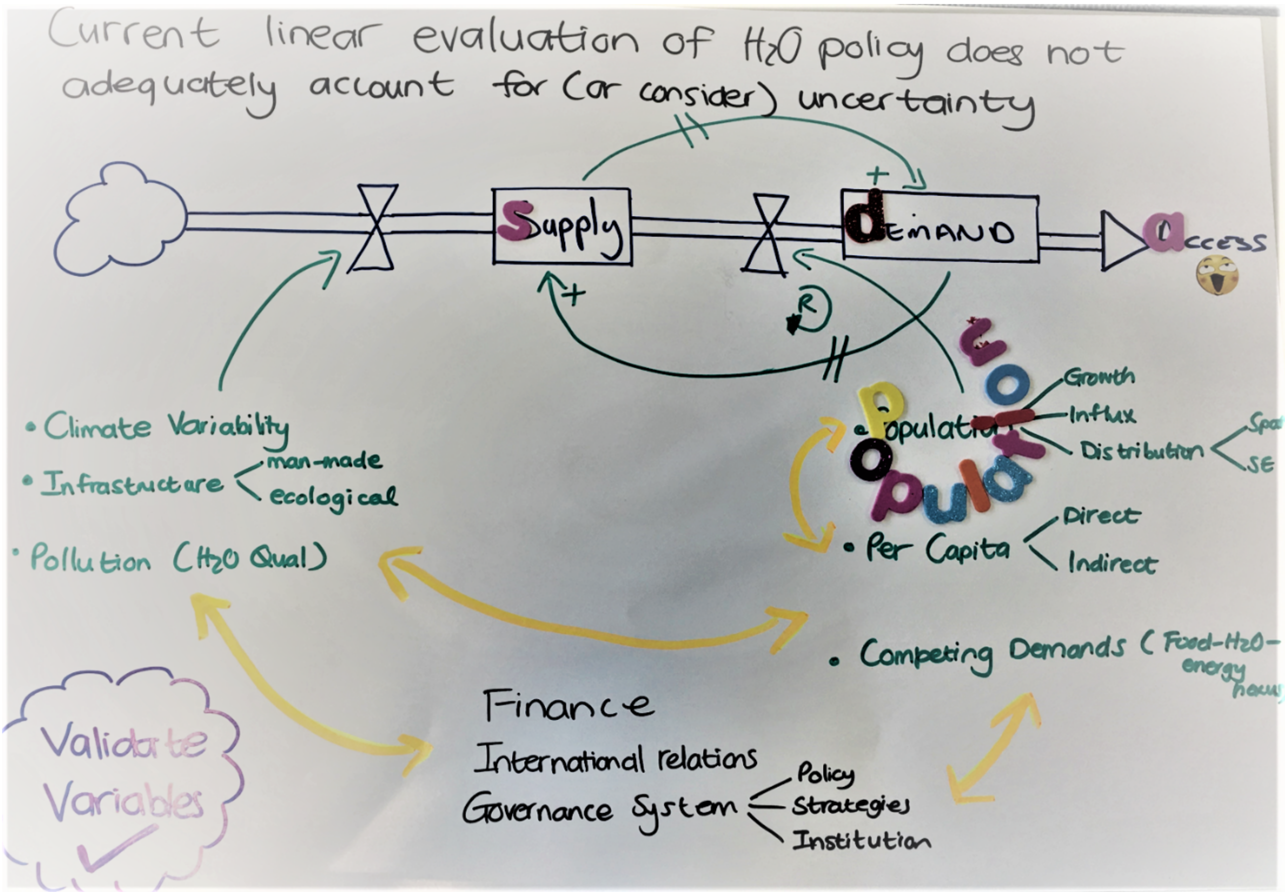


Figure 7.1: High-level visual map of the water resources policy management system in South Africa (Source: Research Workshop 1, personal communication, June 13, 2018)

Appreciating that water supply, demand and equity are the higher-level water resources policy management system variables of interest, **Figure *7.1*** also allows for the identification of a number of the foundational level variables. Together, these variables interact to influence the performance of the water resources policy management system with embedded implications to achieving equity through the social, economic and environmental benefits derived from water utilisation. The emerging picture immediately reveals the complex nature of the interconnected and multidimensional variables involved through which water resources policy management efforts must navigate towards impact.

These include issues variables such as climate change, climate variability, international relations, governance, water quality, population dynamics, etc. As demonstrated in **Figure *7.1***, stakeholders also noted that current policy performance M&E tends to assume a logical or linear sequence of policy performance interactions, which unfortunately do not adequately account for (and often simply do not consider) the uncertainty of outcomes resulting from the interactions and interdependencies of the multiple variables involved. Importantly, such interactions and interdependencies could disrupt any assumed or intended logical policy goal performance paths. The policy management process needs to be intentional in order to show how the connectedness characteristics of the system are thoroughly analysed and exposed, so as to allow for identification and employment of improved and more resilient policy management strategies towards performance efficiency and effectiveness to take place.

7.2.2. Identifying the variables that interactively determine the performance of the water resources policy management system

The second workshop helped to collaboratively identify the variables that interact to positively or negatively influence the performance of the water resources policy management system. The workshop was framed against the strategic goals of the water resources policy management strategy (DWA, 2013a). The NWRS2 identifies the following strategic objectives for water resources management:

i. ensuring that water supports development and helps to eliminate poverty and inequality,
ii. ensure that water contributes to economic growth and job creation, and

iii. ensuring that water resources are protected, used, developed, conserved, managed and controlled in a sustainable and equitable manner.

As highlighted in **Figure 7.2**, the stakeholders identified numerous variables classified into two categories; 1) Internal variables, understood to be the issues that are primarily the daily responsibility of water resources policy managers e.g. dam construction, water quality, etc. and 2) external variables, which overlap beyond the primary management scope of water resources management, such as funding for dam construction or air quality. The internal variables related mainly to water supply including rivers and catchment health, water quality, water storage infrastructure, groundwater management, water transfers, managing transboundary water sharing responsibilities, water recycling and reuse as well as water security and allocation.

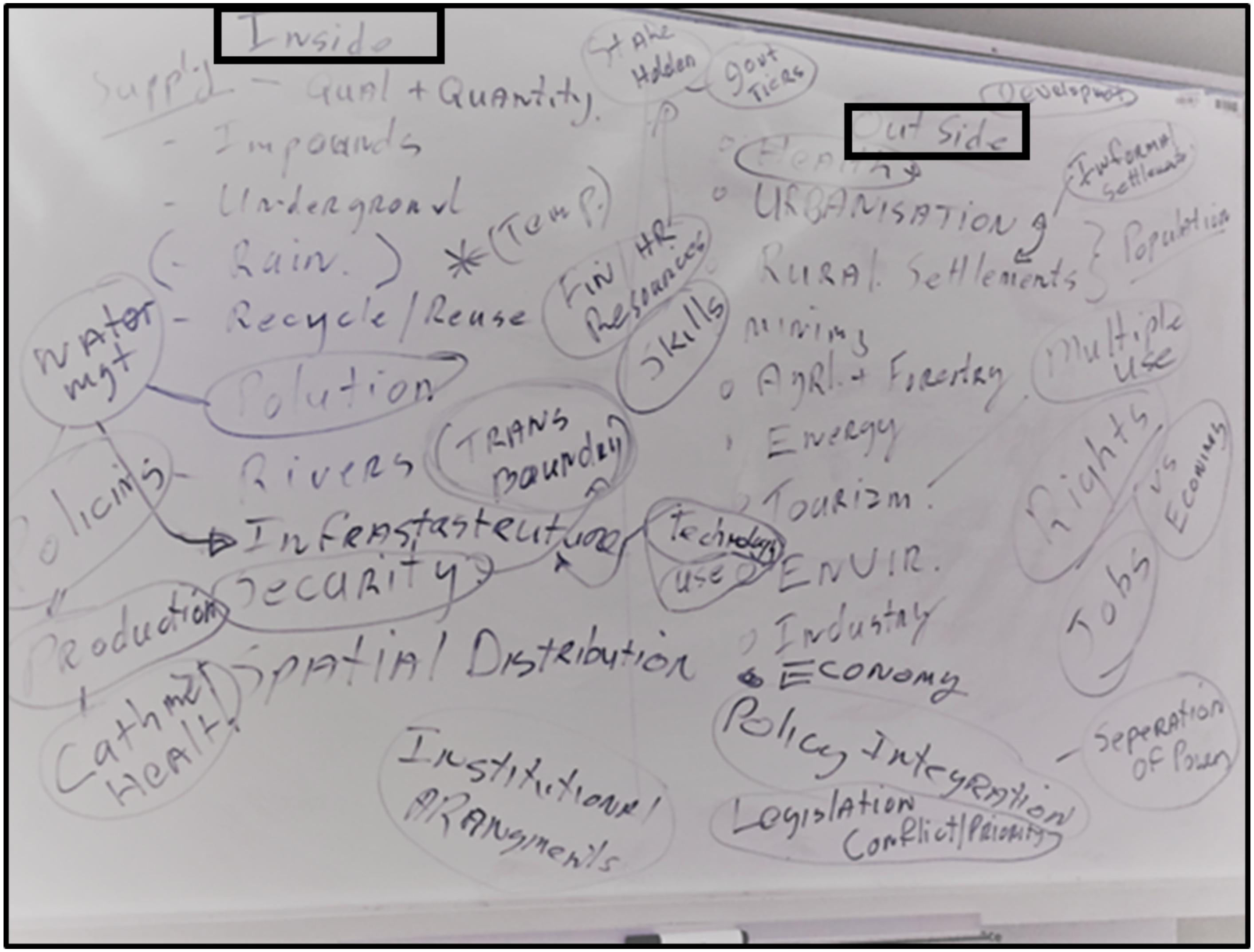


Figure 7.2: Internal and external variables involved in the water resources policy management system (Source: Research Workshop 2, personal communication, November 27, 2018).

On the one hand, to achieve effective water resources supply management, stakeholders also noted the need to consider improved governance and management support issues such as equitable water allocation, institutional arrangements, finance, and human resources as some of the internal variables necessary to implement water resources policy management actions. On the other hand, stakeholders also identified most water demand variables as generally falling outside the direct control of water resource managers. These included the constitutionally protected rights to social, environmental and economic benefits that sustain basic life (i.e. health, food security and income). These are influenced by population growth needs in urban and rural areas, and directly or indirectly manifested through water utilisation in sectors such as mining, agriculture and forestry, energy, tourism, the environment and industry. Importantly, this implies that managing water resources cannot occur in isolation from the national and regional development agenda, where water is a central development resource input. The different variables involved in the South African water resources policy management system and related subsystems were manually organised and mapped into a structured system of interactive causal relationships. Ultimately, the systems' map synthesized all the stakeholder inputs into a causal diagram of the system as a whole. **Figure *7.3*** shows the first-level product of the mapping exercise with 90 variables and 316 connections that interdependently interact to influence different performance outcomes of the water resources policy management system. The emerging picture was a useful visual to analyse the system including tracing out significant paths of influence, identifying system vulnerabilities and feedback loops, toward the suggestion of policy actions. In effect, the research stakeholders and the researcher guided a great part of the analysis in order to avoid overreliance on the systems mapping software for the analysis.

Figure 7.3*:* Variables within the South African water resources policy management system (90 nodes and 316 connections).

The causal diagram of the water resources policy management system was built node after node, starting from water availability, water use and water supply variables, with a vision to build the water resources policy management system towards equity. Node causal relationships were connected, as subjectively determined by the stakeholders, using cause-and-effect questions between two variables related to the following questions:

- which are the nodes/variables that are affected by or that affect a particular node and how?
- are the causal effects between two nodes same directional or opposite, and ;
- for how long would the impact of the causal effect be experienced, i.e. short-, medium- or long-term?

For example the node '*Water Availability'* is affected by *'Rainfall'* with the same directional change impact (i.e. more rainfall will result in more water being available) and the causal impact of the effect could be experienced in a matter of weeks (i.e. increase in dam levels). Another example could be the case of '*Agricultural Water Use'* which would affect '*Water Availability'* with an opposite directional change impact (i.e. more agricultural water use will result in less water available for other sectors) and the causal impact of the effect could be experienced in the medium term. In the causal diagram of the water resources policy management system, water supply is represented by the node *'Water Availability'* and water demand is represented directly by the water using sector nodes such as *'Mining Activity'* or '*Agriculture Development'.* Importantly, underlying demand and supply management, in the context of water resources policy management in South Africa, are the key principles of equity and inclusive development. South African water resources policy management exists to ensure water availability for the direct and indirect social, economic and environmental benefits of all. *Water Availability* effectively forms the primary basis for water resources policy management upon which the rest of the nodes, which constitute the system, are effectively established. Water resources policy managers therefore have the primary responsibility to ensure the sustained availability of good quality water resources to support the extended social, economic and environmental development needs of the resource that sustain life. *Water Availability* directly affects the capacity and potential to realise national water security, equity and sustainability as the ultimate goals of water resources management in South Africa's developmental State agenda.

7.3. Analysing the systems mapping results

Once the variables that interactively influence the performance of the water resources policy management system were identified, the next steps was to analyse the emerging picture to give contextual meaning in line with the purposes of this study.

7.3.1. Classification of variables

Water resources management is generally understood to be an environmental issue. However, in practice, water resources management includes a number of other issues relating to its protection, use, development, conservation, management and control (see **Figure *7.4***). Classifying the different variables involved in the system helped to provide a visual overview of the fact that water resources policy management occurs in a realm of numerous environmental, economic, socio-cultural and political issues.

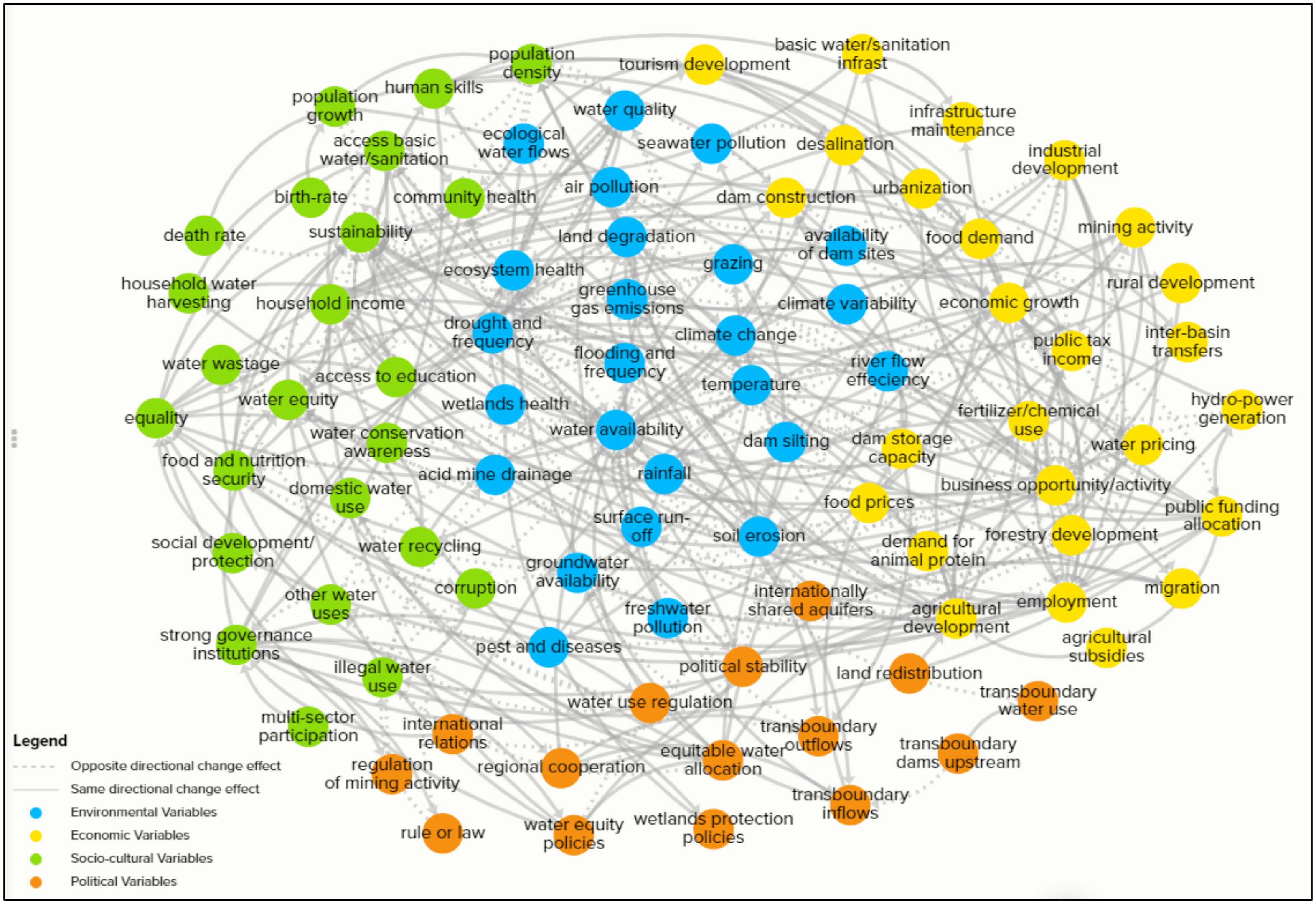


Figure 7.4*:* Classification (environmental, economic, socio-cultural and political) of the variables influencing the South African water resources policy management system.

The classification presented in **Figure *7.4*** helps to establish the diversity of variables involved in the system and the sectors that could potentially collaborate to facilitate efficient adaptive and integrated water resources policy management. Indeed, while some of the environmental, economic, socio-cultural and political variables would be considered internal to water resources management, they are interactively embedded on issues beyond the water sector. For example, the funding of water storage infrastructure development is an economic variable specifically within the water sector but with funding dependencies on the performance of the wider national economy. Successful water resources policy management therefore demands a diverse set of management skills from multisectoral stakeholders. While, the classification in **Figure *7.4*** highlights a wide distribution of the variables involved, the number of variables per cluster is not necessarily a reflection of a greater weighting or importance of those variables. The different specific variables represent varying potential impact on the performance of the overall water resources policy management system.

The classification of the different variables also considered their implied functional role in the water resources policy management system. In this regard, there are variables that can be manipulated to influence certain policy outcomes as compared to variable that effectively drive the system towards an undesired state. In a context of policy management, there are also variables within the system that represent the goals for which the policy was designed to achieve in relation to influencing the system towards a desired state instead. Accordingly, the mapped variables involved in the water resources policy management system and its related subsystems were also classified according to, public policy drivers, policy lever variables, and policy goal variables (see **Figure 7.5**):

- ***Policy driver variables*** are effectively the driving forces over which policy makers have little or no control;
- ***Policy leveraging variables,*** which are the variables that can be manipulated to influence certain desired policy performance outcomes, and;
- ***Policy goal/outcome variables***, described as the desired outcomes that policy makers are effectively pursuing by putting together the current water resources management policy as contextually located in the South Africa.

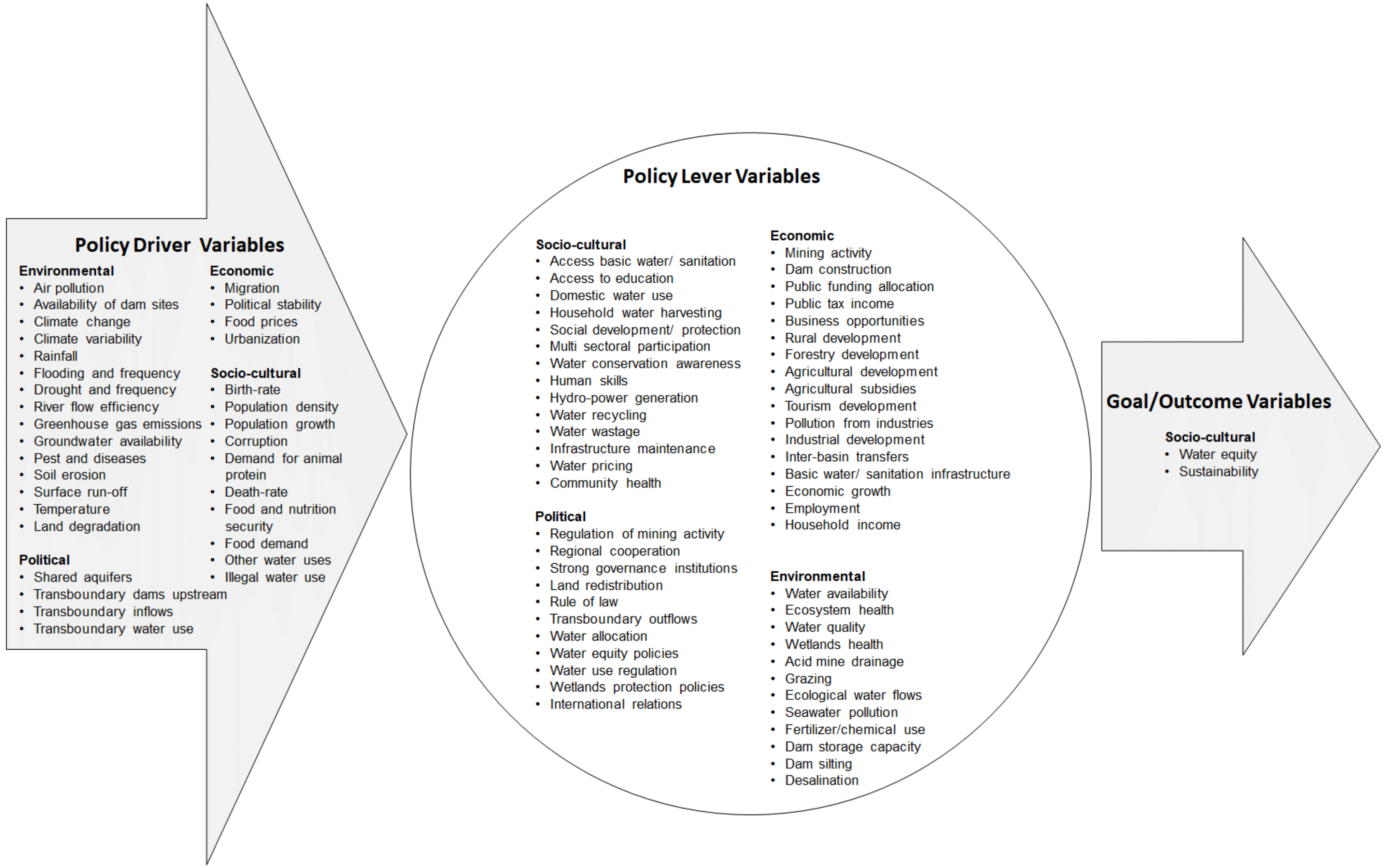


Figure 7.5: Classification (i.e. driver, lever and goal/outcome variables) of the variables involved in the South Africa water resources policy management system and related subsystems.

7.3.2. Equity as a central variable to South African water resources management policy

While the water management scope presented through the NWRS2 is justifiable, specifically from a practical management point of view, focusing on issues mainly within the direct control of water managers (basic water use and supply) could limit management efficiency and the effectiveness of the system. This might particularly be the case in the interactions between the primary water resources management system and other environmental, economic, socio-cultural and political systems' variables. Some of these variables could be considered peripheral to the direct management control of water managers, but could have significant impacts on water resources policy management performance. Oppositely, it could be overwhelming if not infeasible for water resources policy managers to consider the entire system and its subsystems in their totality when planning, monitoring and evaluating water resources policy management performance. This dilemma raises serious questions about the best approaches to balance and manage water resources policy planning and evaluation responsibilities in a manner that is affordable, feasible and practical.

At a practical level, water resources policy management exists to ensure sustainable good quality water supply that equitably and sustainably meets the social, economic and environmental needs of society. As such, water supply potentially allows for the direct and indirect benefits that could be accrued from water resources utilisation for sustainable growth and development. In line with the water resources management policy principles provided in the legislation, the strategic objectives of the NWRS2 provide the framework for the key focus areas to be considered for comprehensive evidence-based policy monitoring and evaluation. Optimal water use also includes environmentally sustainable water use by ensuring a balance between water use and the protection of the resources from being degraded beyond the point of recovery. Ultimately, the tasks for water resources policy managers is to identify the most appropriate strategies, institutions and practices to support the achievement of the different aspects of water equity. M&E efforts must be able to track and generate insights that make it possible to make evidence-based decisions to achieve sustainable water equity. South Africa's water legislation identifies sustainable *Water Equity* as the central and ultimate goal of current water resources policy management efforts (RSA, 1998; DWA, 1997, DWA, 2013a). Equity in this case is understood to include the following aspects:

- **Equitable access to water services** (ensuring access to safe, clean and basic water and sanitation services);
- **Equitable access to water resources** (ensuring that there is increased direct access to water for productive purposes), and;
- **Equitable access to the benefits accrued from the optimum use of water resources** (ensuring that water is allocated and used in a manner that affords maximum direct or indirect benefit for all).

The concept of equity in this regard, implies the need to ensure fairness in how water resources management activities respond to different social, economic and environmental needs now and in the future. Achieving water equity would make a great contribution to sustainable development efforts in South Africa, including the increased resilience of communities to climate induced risks such as floods and drought. While the principle of equity is central to the South African context, there is added responsibility of redress with special attention given to addressing the needs of those who were historically disadvantaged in accessing the resource especially for economic activities, during the apartheid era. Although, there are numerous process policy performance goals, water equity takes the highest priority as the end goal from a water resources policy management perspective. The rest of the outcome indicators effectively represent a list of process outcome indicators that must be achieved in order to ultimately ensure that societal water demands are met sustainably and equitably.

7.3.3. Variables identified to directly affect equitable water resources policy management performance outcomes

Water Equity is a high-level node that can only be achieved if the different variables responsible for water supply and demand management are in place. Over and above the basics of water supply and demand are the different variables that make it possible to realise the social, economic and environmental water equity benefits that could be accrued from the direct or indirect use of water resources. Multiple water utilisation activities for example, are responsible for the production of direct or indirect social, economic and environmental benefits that could potentially lead to *Water Equity* outcomes. However, water utilisation itself, as a function of allocated water rights, may affect the amount of water resources available for other potentially new water users, especially for economic activities. Water utilisation has a direct effect on *Water Equity.* Considering shared watercourses, for example, it is important to note that *Water Utilisation* needs are not only limited to the pressures presented by South African users, but also similar pressures from neighbouring countries that share water either upstream or downstream. In this case, all neighbouring countries that share water resources with South Africa, i.e. Lesotho, Botswana, Namibia, Zimbabwe, Mozambique and Eswatini. Shared water includes inflows and outflows in the different rivers systems (e.g. Komati, Vaal, Orange River systems) and water storage infrastructure such as the Lesotho Highlands Project and Maguga Dam in Eswatini. In planning and evaluating water resources policy management performance related to *Water Equity*, policy makers must therefore acknowledge that, although South Africa has its own socio-economic and environmental development pressures demanding increased water availability, these pressures also exist in the neighbouring countries that share transboundary watercourses. Importantly, such transboundary responsibility to share water resources increases the uncertainty and complexity associated with managing the resource. As such, greater appreciation of international relations and cooperation is required to improve policy management performance and decisions.

Achieving *Water Equity* directly depends on a number of variables amongst many interconnected and interdependent variables within the wider water resources policy management system as demonstrated in **Figure 7.4**. While, *Water Equity* outcomes are connected to a number of variables that interactively influence the water resources policy management system, in this thesis a deliberate decision was made to only prioritise the variables with a direct causal relationship with *Water* Equity (see **Figure 7.6**). **Figure 7.6** highlights only the fifteen (15) variables within one-step causal relationships with Water Equity (also referred to in this thesis as direct connections). In **Figure 7.6**, the solid lines represent variables that have the same directional change effect, where a positive change in one variable also results in a positive change in the other variable. For instance, if

Employment increases because of direct or indirect water utilisation, then the *Water Equity* also increases. Contrary, the dotted lines represent variables that have an opposite directional change effect on other variable where a negative change in one variable will results in a positive change in the other, and vice versa. For example if *Population Density* increases, then *Water Equity* decreases.

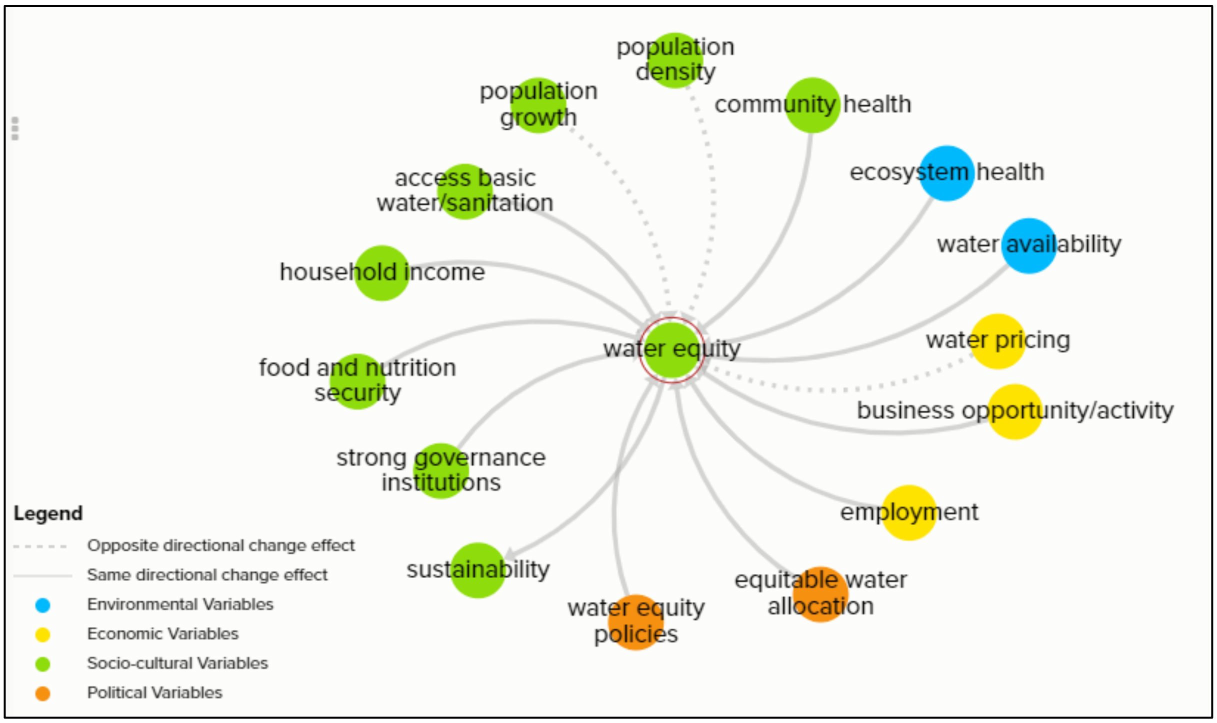


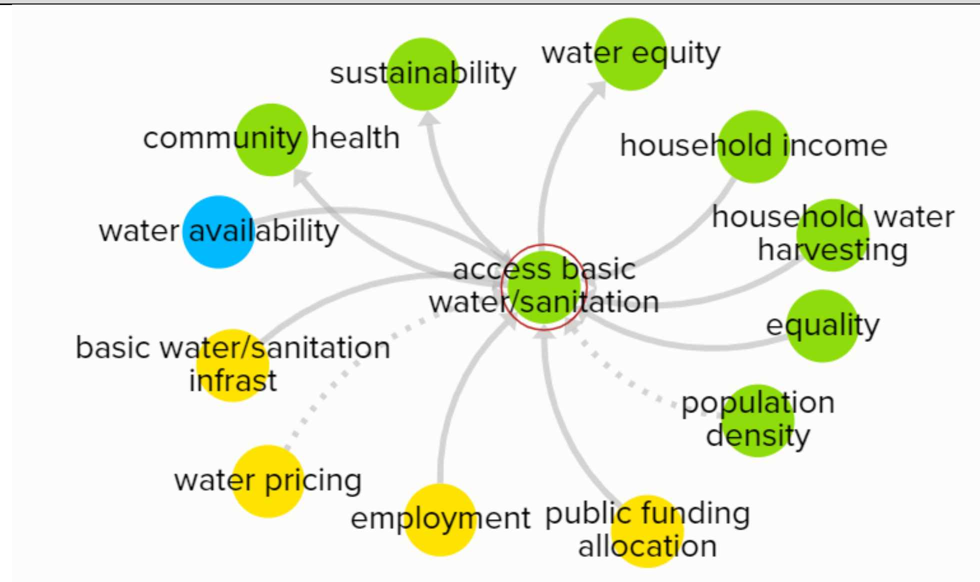
Figure 7.6: Variables directly affecting or affected by Water Equity.

Prioritising the variables with a direct causal relationship with *Water Equity* does not imply that the influence of the wider set of the variables involved in the water resources policy management system is downplayed, as most of the other variables remain embedded on those with a direct causal effect with *Water Equity*. For example, *climate change* and *climate variability* may influence the amount and distribution of *Rainfall* in a given area. Although *climate change and climate variability* are not directly connected to *Water Equity,* they present an indirect effect through their influence on *Water Availability* as a variable directly influencing *Water Equity.* As such, the decision to prioritise the variables with a direct influence on *Water Equity* is effectively representative of numerous other related variables with an indirect effect as represented in the wider water resources policy management system. Importantly some of the variables directly influencing *Water Equity,* such as *Population Growth, Population Density, Food and Nutrition Security, Demand for Animal Protein* and others such as *Economic development/growth*, fall outside the full management scope and control of water resources policy managers. As such, this raises the need for integrated management support that can be achieved by collaborating with other social, private and public partners beyond dedicated water resources management policy governance institutions.

7.3.4. Comprehensive variables identified to monitor and evaluate RSA water resources policy management performance towards equity

In **Table *7.1***, the fifteen (15) nodes that are within one-step causal relationship with *Water Equity* are dissected further and individually analysed as the variables that would need to be monitored and evaluated for improved learning about the performance dynamics of the water resources policy management system towards sustainable *Water Equity*. A brief description is provided for each variable in line with how it is understood in the context of the South African water resources policy management system. A schematic representation for each of the variables is presented to highlight the variables directly affecting or affected by that particular variable within a one step-causal relationship. In this regard, an argument is made that in monitoring each of the variables, it would be important to establish how that variable is likely to behave in relation to the variables that directly affect it. As an example, *Employment* may be determined at a particular percentage at a particular given point in time; however an understanding of variables, such as *Economic Growth*, could help establish a better appreciation on the most likely behaviour of *Employment* patterns over time.

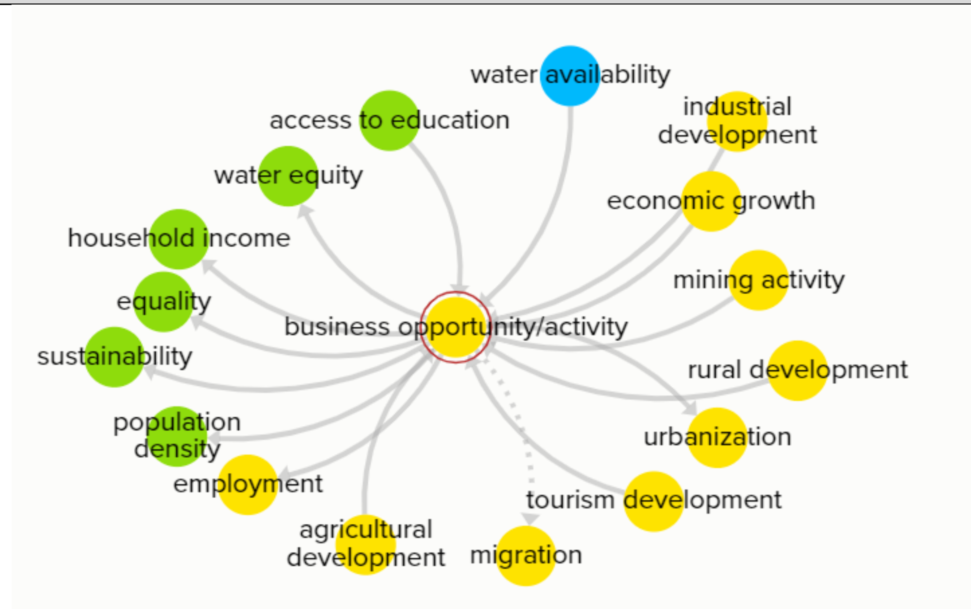
Table 7.1: Comprehensive variables identified to monitor and evaluate water resources policy management towards Water Equity in South Africa.

Variable/nodes (Description)	Influencing variables to monitor node resilience or vulnerability	One-step variables affecting or affected
Access to Basic Water/Sanitation *(Households with access to domestic water and sanitation)*	• Public funding allocation • Households water harvesting • Water availability • Water pricing • Equality • Employment • Household income • Population density • Basic water/sanitation infrastructure	

Example of related indicators:

- *Percentage increase in the number of households with access to basic water and sanitation*
- *Amount of households harvesting water resources in a particular area*
- *Amount of public funds allocated to facilitate basic water and sanitation services*

<table>
<tr><th>Variable/nodes (Description)</th><th>Influencing variables to monitor node resilience or vulnerability</th><th>One-step variables affecting or affected</th></tr>
<tr><td>Business Opportunity/ Activity

(Entrepreneurial opportunities, activities and services available and utilised by society)</td><td>• Economic growth
• Industrial development
• Agricultural development
• Rural development
• Mining activity
• Tourism development
• Water availability</td><td>
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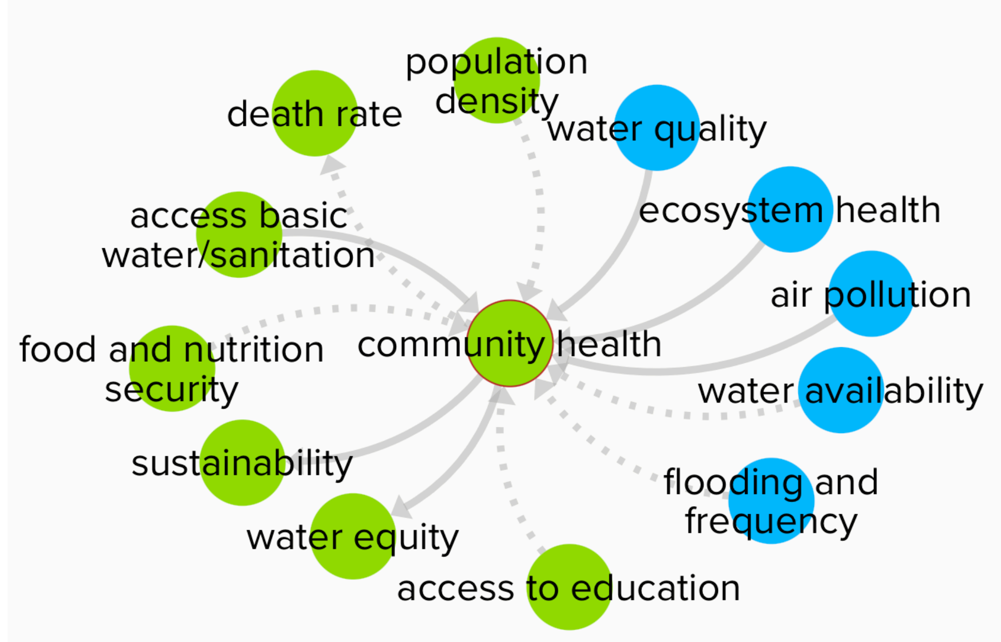
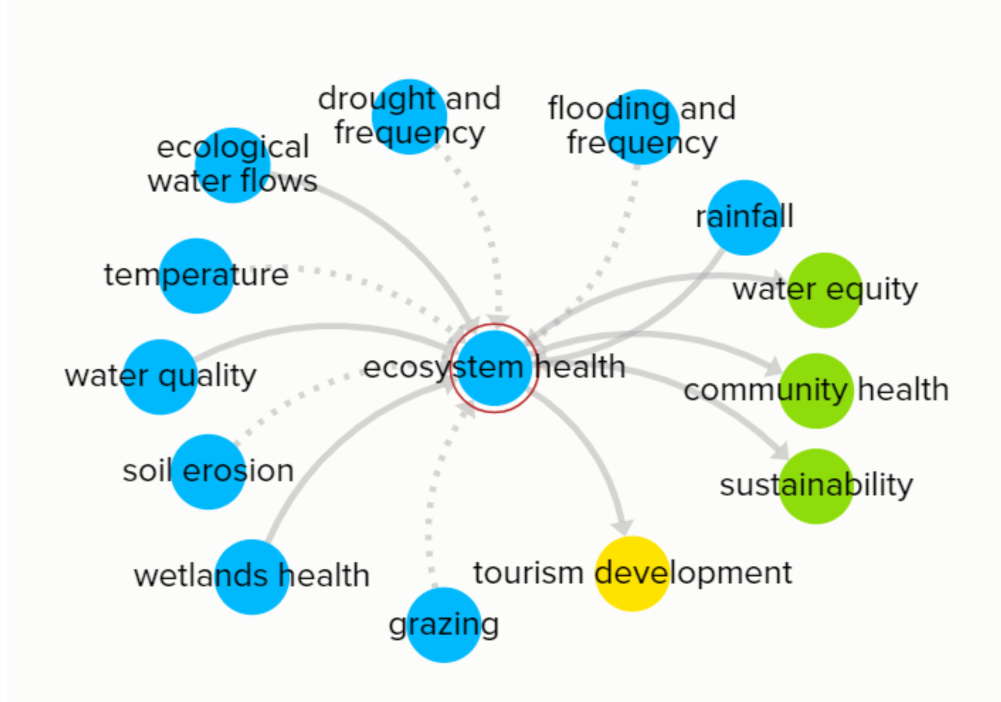
Example of related indicators:

- *Percentage of household income resulting from water using businesses*
- *Rural development projects benefiting from water utilisation*
- *Number of tourism establishments benefiting from the ecological reserve*

Variable/nodes (Description)	Influencing variables to monitor node resilience or vulnerability	One-step variables affecting or affected
Community Health *(Aspects of community health that are water induced e.g. water-borne diseases resulting from poor water quality)*	• Access to education • Floods and frequency • Air pollution • Access to basic water and sanitation • Food and nutrition security • Water quality • Water availability • Population density • Ecosystem health	

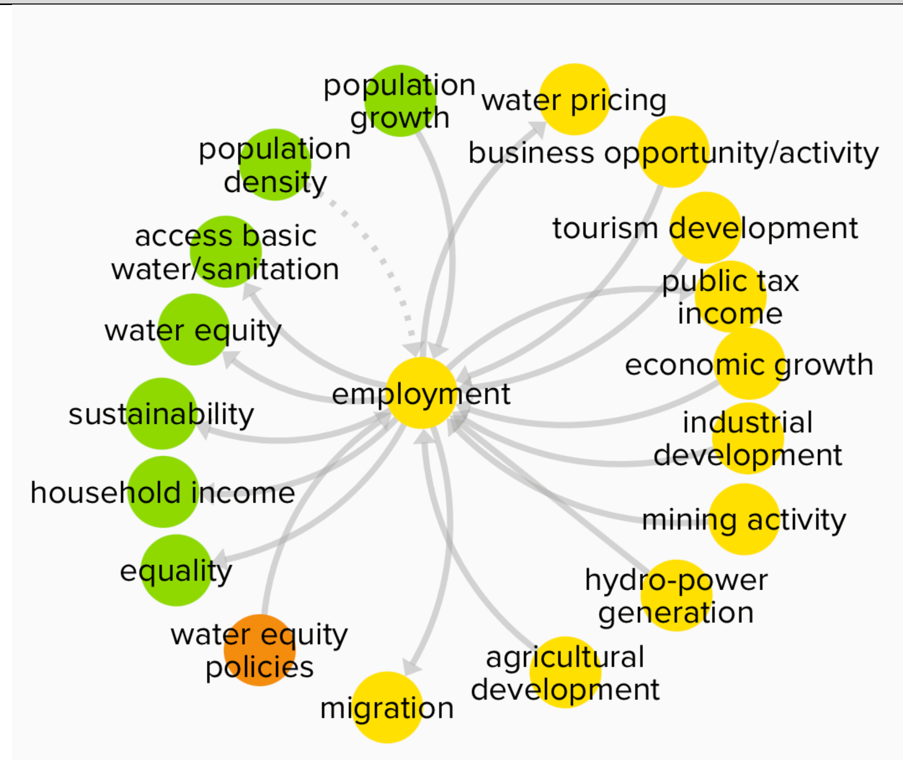
Example of related indicators:

- *Percentage outbreaks of water induced diseases*
- *Number of deaths cases related to water borne diseases*
- *Number of deaths cases resulting from flooding*

Variable/nodes (Description)	Influencing variables to monitor node resilience or vulnerability	One-step variables affecting or affected
Ecosystem Health *(Condition of an ecosystem whose natural structure can either be in a good or bad state)*	• Water quality • Ecological water flows • Temperature • Wetlands health • Rainfall • Drought and frequency • Soil erosion • Overgrazing • Flooding and frequency	

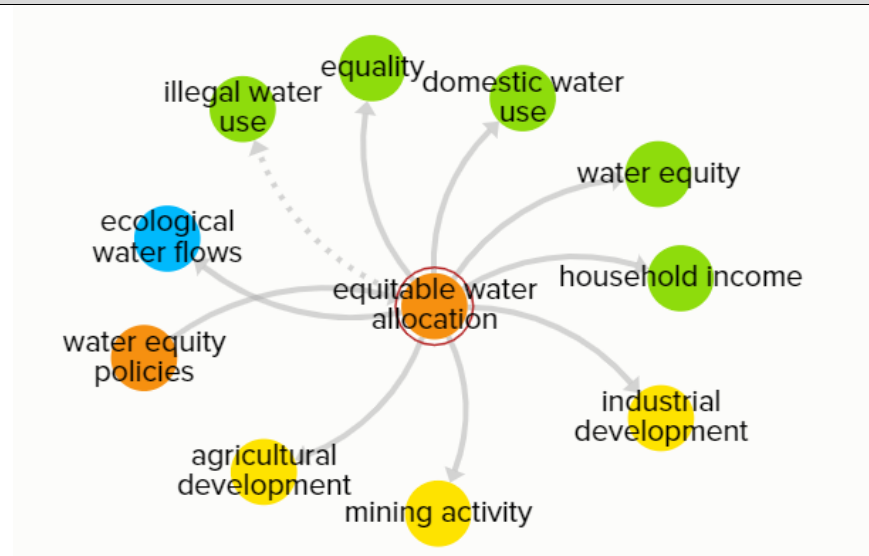
Example of related indicators:

- *Rate of erosion of stream banks resulting from overgrazing*
- *Percent of water allocated as the ecological reserve*
- *Dam silting percentage*

Variable/nodes (Description)	Influencing variables to monitor node resilience or vulnerability	One-step variables affecting or affected
Employment *(Temporal or permanent jobs or services in return for cash)*	• Population growth • Population density • Tourism development • Water pricing • Hydropower generation • Industrial development • Human skills • Business opportunity/activity • Agricultural development • Mining activity • Economic growth	

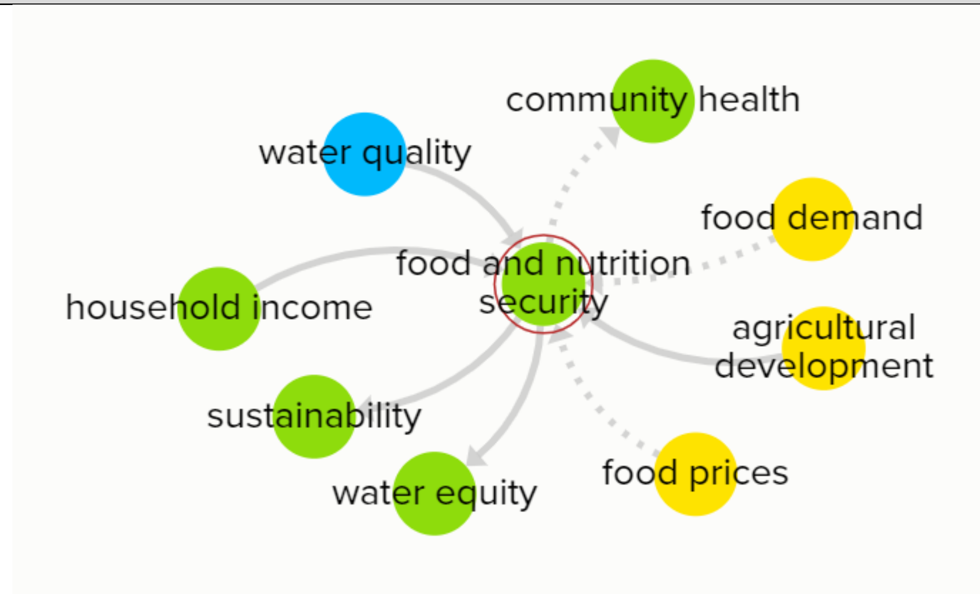
Example of related indicators:

- *Number of people employed by the different water using sectors*
- *Number of people employed by age and/or gender, e.g. youth, women*
- *Racial distribution of people employed by different water using sectors*

Variable/nodes (Description)	Influencing variables to monitor node resilience or vulnerability	One-step variables affecting or affected
Equitable Water Allocation *(Water allocated by sector)*	• Water equity policies	

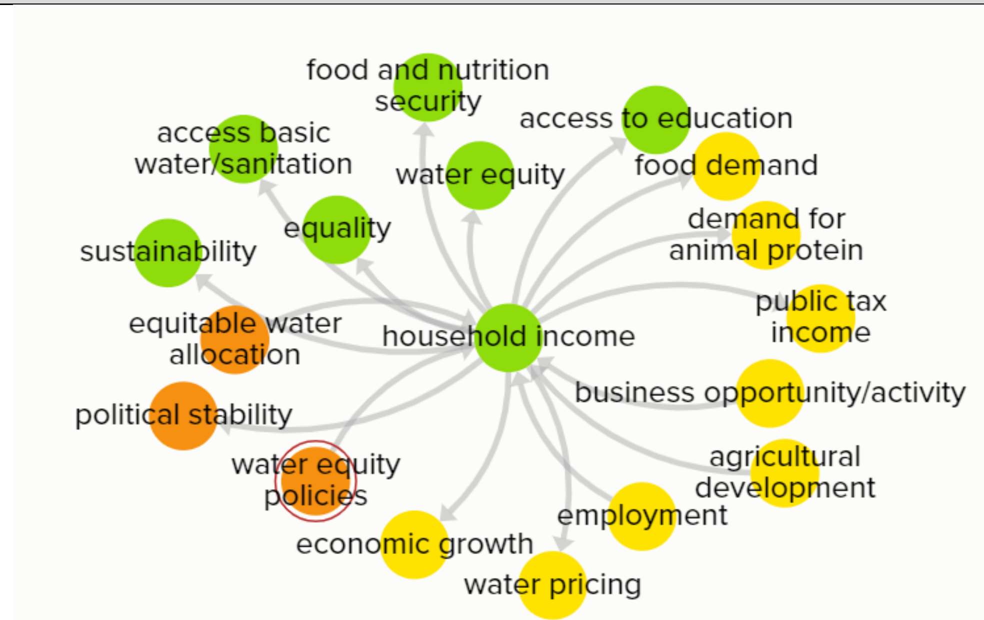
Example of related indicators:

- *Number of policies that promote and facilitate water equity*
- *Amount of water allocated by sector*
- *Number of previously (apartheid era) discriminated people/ enterprises allocated water utilisation licences for economic activity*

Variable/nodes (Description)	Influencing variables to monitor node resilience or vulnerability	One-step variables affecting or affected
Food and Nutrition Security *(Physical, social and economic access to food of sufficient, and quality of food that meets people's dietary needs in an environment of adequate sanitation and health)*	• Agricultural development • Household income • Food demand • Food prices • Water quality	

Example of related indicators:

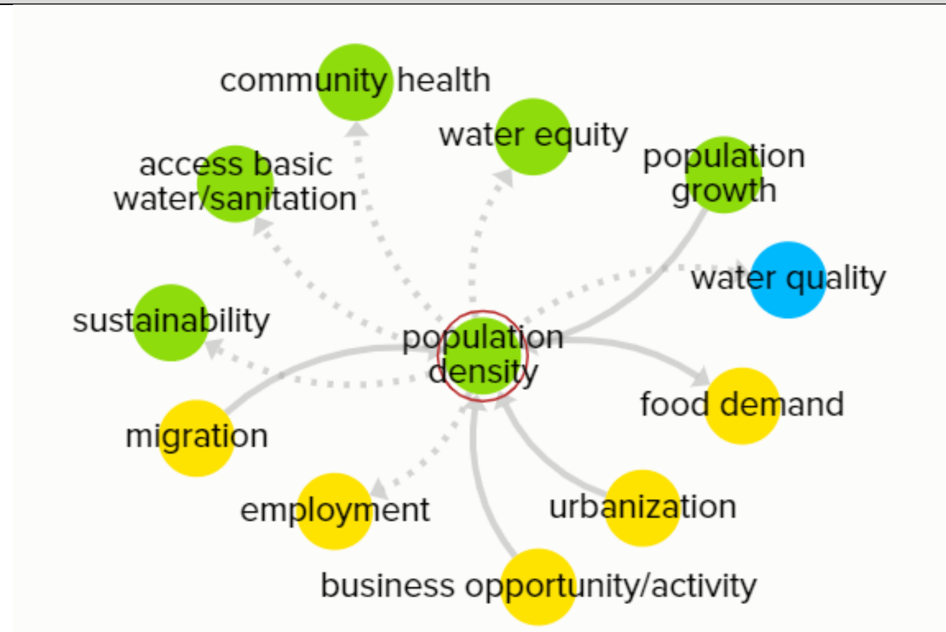
- *Cost of the national food basket*
- *Consumer price index*
- *Household income to access food*

Variable/nodes (Description)	Influencing variables to monitor node resilience or vulnerability	One-step variables affecting or affected
Household Income *(Money generated per household through economic activities, employment or remittances)*	• Employment • Agricultural development • Water allocation • Business opportunity/ activity • Water equity policies	

Example of related indicators:

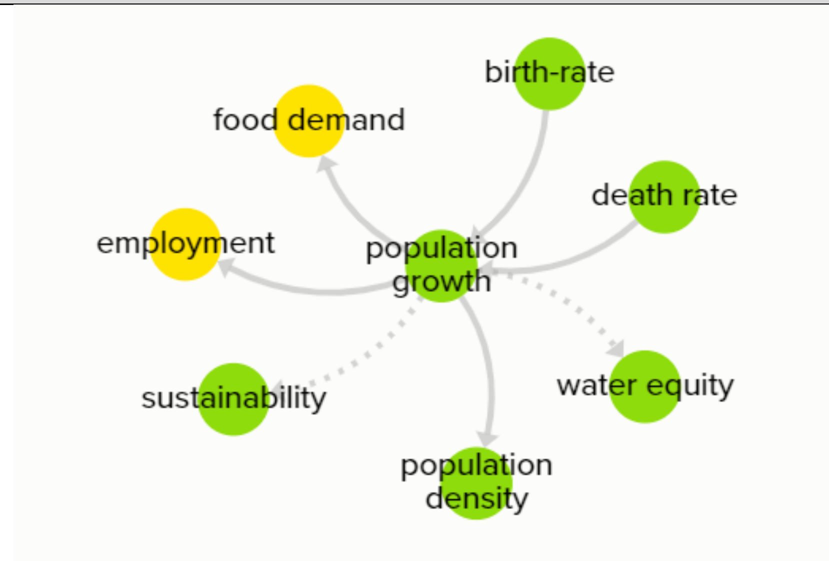
- *Household income derived from direct use of water resources*
- *Number of people employed in different water-using sectors*
- *Amount of water allocated to households for economic activity*

<table>
<tr><th>Variable/nodes (Description)</th><th>Influencing variables to monitor node resilience or vulnerability</th><th>One-step variables affecting or affected</th></tr>
<tr><td>Population Density

(Measure of people per unit area)</td><td>• Urbanisation
• Migration
• Business opportunity/activity</td><td>
</td></tr>
</table>

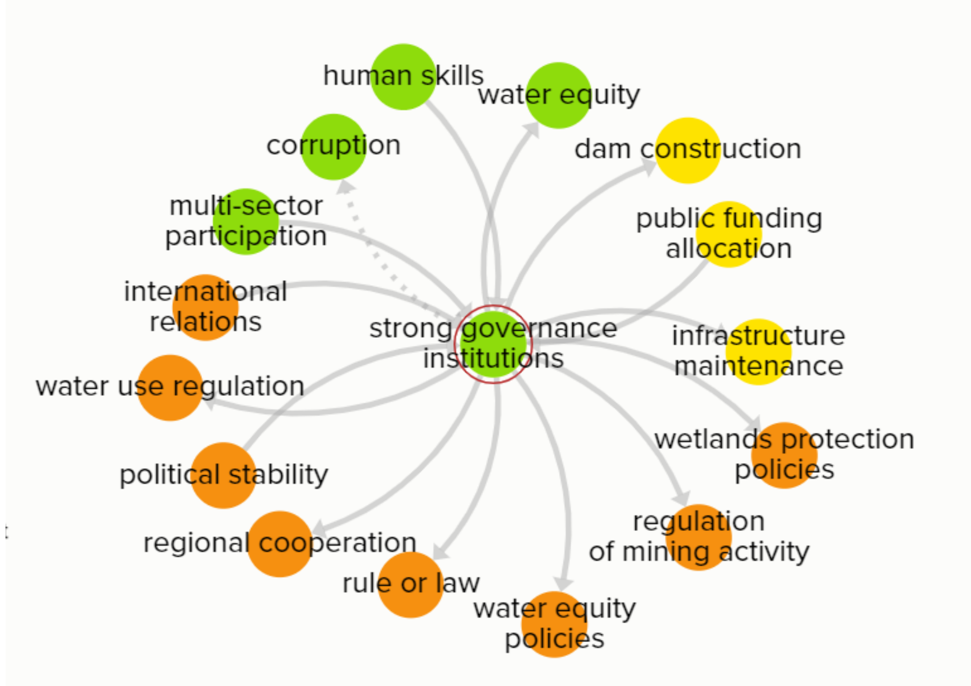
Example of related indicators:

- *Number of people per square kilometre*
- *Rate of urbanisation*
- *Concentration of business opportunity/ activities*

Variable/nodes (Description)	Influencing variables to monitor node resilience or vulnerability	One-step variables affecting or affected
Population Growth *(Population increase in South Africa and its neighbours)*	• Birth rate • Death rate	

Example of related indicators:

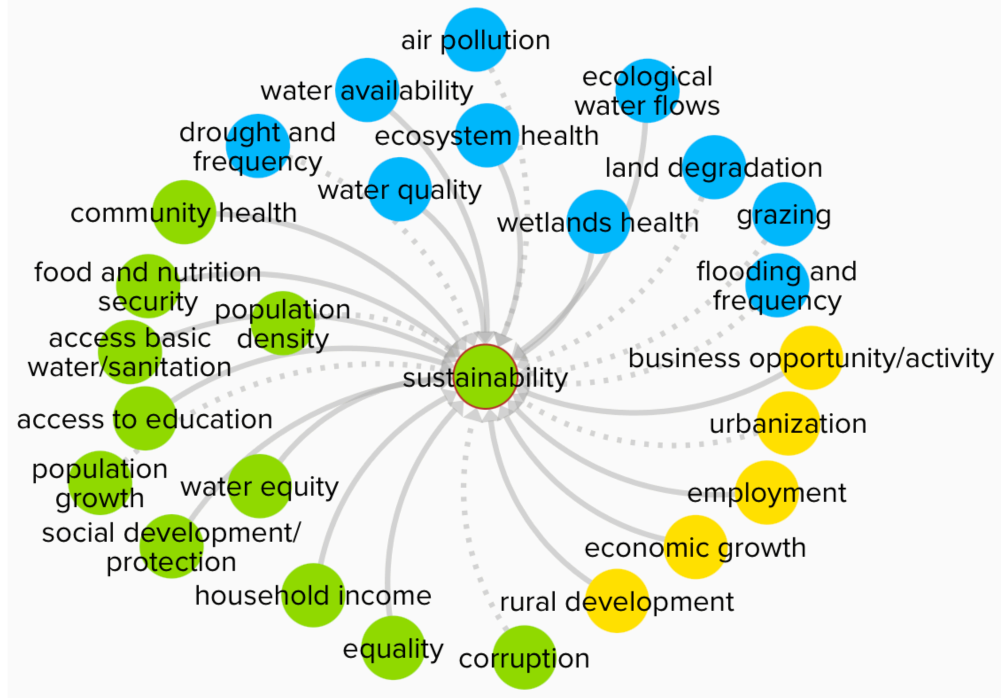
- *Population increase*
- *Birth rate*
- *Death rate*

Variable/nodes (Description)	Influencing variables to monitor node resilience or vulnerability	One-step variables affecting or affected
Strong Governance Institutions *(Water governance institutional arrangements at local, provincial, national and international levels)*	• Multi sectorial participation • Political stability • International relations • Human skills • Public funding allocations	

Example of related indicators:

- *Consistency and number of multisectoral institutions participating in water resources policy governance structures*
- *Number of multidisciplinary skilled individuals participating or employed in water governance institutions*
- *Amount of money allocated to water governance institutions*

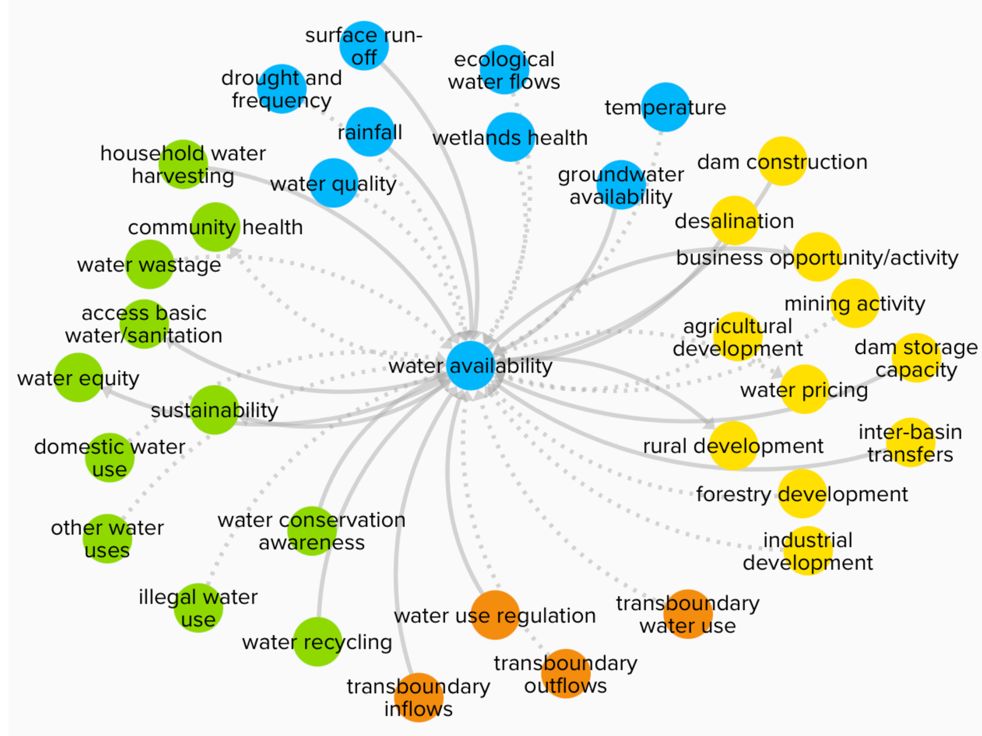
<table>
<tr><th>Variable/nodes (Description)</th><th>Influencing variables to monitor node resilience or vulnerability</th><th>One-step variables affecting or affected</th></tr>
<tr><td>Sustainability

(Development fairness in consideration of current and future generation's' social, economic and environmental needs)</td><td>• Ecological water flows
• Social development/ protection
• Employment; Urbanisation
• Population density; Population grown
• Water availability; Rural development
• Equality; Ecosystem health
• Water equity; Water quality
• Wetlands health
• Food and nutrition security
• Air pollution
• Access to basic water and sanitation
• Corruption; Community health
• Land degradation; Economic growth
• Access to education</td><td>
</td></tr>
<tr><td colspan="3">Example of related indicators:
○ Amount of water allocated for the ecological reserve
○ State of national wetlands
○ Rate of population growth</td></tr>
</table>

<table>
<tr><th>Variable/nodes (Description)</th><th>Influencing variables to monitor node resilience or vulnerability</th><th>One-step variables affecting or affected</th></tr>
<tr><td>Water Availability

(Development and protection of water resources to a point accessible for utilisation)</td><td>

- Other water use; Domestic water use
- Water wastage; Mining activity
- Ecological water flows
- Dam construction; Desalination
- Illegal water use; Water pricing
- Transboundary water use; Transboundary outflows; Ground water availability
- Water use regulations
- Rainfall; Surface runoff
- Temperature; Forestry development
- Household water harvesting; Water recycling;
- Drought and frequency; Inter-basin transfers
- Dam storage capacity
- Water quality; Agricultural development; Industrial development

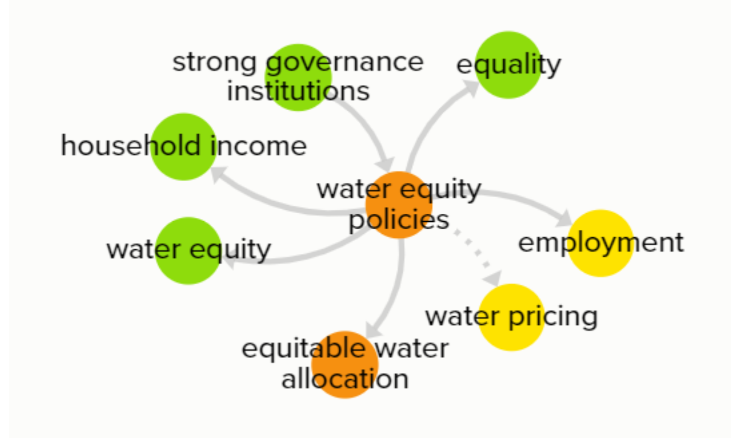
</td><td>
</td></tr>
<tr><td colspan="3">

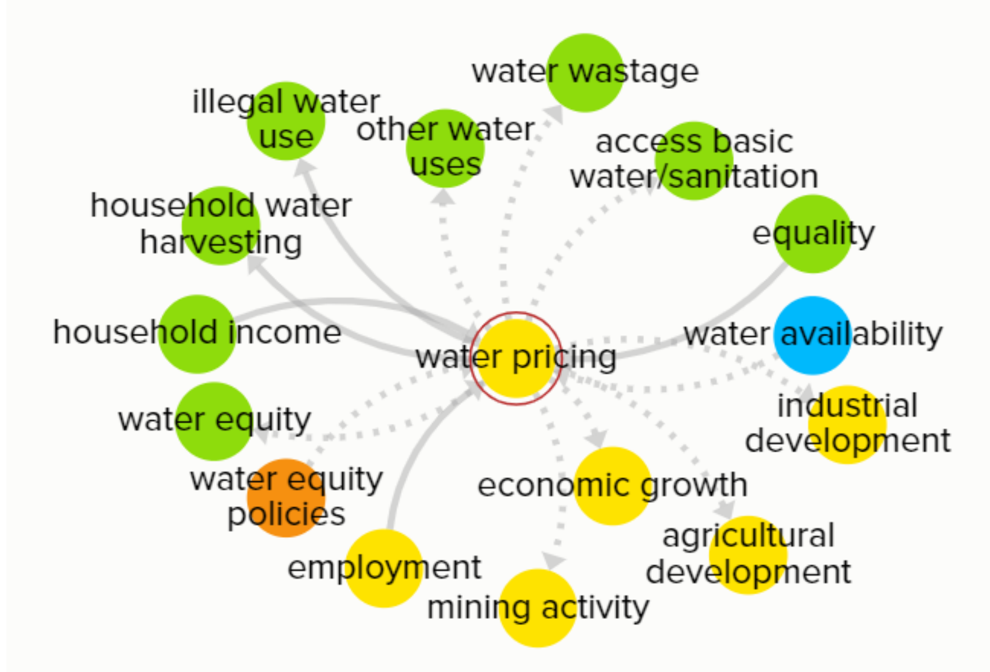
Example of related indicators:

- *Amount of rainfall per annum (national and international-upstream)*
- *Amount of dam/ground water storage capacity nationally*
- *Amount of water resources demands of upstream and downstream international neighbours to South Africa*

</td></tr>
</table>

<table>
<tr><th>Variable/nodes (Description)</th><th>Influencing variables to monitor node resilience or vulnerability</th><th>One-step variables affecting or affected</th></tr>
<tr><td>Water Equity Policies

(Policies to facilitate water equity for all through direct or indirect access to water and its social and economic benefits)</td><td>• Strong governance institutions</td><td>
</td></tr>
<tr><td colspan="3">Example of related indicators:
○ Human skills to design equitable water policies
○ Policy enforcement capacity for water governance institutions
○ Number of policies targeted at for facilitating water equity</td></tr>
</table>

Variable/nodes (Description)	Influencing variables to monitor node resilience or vulnerability	One-step variables affecting or affected
Water Pricing *(Tariffs attached to accessing water resources or services)*	• Water availability • Water equity policies • Equality • Household income	

Example of related indicators:

- *Water pricing structure determinations for different segments of society*
- *Percentage of poor households accessing water resources*
- *Inequality measurement across South Africa*

The policy variables determined to directly influence *Water Equity* are, to a great extent, the main contributors that could help realise this policy outcome. Indeed, the relationship between water availability, water allocation and utilisation and water equity is more complex in practice than could be represented through simplified causal relationships. Although increasing *Water Availability* could improve the opportunities that water might be allocated in an equitable manner, there are other factors that would eventually influence equitable allocation of the resource including access to land and active participation in business activities. Importantly, the causal relationships within the water resources policy management system might not always behave in-line with the assumed logical effect. Indeed, establishing how different policy components interact to produce or fail to produce specific outcomes is already a challenge for stable policy conditions (Chen and Rossi, 1983:284). This challenge is of even greater concern when considering policies operating under uncertain, complex and emergent management conditions. Efforts to comprehend the policy performance dynamics must therefore explicitly cater for internal and external policy system complexities, emergent environmental, economic, socio-cultural and political uncertainties and how these variables are causally interdependent. In their current form, traditional evaluation approaches fail to achieve this. Unless there is a comprehensive understanding of the policy issues in question from a systems perspective, then the utilisation of linear logical frameworks may be misplaced and inconsistent with the actual performance dynamics of the water resources policy management. **Table *7.1*** systematically organises the internal and external environmental, economic, socio-cultural and political variables that interactively influence *Water Equity* outcomes in South Africa. This thesis argues that monitoring and evaluating the water resources policy management system would have to be intentional about how the different variables identified in **Table**

7.1 are measured in order to help in the generation of comprehensive policy performance evidence to guide credible adaptive and integrated water resources policy management decisions.

Figure ***7.7*****:** illustrates water resources policy management performance dynamics as occurring in a black box. As noted by Patton (2011), interactions within, between, and among subsystems or parts within the systems can be highly volatile, turbulent, rapidly emergent and unpredictable. Unfortunately, these change reactions are uncontrollable and unknowable in advance. The black box is a chaotic space where the policy design and implementation efforts may intentionally or unintentionally produce outcomes that could be potentially positive and/or negative. The interactions within the black box includes both internal (e.g. rainfall, water storage, water quality, etc.) as well as various external environmental, economic, socio-cultural and political variables. Improved handling of water resources policy management system can therefore be achieved by paying greater attention to all the casual relationships across all the variables identified to influence *Water Equity*.

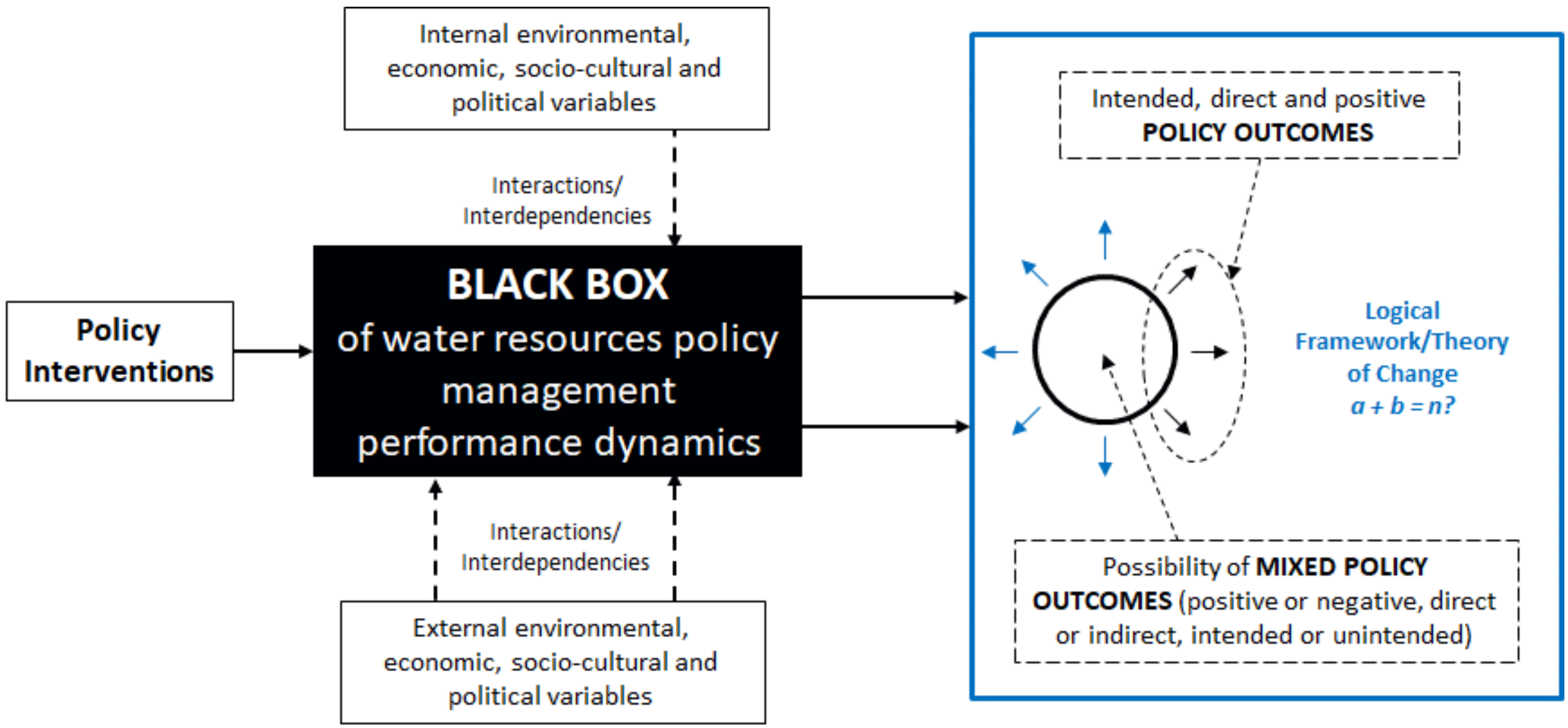


Figure 7.7: Analytical framework for the consideration of internal and external variables that influence water resources management.

In **Figure 7.7:** , the interaction of external environmental, economic, socio-cultural and political variables with the internal water resources policy management system variables, are highlighted as playing a key role in the policy performance dynamics within the black box. Importantly, these variables present interlinked and interdependent, complex and uncertain relationships, which makes it complicated to pin down or solve their associated negative or unintended outcomes. The interconnected nature of the different variables also presents considerable structural uncertainty and thus cannot be reduced to any kind of deterministic understanding. Therefore, in its widest form, the interdependencies and complexities of the water resources management system presents great potential for uncertain consequences or outcomes, relating to how the future may evolve over-time. More questions arise from the potential manifestation of the choices policy makers' take in the face of uncertainty. As such, this thesis argues that water resources management policy makers should look beyond the core water resources management system to improve their understanding of the system's performance dynamics as a function of the interaction and interdependencies with other connected systems. This would help to establish the most appropriate policy architecture and to a degree, some control towards improved planning, implementation and performance.

7.4. Conclusion

Policy interventions designed to address rapidly changing and complex problems, such as those encountered in water resources management, are more than likely not going to follow a linear theory of change. Instead, a number of external, unexpected and unanticipated divergences and developments, other than those directly within water resources management policy in terms of management control, could affect the policy impact pathways. This increases the chances of policy failure and/or unintended policy outcomes not being detected early enough, especially if the policy monitoring and evaluation M&E processes only focus on internal indicators of the water resources policy management processes, rather than a comprehensive (internal and external) outlook. The water resources policy management system mapping exercise conducted in this chapter helps to establish the key variable to consider in ensuring comprehensive policy performance, by including what could be ordinarily considered ‘external variables’ in in monitoring and evaluating water resources policy management performance. Identifying key variables influencing policy performance is certainly not enough to determine how a policy will perform. There are other key factors at play, including how these variables interact in practice, particularly in the South African context of complex water resources policy management, and how they contextually interact with the country’s socio-economic and environmental development interests. Therefore, efforts to establish performance paths, that may determine success, failure or other opportunities for improving policy performance, may help generate insights of substance for management decisions.

CHAPTER 8 : DISCUSSION AND CONCLUSION

8.1. Introduction

As stated in Chapter 1 (*Section 1.2),* the aim of this study was to investigate the conditions ideas that would be required for the adoption of a successful adaptive and integrated water resources policy management strategy and to determine the variables that should be comprehensively monitored and evaluated to ensure the credibility of the policy evidence-base generated in the face of complexity and uncertainty in South Africa. To address the study aim, the following objectives were used to guide the research:

- ***Objective 1:*** *To determine how the historical context and legacy of the racial discriminatory policies of the colonial and apartheid era inform current water policy problems and policy positions in South Africa;*
- ***Objective 2:*** *To identify the sources of uncertainty and complexity for water resources policy management in South Africa and their implications for evidence-based policy management;*
- ***Objective 3:*** *To identify the conditions that would be required for the adoption of a successful adaptive and integrated water resources management strategy in South Africa; and*
- ***Objective 4:*** *To identify the variables that should be comprehensively monitored and evaluated to ensure the credibility of the policy evidence-base generated in the face of complexity and uncertainty in South Africa.*

Chapters 4 and 5 were used to address to Objectives 1 and 2. These chapters were conclusively based on a literature review. Chapter 4, was an exploration of how the legacy challenges presented by the historical context of the past apartheid government's discriminatory policies inform current water resources management problems and therefore the policy goals being pursued. Chapter 5 endeavoured to determine the sources and implications of uncertainty and complex policy management conditions for evidence-based adaptive and integrated water resources policy management in South Africa. Chapters 6 and 7 were used to address the Objective 3 and 4 of the study. Chapters 6 and 7 effectively forms the primary knowledge contribution of this study including the relevance of adaptive policy management approaches for policies implemented under uncertain management conditions and in particular AIWRM in South Africa. The chapter presents data collected through interviews with key informants specifically on policy design, institutional policy arrangements and implementation requirements for successful AIWRM adoption in South Africa. Chapter 7 acknowledges the need for evidence-based AIWRM policy interventions and takes the study towards collaboratively determining (with multiple water resources policy management stakeholders) the systems' variables that should be comprehensively monitored and evaluated for credible and comprehensive effective evidence-based AIWRM policy planning and performance management.

In the process of facilitating this study, there are some limitations that were noted as significant. First, was the limited applied understanding of the concepts of uncertainty and complexity and how they apply in for policy management, and adaptive policy approaches as a management response for deeply uncertain policy management conditions. As such, the conceptual framework had to be thoroughly explained before every interview and workshop conducted for this study. The second limitation was the lack of consistency and diversity of the stakeholders that participated in the research workshops. The inconsistency challenges regarding stakeholder participation was circumvented by the researcher personally meeting each of the most relevant research stakeholders to solicit their inputs outside the formal confines of the research workshops.

This chapter presents the summary and conclusions of the main arguments and research findings of this research in response to the research problem and in line with the study aim and objectives as presented in Chapter 1.

8.2. Summary of the research findings

The discussion on the study findings is organised into four areas in line with the research objectives. These include the key messages emerging from the surveyed literature in relation to the historical context and the legacy of racial discriminatory policies of the apartheid government and how it informs current water problems and policy; a comprehensive picture on the sources uncertainty associated with water resources policy management and their implications for evidence-based planning and performance management; the study findings related to the conditions identified as necessary for the successful adoption of an adaptive and integrated water resources management strategy in South Africa; and a presentation of the variables that should be comprehensively and interactively monitored and evaluated to support evidence-based adaptive water resources policy management in the face of complexity and uncertainty in South Africa.

8.2.1. Historical context informing current water resources management problems and policy

This study looked at literature to establish how the legacy of the past apartheid racial discriminatory policies shaped current water access problems and policy objectives. The focus was specifically on water resources management, which has overall implications for the water available for water services. The study frame was not meant to challenge or justify the policy positions of the racial discrimination of the colonial and apartheid regimes, but rather to contextualise their legacy and impact on modern-day water problems in South Africa and thus suggested policy interventions. While the United Party government (before 1948) had already instituted discriminatory policies against black South Africans, it was only after the takeover by the National Party government in 1948 that racially discriminatory laws were effectively cemented. According to Tempelhoff (2017), the National Party strategy was the purposeful principle of racial discrimination that saw white South Africans as the self-proclaimed 'supreme race' that had to be prioritised as the main beneficiaries of the State's policy interventions at the cost of all other races. The State prioritised people of European descent and legislated their preferential access to strategic production resources such as land and water. The Water Act 54 of 1956 further strengthened the discriminatory appropriation of indigenous land by legislating water access as a riparian right (RSA, 1956) to benefit white South Africans who owned the majority of the arable land. The homelands (including Transkei, Bophuthatswana, Ciskei, Venda, Gazankulu, KaNgwane, KwaNdebele, KwaZulu, Lebowa, and QwaQwa), where black people were settled, were excluded in most of the strategic provisions of the water legislation. These included control over and use of subterranean water as well as access to water courts, water boards, irrigation loans, liabilities and subsidies (RSA, 1956). Land, even in the homelands where black people were settled, could therefore be expropriated for the development of government water works and related projects (e.g. construction of dams, irrigation schemes, and the generation of electricity) which benefited white South Africans. Since land ownership was prioritised for white South Africans during the apartheid era, it would therefore follow that access to water was also skewed in their favour (Maphela, 2015).

Importantly, the research established that the past apartheid government's racial discriminatory policies have created great and significant problems for water resources management in South Africa. Although current legislation provides for equitable allocation of the resource, actual access remains skewed following land ownership and general economic activity such as mining that are dominated by white commercial farmers and big corporates (NPC, 2012; van Koppen & Schreiner, 2014). In 2007, water inequality was measured at a Gini coefficient of 0.99 (Cullis & van Koppen, 2007). Cullis & van Koppen (2007) found that 1.2% of households in rural South Africa used about 95% of agricultural/rural water with the other 98.8% of the population (the majority of whom are black subsistence farmers) only accessing the remaining 5%. Evidence based management efforts must therefore be appreciative the unique complex and uncertain policy management context through which water resources policy management must efficiently navigate to ensure accelerated and sustained success and impact. The black majority population of South Africa, which was estimated at about 67.5% of the national population in 1960 (Steinberg, 1967), effectively had no say on the allocation and management of water resources until the introduction of the National Water Act 36 in 1998

(RSA, 1998). Current water legislation is therefore driven by a reform and redress agenda. The overarching principle is to use the country's water resources for the equitable benefit of all South Africans. Sustainable water security and water equity are the ultimate policy goals. Water equity in this regard could be achieved directly through access to water for economic benefits or indirectly by equitably sharing the benefits accrued from water utilisation such as employment and food and nutrition security for all. In this regard, water has been identified as a central resource in the developmental State agenda of South Africa. While the injustices of the past are obvious, solutions to address these challenges in a democratic setting is complicated.

The water resources policy management task in South Africa, therefore goes beyond the common challenge of managing water supply and demand. South African water resources management policy endeavours to correct the socio-economic access injustices associated with the past racially discriminatory policies to scarce water resources as an effort to support the developmental State agenda of addressing the national problems of poverty, inequality and unemployment. The centralisation of water resources as a strategic developmental resource emphasises a greater need to collaboratively facilitate greater integration and learning across multidiscipline and multiple sectors. This increases the policy management responsibility and the associated complexity and uncertainties that could possibly emerge from stakeholder divergence. The policy reform and redress challenges for South Africa are further complicated by the fact that there is no precedence to learn from to address a blunt racial discrimination and natural resource dispossession act of this magnitude. South African policy makers must find their own innovative means to navigate extremely complex policy management conditions towards national water security, equity and sustainability.

8.2.2. Sources of uncertainty and implications for evidence-based water resources policy management

Initially, this study considered climate change uncertainty as the main information gap to address in order to facilitate evidence based AIWRM. However, it emerged early in the study that although key, climate change related uncertainties are slightly more stable as the change is observed over-time. Climate variability rather introduces more volatility and uncertainty regarding the degree, magnitude or sign and spatial extent of precipitation change with major impacts on the hydrological system (Hewitson et al., 2005; Schulze, 2005a). Importantly, the study established through literature, that climate change uncertainty will be exacerbated into a state of wickedness (i.e. the combined effect of complexity, deep uncertainty and stakeholder divergence on the policy) when overlaid with other environmental and socio-economic development issues (Neumann et al., 2007; Head, 2008; Head, 2010; Ziervogel et al. 2014; Head & Alford, 2015). Most of the environmental, socio-economics and political activities that interactively influence the water resources policy management system are interconnected and highly emergent issues extending beyond the management scope of water resources policy managers. These include issues such as;

- accelerated water demand against limited water supply and its associated drivers and vulnerabilities;

- transboundary water interdependencies that stretch the resource management responsibility beyond the South African borders;
- the water system interconnectedness and interdependencies with other sub-systems;
- rapidly evolving water governance challenges and stakeholder divergence; and
- uncertainty emerging directly or indirectly from related policy directives of the state through a lack of clarity or emerging management conflicts.

Unlike for policies that are relatively stable and where policy performance is likely to follow a linear logic. In complex and deeply uncertain contexts, dominant past trends may prove insufficient and possibly misplaced to guide credible futuristic planning and performance behaviour (Head, 2008; Head & Alford, 2015; Kwakkel, Walker, Haasnoot, 2016; Walker et al., 2013; Walker et al., 2003; Marchau & Walker, 2003). Consequently, it becomes increasingly difficult to produce a reliable or credible ToC or policy logical frameworks in context of uncertain and complex policy management conditions. The challenge about linear performance logic models is that they assume a degree of certainty in the policy performance chain. In deeply uncertain and complex contexts, however, policies tend to be characterized by complex nonlinear performance dynamics that are almost impossible to pre-determine with certainty. Complexity presents great ambiguity around the formulation of a policy problem, which could lead to the development of a misplaced logic of the policy performance dynamics. Importantly, this implies that in deeply uncertain policy management contexts, the understanding, interpretation and formulation of the policy design and performance indicators to track policy performance may be inaccurate, such that the policy targeting and potential outcomes risk being equally inaccurate.

In this thesis, it is argued that ToC designed for policies implemented in the context of deeply uncertain and complex management conditions, must be able to account for uncertainty and complexity emerging from the policy interdependencies and interconnectedness with other related policy management systems. In this way, there could be more opportunities to identify any policy performance risk that could be intentionally addressed or circumvented. For example, water equity would not be an achievable target in a context where land ownership is not equitable, whereas successes in land reform might offer greater prospects for achieving water equity. Water resources policy managers, however, cannot do justice to water equity policy targets by simply stating land reform as a dependency or risk for water resources management policy success in their ToC for water resources policy management. Policy managers and evaluators must work together to continuously develop, improve, and apply learning across the relevant areas in the policy management process as the future unfolds and as the different management conditions emerge. A feedback systems logical framework as proposed by Patton (2011) could be instrumental in facilitating real-time learning processes, embracing, and recognising the policy management complexity and deep uncertainty and adjusting policy targets towards as informed by reality check and balances established through the wider systems' thinking perspective. Hence, instead of policy management strategies that are averse to failure thus seeking to reduce complex policies to a level that could be controllable and deterministic, there is a need to consider policy management and evaluation strategies that pursue resilience by emphasizing continuous learning and adaptive flexibility (Cloete & de Coning, 2018). In the context of complexity, the performance of the water resources policy management systems could be improved by monitoring and evaluating the behavior of influential variables located in other interdependent and connected policy systems. This could facilitate real-time policy adjustments in response to external risks extended onto the water resources policy management system by other systems. According to Patton (2011), policy M&E must be as comprehensive as possible to help facilitate effective evidence-based adaptive management. This could help to reflect, not only of the internal policy system risks that are within the control of water resources policy managers, but also the external variables that bear the greatest potential to undermine internal policy management.

8.2.3. Required adjustments to support adaptive water resources policy management effectiveness

Under complex and uncertain policy management conditions, it is accepted that the policies designed to operate within a certain range would face multiple challenges from outside the anticipated range with greater risk for policy failure (Head & Afford, 2013). Policy makers must be willing to continuously revise their game plans. Adaptive policy management helps to facilitate this responsive change to learning and provides a window of opportunity for policies to deliver on the public goals they were intended for. Ultimately, what is required is adaptive efficiency that ensures short time lags between learning, deciding, and action. In in practice, applying such agile learning and adaptive efficiency remains a very difficult task (Allen & Gunderson, 2015). In practice, the learning and adapting task is facilitated within the wider government policy governance machinery that is often not as flexible to navigate with the kind of ease that would be required for agility. Adaptive agility however is required to move from learning to action. The task is to build-in preconceived adaptive elements in the policy design phases to create a policy design, governance system and operational implementation capacity that support adaptive policy management implementation. The shift from towards adaptive policy management cannot only occur in the theoretical position presented in policy documents as suggested in the draft National Water and Sanitation Master Plan (NW&SMP) for instance. The government proposed that as an implementation plan of the National Water and Sanitation Resources and Services Strategy (NWSRSS) "the NW&SMP will be reviewed and reported on annually, it is considered a 'living plan' and will therefore, be updated utilising an adaptive management approach" (DWS, 2018, p. 470). There must be an applied part of the plan to create the management environment and capacity that would be able to management adaptive responsibilities with the kind of agility they require.

As established through interviews conducted for this study, this discussion picks on three areas of water resources policy management as the aspects where transformational adjustments could produce greater gains for the adoption and successful implementation of AIWRM. Water resources policy makers must be intentional about building-in adaptive capacity and flexibility at all the management levels to ensure the necessary congruence from learning to decisions and implementation. These levels are at best integrated such that implementation governance and design dependencies are hardly repeatable. For example, without a financially feasible policy plan, no amount of consistency and quality of stakeholder participation and governance design or skills would make it possible to implement such a plan. The approach to separate these aspects of policy management levels is to help to work through the transformational task structurally or systematically. Transformational adjustments would have to be effected at the substantive policy design level to build-in adaptive flexibility and robustness into the plan; at the institutional policy arrangement level to support adaptive policy governance; and at the policy implementation level to follow-through on the execution of adaptive decisions and facilitate continuous learning that feeds back to the decision-making processes. The analysis builds on the adaptive policy management criteria of tools determined by Swanson et al., (2010) and contextually informed by the South African context of water resources policy management. Integrated and forward-looking analysis; promoting variation; multi-stakeholder deliberation; self-organisation and social networking; decentralisation of decision-making processes; automation of policy adjustment processes; and formal review and continuous learning, are some of the tools that must be ultimately in place to successfully facilitate adaptive policy management efforts. Included in this study are issues that emerged during the study interviews as contextually relevant for successful adaptive water resources policy management in South Africa. Importantly, adjustments in these areas would help to strengthen the operational elements of AIWRM and ensure full implementation of every aspects of the policy for improved operational learning, adapting, performance and impact.

8.2.3.1. Policy Design

- ***Intentionality to address complexity and uncertainty:*** adaptive policy effectiveness is foundationally dependent on the policy plan in place (Swanson et al., 2010; Kwakkel et al., 2010). Adaptive actions cannot be completely left to ad hoc management practices where the adaptive thinking is only considered at the point of a problem. Some proactive planning must be made where possible at least to the extent possible based on the available information. This study found that while water resources policy makers in South Africa acknowledge uncertainty but there is limited purposeful actions taken to building-in policy dynamism and robustness through different policy design features. Importantly, adaptive policy plans are developed in response to complexity and uncertainty problems are therefore do not enjoy the luxury of access to all the facts necessary to guide the perfect approach. This challenge however, does not imply making no planning effort at all. In the spectrum of the uncertainty definition from deterministic to unknown uncertainty as presented by Walker et al. (2003) (see **Table 5.1**), for any policy, there are reasonable planning activities that can already be taken to strengthen the robustness of the policy plans. This could include the identification of the key factors that could potentially affect performance and their interactions; identifying different plausible futures of key factors; determining different policy options and indicators of success; as well as the alternative adjustments that can be triggered by different factors to ensure continuous performance (Swanson et al., 2010). To increase the robustness of the basic policy plans, Kwakkel et al. (2010) suggest that policy makers should endeavour to identify the different certain and uncertain factors could render the plan ineffective and/or inefficient or even redundant in order to design mitigating and hedging actions beforehand as well as to consider seizing actions to allow the policy to capitalise on potential opportunities for accelerated impact. Additionally, Kwakkel et al. (2010) suggest the need to identify different signpost during the policy implementation phase that may help to trigger different capitalising, defensive, corrective actions or possibly the need to reconsider totally revising the policy interventions. Such different scenarios must be proactively built into the policy planning process. Concurrently, contingency plans and necessary supporting resources should be put in place to support adaptive decisions in case any of the anticipated scenarios become a reality.

- ***Policy flexibility:*** The study found that water resources management policy only provides for fixed temporal opportunities to adapt, which may limit learning and adapting outside the legislated time intervals of five years. Legislated policy creates policy rigidity, which could stifle adaptive action in cases where the required policy actions are outside the legislation confines and therefore legally restricted. This presents a complicated dichotomy for water resources policy management in South Africa, where on the one hand policy legislation is necessary to enforce certain policy interventions as part of the water resources management policy reform agenda of the State. Yet on the other hand, the legislation is restrictive for the adaptive decision making cycle which must be as short as possible from making the decision to execution. Unless there is technical and political appreciation of the urgency of water resources management interventions required, it would be difficult to expedite AIWRM policy decisions. In a context where adaptive policy approaches are valued, there should be an alternative approach developed to manage the decision making process in order to help speed-up adaptive actions. All aspects of adaptive policy management are effectively vested on implementing, learning, improving/adapting cycle. This also applies to the policy planning phase. It should rather be treated as a concurrent phase that only starts before implementation rather than one that must be completed to perfection before it is implemented. The challenge about the overreliance on planning is that is that there is a risk delaying executing on the lessons in time to not miss out on the identified adaptive window while the policy issues are still emerging or while the opportunities to capitalise are still active and relevant. This is noted as a great challenge observable across different sectors in South Africa where policy documents are not implemented, but more revised polices are developed. This is with the argument made by Allen and Gunderson (2011), that the desire to develop the most perfect plans can result in a situation where adaptive policy makers are makers are overly invested which is mistakenly purported as a panacea rather than a process that be equally continually revisited and improved as more information becomes apparent.

- **Policy clarity and stakeholder consensus towards collaboration:** One of the major findings of the study revealed that there are major divergent values demonstrated by different stakeholders on the currently pursued water resources management policy goals and the selected appropriate policy strategies to achieve those goals. This is a practical demonstration of the 'wicked problems' characteristics (Head, 2008; Head, & Alford, 2015), where the policy being pursued is so complicated that it is difficult to get consensus on the appropriate strategies to address the problems. In this study, the key informants noted that, most water resources policy planning in South Africa is contracted to external consultants which creates a disconnect (in comprehending the developed policy problems and preferred intervention strategies) between the consultants and the state officials that should champion the policy implementation as well as the operational level stakeholders where the policy most applies. The risk in this this regard is that the key stakeholders including government officials and other strategic partners could resist the policy only at the stage of implementation. The planning process must therefore be as inclusive as possible of the relevant stakeholders to help make sure of its feasibility on content but also on clarity and public support. Still however, there is room to workshop whichever decision is taken in such a manner that there is clarity on the policy position in order to get stakeholder consensus even if there may be no buy-in to support its implementation for different reasons. Water resources management policy reform includes redress which already implies greater prospects for resistance from some stakeholders in South Africa. Stakeholder resistance however, does not have to imply lack of clarity of the policy stance and subsequent interventions. Achieving consensus could be helpful to win-over most of the policy stakeholders to support the collaborative management of the policy as one of the key characteristics of successful adaptive policy management.

8.2.3.2. Institutional Policy Arrangements

- **Political interference on policy governance:** This study found that South African water resources policy management processes have opted for politically guided solutions (that are sometimes deemed as interference) to facilitate water resources management policy reform and governance. This is argued to be the most feasible approach as a response to addressing the racially discriminatory past of water access and continuing legacy of inequality for economic and social access to the resource. Political and policy management actions are argued to demonstrate a racial bias in their pursuit policy reform and equity in the access to water resources and its economic benefits. In a context where past water resources policy management decisions were racially biased it would follow that water resources management policy redress is racially informed. As such, policy management evidence is understood in the context of reform and redress of the country's racially discriminative past. The contextual understanding of the water resources policy management decisions is an invaluable part of water resources policy management in South Africa, such that even when the evidence suggest otherwise (i.e. amount of available water), a political decision should still be made to advance the interest of the previously discriminated races. Alternatively, the dominating white race in terms of water access could voluntarily prioritise efforts that demonstrate equitable benefit sharing of the economic benefits derived from the utilisation of the resource. As is, the racially biased response of the politically guided solutions to water resources management policy reform is justifiable in the South African context.

- **Management discretionary over social learning and consensus:** Along with general findings in literature, this study also found that South African water resources policy management offers too much discretionary power to the Minister of Water Affairs and Sanitation. Unfortunately, this could limit wider stakeholder involvement in major policy decisions and thus reduce the necessary buy-in and ownership from policy partners. Swanson et al. (2009) assert that greater success could be realised with wider stakeholder participation, social learning and consensus. This effectively calls for an approach where AIWRM decisions are made collaboratively with the water resources policy management stakeholders, unless the actors stand against the principle of water resources management policy reform which is sometimes the case in South Africa. Water resources policy management in South Africa is presented with great racial discriminatory legacy problems from the past apartheid regime for which the solutions will not necessarily come from achieving social consensus the very individuals who championed racial discrimination and resource dispossession in the first place Brown (2011). A more pressing problem is the way the hydraulic mission not only privileged white people but also western socio-economic interests and practices. Water reforms are thus restricted by the perceived economic costs of transformational change. The State in this regard is conflicted on how far stakeholder engagements can be used to help determine policy targets and solutions in a country that remains divided on economical and natural capital access grounds. Decentralising water resources policy and decision making may have benefits that could be of great value elsewhere, but in the South African context, it might risk perpetuating historical inequalities. As such, the States continued dominant involvement is justified, although there are certainly decisions that can only be achieved with wider consensus.

- **Power dynamics between policy actors:** The findings established that water governance processes in South Africa include multiple stakeholders but are dominated by the State mainly through the Department of Water and Sanitation at the national level. This picture emerges as a result from the resistance of the actors with the greatest benefit from water resources and thus the strong dominance of the State to pursue policy water resources to the reform policy of the State. In such a context of great resistance to change, leaving water resources policy management decisions to the users to self-organise and manage could risk indirectly perpetuating the status core of inequality in the access to water resources and its utilisation benefits. In the context of South Africa, on the one hand, it is a justifiable position for the State to remain involved in providing the necessary policy oversight to ensure and in some cases enforce water resources management policy reform. On the other hand, those with the capacity to move things in a progressive direction seem fearful of the perceived social and economic consequences.

- **Trust between policy stakeholders:** Adaptive policy management derives great value from multiple stakeholder collaboration for policy management. The study found however that due to the highly contested issues of scarce water resources between stakeholders, unfavourable policy decisions to some water users have created a lack of trust and transparency in the decision-making processes between public, private, social partners and communities. Without trust, the collaborative agenda to manage water resources is simply not feasible. Greater policy clarity of the policy positions could be helpful to facilitate stakeholder consensus and clear appreciation of the policy position of the State and possibly help to improve trust between collaborating water resources management actors.
- **Stakeholder divergence**: The study found that there is no consensus on the best way to manage water resources, which creates more divergent views and hostility between stakeholders on how best to equitably distribute the resource and its benefits. Although, clarity is necessary to appreciate certain water resources management policy positions, consensus is a prerequisite for collaborative policy implementation. In a racially and economically divided society like South Africa, the challenge to achieve such consensus, especially in

pursuit of the water equity agenda of the State would be extremely difficult. Nonetheless, greater success in this regard could be achieved through improved communication and negotiations between by the State and water resources management stakeholders.

- **Policy variation and innovation:** This study found that the approach to water resources policy decentralisation is generally a homogeneous one even in cases where there is evident social, economic and ecological heterogeneity, which could benefit from locally tailored approaches to govern the resource. By acknowledging the heterogeneity of the local contexts at which water resources policy management is effected in practice, South African water resources policy management could be better positioned to adopt equally heterogeneous approaches to efficiently manage the resource. While a nationally homogenous approach to water resources policy management may imply a reduced management burden for the State, locally tailored heterogeneous approaches could potentially yield better policy outcomes.
- **Decentralisation efficiency and effectiveness:** The study found that Water Management Areas are generally too large such that it could limit the management efficiency of the water resources policy management decentralisation strategy. While this is acknowledged by the different actors involved, challenges related to the implementation of Catchment Management Agencies (CMAs) implies the increased need of the national government to be involved at the local level. Some stakeholders do however argue on the contrary, that some of the local CMA level challenges stems from central government interference. Furthermore, the study found that water governance institutions are

generally devolved without power, such that even in cases where CMAs are established, numerous major water resources management decisions are still made at the national level e.g. water allocations. The decentralisation strategy in South Africa's water resources policy management therefore seems to follow international norms that are often found to be limited when applying the local needs in managing the resource. Although there is value to learning from other countries, contextually applying the international lessons could produce improved results for South Africa's water management goals that are certainly unique to those of many other countries due to the legacy of the country's racially discriminatory past.

- **Formal versus informal water governance structures:** The study found that in the absence of formally constituted water governance institutions, there is an emergence of informal private (such as Sasol, Eskom, mining companies, Rand Water, Agri SA in Gauteng province) driven local water resources governance structures taking charge of water resources management at the local level with increased risk for diverging from the nationally desired policy goals of water security and equity. Although the State demonstrates limited capacity to be fully involved at every level of water resources management, the role of private and social partners adds great value. The State does however have the responsibility to get involved in providing legislated oversight responsibilities to support and ensure that the goals of such informally constituted water resources governance structures are aligned to the national goals for water resources management.
- **Decision-making capacity at the local level:** The study findings revealed that, depending on the complexity of the management challenge, there is increasingly

limited decision-making capacity and responsibility taken at the local levels of water governance. The national government have local representation through its regional offices. The regional offices however, continuously demonstrate limited power to make decisions at the local level. Often major water resources policy management decisions are still made at the national level which risks a delayed reactional cycle, from the identification of local water resources management problems/ opportunities, to making the necessary decisions and adaptive actions to address them. As such, there would be great adaptive efficiencies gained by it could work better to strengthening the capacity and autonomy of the locally based national government representative institutions to be the take greater responsibility for the full custodians of the water resources policy governance decisions across the value chain at the local level. Yet on the other hand, at least under the current context of water reform in South Africa, total local autonomy could alienate the necessary voice and influence of the State for policy reform.

8.2.3.3. Policy Implementation

- **Implementation compliance with policy legislated provisions:** The study found that there exist a culture where the lack of policy compliance related to policy implementation by both the State and water users occurs without consequences. South African water resources management policy legislation provides clear framework for the policy goals and principles being pursued as well as the institutions and strategies that should be developed to facilitate the policy. The legislation also provides guiding timeframes for which strategies should be periodically developed. Evidence from this study however suggests that the State has continuously failed to meet its own legislated requirements for water resources policy management in South Africa. Yet there has not been any evident actions taken against the poor policy performance. Importantly, the impact of such poor policy performance is demonstrated through the continued injustice on the poor and marginalised citizens as perpetuated by the legacy of the previous racially discriminatory policies of the apartheid government. Summarily, improvements in water resources policy management compliance in line with the theoretical legislative provisions could go a long way to achieving greater policy effectiveness, efficiency and the desired impact.

- **Evidence-based learning and policy interventions:** The study found that while most aspects of the of water resources management policy are not fully implemented, there are often a number of new policy proposals for consideration to change and adapt on-going policy decisions virtually without enough evidence to suggest ineffectiveness or any specific inefficiencies to be considered for improvements. As such, there is a great possibility that most of the current policy positions of the State could be effective if implemented yet they are generally changed before being fully tested in practice. Indeed, it is also possible that some of the suggested policy interventions are also not contextually feasible to implement such that they cannot be implemented more than the fact that they are prematurely altered. Either way, water resources policy managers should establish the evidence to demonstrate to the best level possible that some of the interventions are simply not feasible to implement (which has not been the case as established in this study). Otherwise, poor policy implementation and prematurely altered policy interventions could remain as some of the recognisable reasons for water resources policy failure in South Africa.

- **Turnaround time from learning to decision to action:** Allen and Gunderson (2011) assert that one of the challenges affecting adaptive policy management efforts is that often new information is generated but it is hardly acted on because the required actions are too politically, economically or logistically difficult to implement. This is typical of the finding of this study, where water equity for example remains a problem almost 25 years since democracy. Limited financial capital also makes it difficult to intervene meaningfully. This study found for example that outside the national well-resourced and prioritized pilot cases to guide policy implementation, major water resources policy management decisions are often extremely slow or not implemented. The interviews noted that, there are also exacerbated by lengthy policy consultation processes and general indecisiveness and lack of execution. A great deal of the delay in the turnaround time from water policy learning to decision-making and action is also related to a disconnect between the national government as the national custodian of water resource and the local institutions that manage the resource on a daily bases. The turnaround time from learning to decision to adaptive action is a critical part of adaptive policy management that could be strengthened with improvements through the adopted decentralisation strategy for water resources policy management in South Africa. The more capacity and autonomy is rendered to the local level water resources governance institutions the better could be the turnaround time for adaptive policy interventions. This can be achieved by supporting full implementation of the legislated CMA institutions to lead the local water resources governance responsibility such as water allocations. Although there are areas where there is not enough data to guide key policy decisions, there is generally quite a lot of data that is collected and is readily available and relevant to a number of issues related to water resource management. Yet even in cases where there is evidence to suggest different adaptive actions, there continues to be procrastination in the decision-making processes of the State sometimes fuelled by lack of human and financial capital to facilitate implantation but also connected with the fear of upsetting the status core. This is an important finding and indeed as collaborated through literature because evidence utilisation is a key component of evidence-based adaptive policy making to prompt timely policy decisions when the merging policy management evidence justifies the need. Otherwise, the delayed time lag could potential reduce adaptive policy gains due to delayed adaptive action.

- **Financial capacity to fund policy actions:** Findings indicate that there is limited water resources policy management funding in general but also due to corrupt and expensive procurement practices which makes it difficult to follow-through with timely evidence-based water resource policy management decisions. Unless adaptive decisions are fully funded, it would not be possible to facilitate efficient AIWRM interventions. Such necessary financial capacity could be facilitated through public-private partnerships rather than only through the State. There are many financial instruments that are designed through public-private sector institutions where lessons could be useful for different aspects of water resources management funding.

- **Human capacity to implement policy decisions:** Limited human skills and experience across all levels and scales of water governance was one of the key findings of the study. This applies at all levels but with greater challenges at the local level of water resources management. This also relates to the challenges related to the institutional policy design for water resources policy management in South Africa as it also does to the entire water resources policy management value chain. As such, although most of the water resources policy management positions of the State are seemingly well-thought on paper, they are difficult to apply in practice mainly due to the limited capacity of the human resources base tasked to see them through. For example, only two out of the legislated nine CMAs have been implemented to manage local water resources. In the absence of local water resources governance. Ultimately institutions such as CMAs, national government continue to lead even at the local level. Ultimately, without the necessary staff complement, especially at the level where policy decisions are implemented, it could be argued that under the current circumstances, the possibility to achieve policy implementation efficiency could be extremely challenged. Contextually informed policy approaches become the most appropriate approach in this regard. With limited capacity, at least at all levels of managing the resource, there should be a strategy to develop the necessary internal capacity of the State and its institutions and to support the development of public-private partnerships that could allow the State to accelerate human capacity strengthening initiatives through the extended benefits offered by the wider stakeholder base.

8.2.4. Comprehensive policy monitoring and evaluation

One of the key ingredients for the efficient management of adaptive policies relates directly to the question of how to ensure that the policy implementation strategy is continuously well resourced with credible evidence to guide and facilitate the necessary adaptive policy management decisions. To ensure policy resilience, robustness and effectiveness, the policy logical performance framework must embrace uncertainty and complexity to ensure policy efficiency. A greater part of the challenge is presented by the narrow limited focus of the policy M&E process which emphasis logical sequencing of policy performance as a focus of the clarificatory evaluation processes, thus reducing a programme into what could be an overly simplified or even worse, a misplaced logical framework. This study highlights two challenges of using the policy logical framework or logically informed theory of change (ToC). First, is the assumption that, once determined, a policy should perform in accordance with the assumed theory of change (ToC, which may certainly not be the case especially in an interdependent socio-cultural and environmental systems as is the case for water resources policy management). Second, because the policy logical framework is also sometimes used to create a very narrow scope that is assumed as the operational performance boundary of the policy. This reductionist approach to policy management is, however, not helpful in enhancing policy performance, especially for interdependent policy systems where a wider set of environmental, economic, socio-cultural and political variables effectively come into play in the policy performance dynamics processes. Systems thinking induced policy logical framework might help to ensure a comprehensive appreciation of the deeply uncertain system boundary of the variables that could influence the logic of water resources policy management performance dynamics.

This study found that the current scope of water resources management remains narrowly focused on internal water resources management issues with limited appreciation and practical integration of the wider external issues at play. What is also clear from the study interviews and workshops is that there is an orthodox understanding of what water is, what it is for and what resource management entails mark boundaries of thinking that make it very difficult to alter the status quo. I could be further argued that while there is more than enough orthodox knowledge available, what is needed is a different way of seeing the resource to entice transformational action. Otherwise, no amount of information would inspire action in the current state of indecisiveness. For instance, there is a general view that (i) there is no water to spare; and (ii) you cannot upset the economy by properly implementing the legislated redress policy towards water equity and security for all by properly implementing the legislated redress policy towards water equity and security for all. As a result, internally focused policy M&E, (without the deliberate consideration of external policy system variables), remains extremely limited, as the evidence generated runs the risk of being out of touch with the social, economic, and environmental reality, which possesses greater relevance for the evaluation of policy effectiveness. Through this research, a comprehensive list of environmental, economic, socio-cultural and political variables that could be considered to support policy planning and performance evaluation of the water resources policy management system were identified. Consequently, water resources policy managers are forced to react to decisions made in other sectors outside the core water resources policy management sector. Under such conditions, policy M&E often struggles to provide the necessary comprehensive and credible evidence for policy planning and performance evaluation, such that policy managers are unable to comprehend the wider policy performance dynamics and therefore not able to act with confidence with the current limited policy management evidence. With water as a required resource across different sectors (i.e., social, economic, environmental sectors), it stands to reason that there needs to be an integrative mechanism for policy assessment across sectors and not within government circles such as the parliamentary policy oversight processes through structures such as the Portfolio Committee on Water and Sanitation.

Water resources policy management is interconnected and interdependent with the entire economic, social and environmental development agenda of the South African State. Consequently, the success of the water resource policy management objectives is embedded in the performance outcomes that are observable at the performance of other environmental, economic, socio-cultural and political systems. This interconnections and interdependencies create greater complexity and uncertainty that affects the accuracy of the policy planning and performance evaluation evidence.

The identification of the different variables is particularly important on three counts. Firstly, to help provide clarity of the most important for water resources policy management performance nodes for improved policy targeting; secondly, to inform targeting of the most relevant variables and performance indicators to the best possible achieve comprehensive systems-thinking informed policy M&E and thus adaptive policy performance evidence means to achieving the set policy targets; and thirdly, to identify the information required as evidence for planning, to measure performance as well as the potential sources of such information. The water resources policy management system variables identified through this study help to determine a comprehensive list of variables that can be monitored and evaluated to provide equally comprehensive and credible evidence about the performance of water resources policy management efforts toward sustainable national water security and equity as the national water resources management policy imperatives for South Africa. In this study a determination was made that comprehensive systems thinking induced monitoring and evaluating efforts should include monitoring and evaluating the following fifteen (15) environmental, economic, socio-cultural and political variables that directly influence *Water Equity* policy interventions (also see **Table *7.1***):

1) ***Access to Basic Water/Sanitation*** *(Households with access to domestic water and sanitation)*

   Relevance for water equity policy monitoring and evaluation M&E (M&E): Access to basic water and sanitation is one of the fundamental basic human rights in South Africa. Access to basic water and sanitation represents the basic level at which progress to water equity policy management efforts with community/ environmental health benefits for people and animals could be measured. There are a number of other variables however, that must be measured to locate the policy performance within a context. Population density, for example, would be helpful to appreciate the pressure exerted on the basic water and sanitation services system, such that, even in cases where the system would be ordinarily sufficient, it may not be because of the density of the population in a particular area. Basic water and sanitation can also be accessible directly by harvesting rainwater. Access to basic water and sanitation could also be affected by the availability of water resources, the pricing structure to access water, as well as household income capacity to pay for water services.

2) ***Business Opportunity/ Activity*** *(Entrepreneurial opportunities, activities and services available and utilised by society)*

Relevance for water equity policy M&E: Water is one of the main catalytic production resources for economic activity. As such, a measure of business opportunities and activities that incrementally benefit from water use would be very useful to measure potential water equity benefits from the direct use of water resources, as there could be greater potential for other spinoff opportunities such as employment. Over and above water availability, there are a number of variables that could help facilitate increased business activity and opportunities such as industrial development, tourism development and/or agricultural development. Therefore, insight into the impact of the availability of water resources could help explain potential and actual achievement of water equity, directly through business activities or indirectly through increased national or household income derived from public taxes and employment. Although water availability could be a useful measure of business activity, it could be useful to understand any other measure that could positively or negatively influences business activity in a particular area.

3) ***Community Health*** *(Aspects of community health that are water induced e.g. water-borne diseases resulting from poor water quality)*

Relevance for water equity policy M&E: Water equity has direct benefits for community health. Access to safe and good quality water is essential for household, community health and sustainable livelihoods, either through basic water and sanitation access or the production of food towards food and nutrition security. A comprehensive understanding of variables such as water availability, water quality, population density or ecosystem health could be helpful to explain their interactive effects on community health outcomes as a function for improved water equity.

4) ***Ecosystem Health*** *(Condition of an ecosystem whose natural structure can either be in a good or bad state)*

Relevance for water equity policy M&E: Ecosystem health has direct benefits to the environment and related sectors such as tourism with greater water equity benefits through employment and economic gains from tourism income. The main issues in this regard would be the amount of water allowed to flow naturally into the river systems. Water flow however can be affected by the imbalances created by economic activities, which may disrupt runoff and river flow efficiency. Even when there is relatively enough water allowed to flow through, the challenges exerted on the ecosystem by other stressors such as droughts, flooding or temperature extremes may mean negligible health benefits to the environment. Ecosystem health effectively depends on a number of variables that must be comprehensively understood to inform evidence-based policy decisions relating to setting the ecological flow thresholds.

5) ***Employment*** *(Temporal or permanent jobs or services in return for cash)*

Relevance for water equity policy M&E: Employment is one of the most practical means to achieve water equity especially in a context where there is generally limited access to direct production resources for the majority of poor

South Africans. Water using sectors could provide decent employment and income opportunities as a public responsibility incentivised through sustainable access to water resources for economic activity. There are a number of variables that should however be measured as part of employment. These could include issues such as population growth, population density and human skills, which could in practice, make it possible or difficult to achieve employment outcomes to the highest possible level. Water pricing for example is one of the variables that could be positively used to incentivise water-using sectors with the highest employment outcomes. Measuring employment could therefore provide greater insights to appreciating the indirect benefits on water use with greater household income and other social benefits as a result.

6) Equitable Water Allocation *(Water allocated by sector)*

Relevance for water equity policy M&E: Equitable allocation of water resources to the different water using sectors could be leveraged for improved water equity outcomes. On the main, the development and enforcement of equitable water allocation policies could help facilitate a process where water is equitably allocated thus ensuring direct equity to the business owners or indirectly allocating water resources to sectors that indirectly ensure water equity through indirect benefits related to employment or food security outcomes for example. Ultimately, equitable water allocation holds greater potential to help achieve equity. Differently put, the water allocation process can incentivise sectors with better equity benefits either directly or indirectly.

7) ***Food and Nutrition Security*** *(Physical, social and economic access to food of sufficient, and quality of food that meets people's dietary needs in an environment of adequate sanitation and health)*

Relevance for water equity policy M&E: Measuring food and nutrition security would be helpful to assess water equity for all. Food production, trade and economic growth contributions are not enough to sufficiently demonstrate value in the utilisation of water resources to benefit of all South Africans. In a free market context, farmers are allowed by law to trade freely. However, due to the fact that they use national water resources, there could be an obligation to ensure that water utilisation beneficiaries use water to first feed the nation before trading food internationally. Otherwise, South African water resources would be virtually traded without an inclusive and wider benefit for the nation and its wider communities.

8) ***Household Income*** *(Money generated per household through economic activities, employment or remittances)*

Relevance for water equity policy M&E: Equity could be also achieved through improved household income - allowing households to enjoy direct benefits of accessing water resources with wider benefits for food security, access to education, etc. Arguably, the more household and small business enterprises with access to water resources for economic activity, the more equitable potential would be the generated income and ultimately water equity. Water equity in this regard could also be indirect measured through employment and ultimately increased household income. Sustained household income could therefore be measured through to direct access to water for economic activities such as farming or indirectly through employment.

9) ***Population Density*** *(Measure of people per unit area)*

Relevance for water equity policy M&E: The concentration of the population in certain areas (local and provincial levels) holds greater potential to undermine water equity policy efforts. In such areas, employment opportunities for example could be greatly affected as there can only be a limited number of opportunities in a given area. Policy efforts could therefore create opportunities to widen the areas with increased business development and employment opportunities, especially towards rural areas, in order to decrease population density challenges in major towns and cities.

10) ***Population Growth*** *(Population increase in South Africa and its neighbours)*

Relevance for water equity policy M&E: Population in general, is one of the biggest pressure points for water and other production resources. Population growth inspires more demand for food and water and further threatens the achievement of policy outcomes such as employment and food security. Population growth is effectively a function of the balance between the birth and death rate. These variables would therefore have to be measured and understood in order to better appreciate and plan for future water needs and the impact on water equity thereof.

11) Strong Governance Institutions *(Water governance institutional arrangements at local, provincial, national and international levels)*

Relevance for water equity policy M&E: The water equity policy design and implementation architecture is effectively grounded on the strength of the institutions tasked to govern the sector. Strong water governance institutions should be able to design and manage intentional water equity policy positions through to fruition. At the heart of effective and efficient water governance institutions however, should be the active participation of multisectoral and multidisciplinary institutions as integrated policy actors, as well as a skilled human resource base to manage the governance responsibility. Adequate funding and the efficient utilisation of allocated funds would be key to help manage the operational requirements of water resources policy management governance institutions.

12) Sustainability *(Development fairness in consideration of current and future generation's' social, economic and environmental needs)*

Relevance for water equity policy M&E: Among other key elements of water equity is a responsibility in the utilisation of water resources such that equity is realised across generations. Different social, economic, and environmental factors that contribute to sustainability are therefore extremely important to the water equity policy agenda. With responsibility to current and future generations, variables such as ecosystems health, ecological water flows, community health, water quality, population growth, air pollution, rural development, economic growth, access to education, etc. must be measured to facilitate evidence-based policy management decisions to safe-guard water resources for current and future water resources.

13) Water Availability *(Development and protection of water resources to a point accessible for utilisation)*

Relevance for water equity policy M&E: Without water availability there would certainly be no opportunity at all to realise water equity. There are a number of environmental variables that are primarily responsible for water availability such as rainfall and temperature. Water resources must however be developed, managed and protected to ensure sustained availability through the construction and maintenance of water storage infrastructure for example. Economic and social activities however, could risk water availability through challenges such as water pollution, water wastage, illegal water use and general over-utilisation, etc. Moreover, water is a shared resource between neighbouring states to South Africa, which implies the need to understand international water use requirements versus availability in order to negotiate appropriate water resources development management and sharing agreements with neighbouring countries.

14) Water Equity Policies *(Policies to facilitate water equity for all through direct or indirect access to water and its social and economic benefits)*

Relevance for water equity policy M&E: To achieve water equity, policy makers must be intentional in designing policies that could help facilitate the targeted water equity policy outcomes. The successful development and implementation of such water equity policies are highly dependent on the political will and strong governance institutions to take the lead and ensure compliance and ultimately the achievement of water equity in South Africa.

15) ***Water Pricing*** *(Tariffs attached to accessing water resources or services)*

Relevance for water equity policy M&E: Water pricing is one of the water resources policy management instruments to create a balance between demand and supply of the resource, while promoting its efficient and productive use. The water pricing policy effectively reflects the value of water as an economic resource, where the costs incurred in the development and management activities are recoverable through the pricing structure. In South Africa all significant water resource use is therefore charged with the exception of water reserved for basic human needs. The principle of fairness does however apply in cases of previously discriminated users. There is a strong consideration of variables such as household income and the amount of available water resources (demand and supply) in determining water tariffs. Other priority areas for discounted water charges relates to developmental projects that demonstrate greater social value share with greater potential to help close the inequality gap in South Africa. Water pricing is therefore a key measure to determine water resources policy management performance towards water equity.

The value of 15 variables presented above is that they represent the most important performance nodes of the water resources policy management system as identified by the system mapping process employed in this study. Comprehensive systems-thinking inspired M&E is required to improve the understanding of emerging complexity related to each of the variables in consideration of the interdependencies with the connected variables to each as presented in **Table *7.1***. The M&E process should be able to help establish a better understanding of how each of these variables is likely to behave in relation to the directly connected variables.

An effective and efficient adaptive water management strategy must therefore be knowledge-intensive, to successfully respond to the highly emergent, and mostly exogenous, management conditions over which water managers, generally, have little direct control. In fact, the governance challenges on the water resources management policy goals predominantly emerge outside the traditional water sector, where policy managers have a limited degree of management control. Most of the variables of interest exhibit complex and deeply uncertain interactive causal relationships with greater potential risk for unintended and negative policy performance outcomes. Consequently, greater management complications emerge from the poor comprehension of the characteristics of each of the goal, driver and lever variables that define the broader water resources policy management system. Accordingly, a comprehensively developed M&E framework could help generate the necessary information and evidence to facilitate the required technical, institutional, and operational levels' learning required for successful AIWRM in South Africa. While policy monitoring and evaluation, along with learning and adapting, can be effected exclusively at each of the different policy management levels, the interconnected and interdependent nature of the system dictates the need to embrace an integrated approach that cuts across the different levels. The interconnected and interdependent nature of the water resources policy management system implies that even small changes, in any of the system variables identified above, may stimulate large highly improbable, unpredictable and unexpected policy performance reactions in different parts of the system. Logical policy frameworks and theories of change developed for policy plagued with deep uncertainty and complexity must therefore be alive to the risk of being totally misplaced. As such, policy managers and evaluators working in such contexts must continually make efforts to adapt and improve the assumed water resources policy management performance logic as more information and knowledge becomes available. Consequently, the variables identified in this study should be interactively monitored and evaluated as part of the wider water resources policy management system rather than independently.

Importantly, as argued though this thesis, a great deal of the *Water Equity* contributing variables occurs outside the management control of water resources policy mangers. Therefore, it would be unjustifiable to expect water resources policy managers to have a total appreciation of all the different variables involved in the system as mapped in this study. The divergence of the variables involved in the water resources policy management system can however, help to appreciate the diversity of the stakeholders who should to be engaged to help collaboratively monitor and evaluate the system towards increased policy efficiency and impact. Such stakeholders could include public, civil society, and private as well as international partners. Importantly, the recognition and meaningful engagement and involvement of multi-stakeholder groups in water resources policy management could further complicate the management processes as a result of potentially increased divergent values and power dynamics that could emerge with widening the stakeholder base. Nonetheless, engaging and ensuring the consistent participation of different stakeholders and communities in the governance of water policy would be the most appropriate strategy to collaboratively and efficiently govern the water resources policy management system.

8.3. Key contributions and recommendations

The knowledge contribution of this research is not framed against what is said to be best practice else-where in the world. Instead such changes must be contextually framed against the unique case of South Africa. This relates to water access issues that persist from the country's political past of discriminatory access to resources as well as the need to achieve equity and equality while in pursuit of feasible economic and social development interests. The world of policy has been talking about integration, complexity, uncertainty, and evidence-based policy for a long time. This thesis however, takes a step further to interrogate the issues of integration, complexity, uncertainty, and evidence-based policy specifically for the context of water resources policy management in South Africa through a process that (i) aggregated this information; (ii) considered it systematically; (iii) brought key expert informants together to critically reflect on it; and (iv) piloted a method for deepening stakeholders' understanding of the challenges in a manner that (v) can be replicated[6]. In this regard, the findings of this thesis are of greater value towards adaptive policy management and evaluation for improved water resources management in the face of uncertainty and complexity in South Africa. Furthermore, the study's contribution to knowledge is particularly useful for ensuring:

[6] I acknowledge this input as part of the comments made by one of the anonymous examiners on the knowledge contribution of this thesis.

- a contextual understanding of the different aspects that would have to be considered or adjusted for the successful adoption and implementing of AIWRM; and
- systems thinking infused water resources policy monitoring and evaluation M&E with a particular interest in generating a comprehensive evidence-base for the interconnected and interdependent internal and external variables that interactively determine water resources policy management performance.

Ultimately, the knowledge contribution of this study offers the means for improved water resources policy planning, learning and performance management through evidence-based AIWRM. Key findings of this research suggest that successful adaptive policy and adaptive capacity must be intentionally pre-developed and planned for, meaning it cannot be integrated at a later stage, by simply overlaying adaptive actions on traditional policy plans and governance systems or institutional structures. Over and above the planning or design elements, adaptive policy management also demands the reform of policy institutions and governance structures to ensure the efficiency of the entire policy management system that is capable to facilitate continuous learning and improvement. Most water resources policy management decisions are hardly tested as they are not well implemented. As such changes in current water resources policy management decisions cannot be comprehensively justified. Poor policy implementation raises key questions however, around the issues that affect water resources policy implementation mainly related to human resources capacity as well as the financial, political, and social capital available for water resources policy management in South Africa. Technical water resources planning and management capacity remains concentrated at the national level in organizations such as the Department of Water and Sanitation and the Water Research Commission as compared to local levels in CMAs. Ensuring efficient and effective policy implementation and learning from the emerging gaps would be the first point of departure to addressing water resources management challenges in South Africa.

In South Africa, it is noted that current water resources policy monitoring generally tends to focus on technical elements of water resources and related implementation processes. As such, it is recommended that this scope is widened to strengthen and improve the generation and flow of information between technical water managers, society, and decision-makers in government as well as the private sector and civil society to inform better planning and comprehensive performance monitoring and management actions. Such information could relate to technical elements of water resources management but also other environmental, economic, socio-cultural, and political information relevant for water resources policy management in the face of complexity and uncertainty. As compared to the current dominance of the State to leading water resources policy management decisions, interconnecting water management with other sectors like agriculture, mining, and energy as well as communities at the institutional level, could enhance comprehensive and transparent decision-making processes to facilitate efficient adaptive water management actions. Realizing this approach to policy management would, however, be a highly demanding task that would require some transformational changes at the policy, institutional and operational levels in the current affairs of water resources policy management in South Africa. Furthermore, well-capacitated, decentralized institutional policy arrangements towards inclusive and integrated water governance structures that allow for the active participation of multi-disciplinary and multisectoral actors at the national to the local levels can assist the efficient and effective facilitation of successful AIWRM in South Africa. The transition from a more traditional approach to managing the resource to AIWRM would require greater investments into collaborative governance, human, financial and social capacity as well as developing and implementing a comprehensive monitoring and evaluation M&E system to facilitate evidence-based adaptive decisions.

Data accuracy, consistency and validity is key to ensuring that the adaptive water resources management strategy is continuously infused with reliable and credible evidence to facilitate efficient and effective evidence-based AIWRM decisions. As such, where possible, triangulation efforts must be made to ensure the validity of all information generated through different institutions involved in the governance of water resources from an M&E perspective. The generation of such comprehensive M&E information on the different variables identified in this study, does not necessarily have to be achieved through the establishment of new institutions. Instead, this could also be achieved by leveraging on already existing institutions and organised structures through networks of common interest so that the State is ultimately able to deliver on its developmental goals. Importantly, the different institutions required to participate in the collaborative generation of information to inform water resources policy planning and performance evaluation must be incentivised to do so. One of the means to achieve this could be to ensure that the different stakeholders derive some value in participating in the water planning and evaluation processes. The different stakeholders involved could benefit from institutionalising the utilisation of evidence generated about the performance of the system in its widest form. In this regard, policy actions may not necessarily be limited to the water sector such that each of the other actors involved are able to derive some value in the generated evidence for their own sectorial decisions. Over and above invoking innovative water resources policy management to circumvent external challenges to the water resources policy management system, the State should also be able to use the information generated on other related subsystems' variables that intersect with the water resources policy management system for other policy planning interests.

Archiving the proposed transformational changes towards successful evidence-based AIWRM could be an extremely difficult task especially under current policy implementation and collaborative governance issues that are underpinned by great political uncertainty and low financial, human and social capital. As such, the question arises whether or not there are any opportunities in current water resources management strategies that could be leveraged for adaptive management benefits. It is well acknowledged, that such a transition towards responsive learning and adaptive capacity can often be hampered by the general belief of policy makers that adaptive management does not constitute any more significant changes from current practices of traditional policy management (Williams and Brown, 2017). Consequently, such a transition would certainly require some dedicated attention to reform institutional barriers within the state and redesigning the decision-making architecture in order to accommodate adaptive water resources policy management requirements with greater prospects for the much desired impact.

8.4. Conclusion

A great part of South Africa' national challenges emerge as a legacy of structural racial discrimination instituted by the apartheid government where the black majority of the population had limited access to production resources such as land, water and finance.

Since 1994, the democratic government has strived to reform access to these resources and ensure equitable and sustainable development for all. Water is one of the central resources to the equitable developmental agenda of the State. The ultimate goal is to achieve sustained water equity where all South Africans can have direct or indirect access to water and its accrued utilisation benefits. In a country ranked among the top five most unequal societies in the world, with an unemployment rate of over 30% and about half of the population living in poverty, the development task is great and the policy impact path-ways are extremely complex and deeply uncertain. Policy management efforts cannot afford to fail. The challenges presented by the South African context of water resources policy management is helpful to establish the potential value of adaptive policy management approaches for improved management of water resources in the face of complex and uncertainty. Concurrently, continuous M&E and learning could better inform policy makers of real-time opportunities to improve policy management under such conditions and allow for effective adaptive decisions as the policy management conditions unfold.

This investigation set out to explore the feasibility of employing adaptive approaches to water resources policy management in South Africa and to understand how comprehensive policy planning and performance evidence can be generated to support such an approach. To determine the latter, systems thinking approaches were utilized to help comprehensively identify and target certain variables with a potential to help improve the comprehensive understanding of the performance dynamics of the South African water resources policy management system with a particular interest to ensure sustainable water equity policy outcomes for all.

As argued in this study, the challenge presented by wicked problems is that they constitute a comprehensive set of variables that are interconnected and interdependent with greater risk for more complexity and uncertainty. The recognition of complexity and uncertainty in water resources policy management dictates the need to embrace policy management approaches that are flexible and fluid to navigate these conditions in order to maintain efficient policy effectiveness. Adaptive policy management approaches demonstrate such potential by increasing and sustaining the capacity to learn and adapt. Such approaches are particularly useful in dealing with policies where there is no precedent to learn from and where extrapolation potential is limited by the lack of reliable trends. At the centre of good policy decisions, especially under deeply uncertain and complex policy management circumstances, should be credible real-time evidence on both internal and exogenous variables that could positively or negatively impact the performance of different water resources policy management options. Good or poor water resources policy management performance can be explained not only by looking internally within the water resources management system, but also at other complex, rapidly emerging and deeply uncertain policy conditions outside the direct control of primary water resources policy managers. The latter is a key point for the evaluation of interconnected and interdependent policy systems such as water resources policy management in South Africa, that exhibit deep uncertainty, complexity and emergent management conditions. In particular, logical frameworks designed for more stable and logical policy performance models, may be limited when applied for policies implemented under deeply uncertain, complex and emergent conditions. This is mainly because the agreed and assumed logic of the policy performance model may after all be illogical as a consequence of uncertainties and complexity that emerges from the performance dynamics of the policy due to the competing interdependencies and interconnectedness of the multiple systems' variables involved with water resources management as a central resource for economic, social and environmental development and sustainability.

South African water resources management policy must therefore be designed and governed in such a manner that it is receptive to new knowledge and information and is able to actively respond and adapt accordingly, so as to better navigate under rapidly changing conditions. It follows therefore, that an evidence-based policy management approach, to inform adaptive policy design, performance monitoring and implementation is justified. This suggests that the policy management process must be continuously infused with comprehensive and credible evidence throughout its existence. However, as demonstrated throughout this thesis, the generation of credible evidence under deeply uncertain and emergent policy conditions remains a major challenge for policy makers. This research argues for the utilisation of systems thinking approaches in the generation of planning and performance evidence. This would help to better comprehend what could be disguised water resources policy management performance dynamics and facilitate adaptive decisions to ensure efficiency and effectiveness as the policy management condition become better understood. In this study, a systems thinking perspective for policy performance modelling was extremely useful for the identification of a set of comprehensive variables that interactively influence water resources policy management performance towards equity. These variables would therefore be useful in future to identify policy planning and performance indicators that can be monitored and evaluated to help facilitate improved adaptive policy planning and performance management.

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APPENDICES

Appendix 1: Ethics clearance for the study (Faculty of Science Research Ethics Committee)

UNIVERSITY OF CAPE TOWN
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10 November 2017

Mr Sandile Ngcamphalala
Department of Environmental and Geographical Science

Developing a comprehensive monitoring and evaluation framework for adaptive water policy management under uncertainty in South Africa

Dear Mr Sandile Ngcamphalala

I am pleased to inform you that the Faculty of Science Research Ethics Committee has approved the above-named application for research ethics clearance, subject to the conditions listed below.

- Implement the measures described in your application to ensure that the process of your research is ethically sound; and
- Uphold ethical principles throughout all stages of the research, responding appropriately to unanticipated issues: please contact me if you need advice on ethical issues that arise.

Your approval code is: FSREC 79 – 2017

I wish you success in your research.

Yours sincerely

Signature Removed

Prof Timm Hoffman
Chair: Faculty of Science Research Ethics Committee

Cc: Dr Olivier Crespo (Supervisor)

Appendix 2: E-mail invitation to key informants to participate in the study

Dear XXXX

Hope this finds you well. My name is Sandile Ngcamphalala, a PhD Environmental Science candidate with the University of Cape Town, Climate Systems Analysis Group (CSAG). The title of the PhD is **'Comprehensive monitoring and evaluation M&E framework for adaptive water policy management under uncertainty in South Africa'.**

My PhD research project looks at how uncertainty applies to the domain of water policies and how it affects the generation of credible evidence to inform design and performance management decisions, especially in view of water and its management being central to the sustainable development of South Africa and the well-being of its citizens. Arguing that traditional evaluation approaches tends to show limitations in facilitating monitoring and evaluation M&E of policies plagued with great uncertainty, complexity and evolving issues, the research therefore offers an opportunity for the development of a monitoring and evaluation M&E framework that is tailored for such policies. Such a framework could be helpful in the facilitation of the generation of credible information about how reliable evidence can be generated regarding the policy effectiveness as well as informing day-to-day developmental policy decisions for sustainable water resources management in South Africa. In other words, what could be the best-tailored evaluation design to facilitate effective adaptive policies in cases where the theory of change or impact pathway is not necessarily straightforward due to deep uncertainty?

In this regard, I would like to request some time with you for a personal interview on the adaptive nature of SA water policy and the gaps or challenges including implementation and performance evaluation. I have attached the interview schedule to allow you some time to look at the questions of interest. Indeed, you may not be full aware of all the areas of the enquiry. I have attached the interview schedule for your information.

As a renowned SA water policy expert, I hope you can find some time to participate in the study to participate in the study and provide your insightful guidance.

Kind regards

Sandile Ngcamphalala

Appendix 3: Example of an e-mail invitation to participate in one of the research workshops with stakeholders

Dear Ms XXXX

Hope this finds you well.

You are cordially invited to a research workshop titled 'monitoring and evaluating water resources policy management in the face of deep uncertainty and complexity: a systems thinking perspective'. the workshop on the co-designing of an innovative monitoring and evaluation M&E approaches for policies plagued with deep uncertainty, complexity and stakeholder divergence, is part of an on-going PhD research study based at the University of Cape Town that is looking at the challenges and implications of uncertainty for water policy design and evaluation.

The workshop will be held as follows:

DATE: Tuesday, 27 November 2018
TIME: 09:00-13:00
VENUE: Agricultural Research Council – Central Office, 1143 Park Street, Hatfield, Pretoria

The objectives of the workshop are:

- To establish a common understanding of water resources management as an interdependent and interconnected system
- To explore the concept of uncertainty and its implications for water resources policy management in South Africa
- To co-design a monitoring and evaluation M&E framework suited for complex and deeply uncertain policy systems i.e. Water Resources Management

For more information on the context and study objectives, please see attached research Abstract. Please also see attached programme for the workshop.

RSVP with Sandile Ngcamphalala on ngcamphalalas@arc.agric.za.

Your active participation will be highly appreciated.

Kind regards
Sandile Ngcamphalala

Appendix 4: Example programme for one of the research workshops

WORKSHOP

Monitoring and Evaluating Water Resources Management Policy in the face of Deep Uncertainty and Complexity: A Systems Thinking Perspective

Workshop Objectives

- ***To establish a common understanding of water resources management as an interdependent and interconnected system***
- ***To explore the concept of uncertainty and its implications for water resources management policy in South Africa***
- ***To co-design a monitoring and evaluation framework suited for complex and deeply uncertain policy systems i.e. Water Resources Management***

DATE: Tuesday, 27 November 2018
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PROGRAMME

TIME	TOPIC/ACTIVITY	FACILITATOR
9:00-9:10	Registration	
9:00 - 09:10 9:10 – 09:45	1. Opening and welcome 2. Uncertainty & Water Policy Management	Prof Sue Walker Mr. Sandile Ngcamphalala
09:45-10:45	3. Facilitated Group Discussion: Deep Uncertainty and Systems Thinking in Water Resources Policy Management	All
10:45-11:15	Tea Break	
11:15-12:50	4. Facilitated Group Discussion: Evaluating Deeply Uncertain & Complex Policy Systems	All
12:50-13:00	Closing & Way Forward	Prof Sue Walker

For more information contact Mr Sandile Ngcamphalala on 082 862 1991 or by email at Ngcamphalalas@arc.agric.za

Appendix 5: Fundamental principles of water policy in South Africa (Source: Adapted from DWAF, 1997)

Legal Aspects of Water
Principle 1: The water law shall be subject to and consistent with the Constitution in all matters including the determination of the public interest and the rights and obligations of all parties, public and private, with regard to water. While taking cognisance of existing uses, the water law will actively promote the values enshrined in the Bill of Rights. **Principle 2:** All water, wherever it occurs in the water cycle, is a resource common to all, the use of which shall be subject to national control. All water shall have a consistent status in law, irrespective of where it occurs. **Principle 3:** There shall be no ownership of water but only a right (for environmental and basic human needs) or an authorisation for its use. Any authorisation to use water in terms of the water law shall not be in perpetuity. **Principle 4:** The location of the water resource in relation to land shall not in itself confer preferential rights to usage. The riparian principle shall not apply.
The Water Cycle
Principle 5: In a relatively arid country such as South Africa, it is necessary to recognise the unity of the water cycle and the interdependence of its elements, where evaporation, clouds and rainfall are linked to ground water, rivers, lakes, wetlands and the sea, and where the basic hydrological unit is the catchment. **Principle 6:** The variable, uneven and unpredictable distribution of water in the water cycle should be acknowledged.
Water Resource Management Priorities
Principle 7: The objective of managing the quantity, quality and reliability of the Nation's water resources is to achieve optimum, long term, environmentally sustainable social and economic benefit for society from their use. **Principle 8:** The water required to ensure that all people have access to sufficient water shall be reserved. **Principle 9:** The quantity, quality and reliability of water required to maintain the ecological functions on which humans depend shall be reserved so that the human use of water does not individually or cumulatively compromise the long-term sustainability of aquatic and associated ecosystems. **Principle 10:** The water required to meet the basic human needs referred to in Principle 8 and the needs of the environment shall be identified as 'The Reserve' and shall enjoy priority of use by right. The use of water for all other purposes shall be subject to authorisation.

Principle 11: International water resources, specifically shared river systems, shall be managed in a manner that optimises the benefits for all parties in a spirit of mutual co-operation. Allocations agreed for downstream countries shall be respected.
Water Resource Management Approaches
Principle 12: The National Government is the custodian of the nation's water resources, as an indivisible national asset. Guided by its duty to promote the public trust, the National Government has the ultimate responsibility for, and authority over, water resource management, the equitable allocation and usage of water and the transfer of water between catchments and international water matters. **Principle 13:** As custodian of the nation's water resources, the National Government shall ensure that the development, apportionment, management and use of those resources is carried out using the criteria of public interest, sustainability, equity and efficiency of use in a manner which reflects its public trust obligations and the value of water to society, while ensuring that basic domestic needs, the requirements of the environment and international obligations are met. **Principle 14:** Water resources shall be developed, apportioned and managed in such a manner as to enable all user sectors to gain equitable access to the desired quantity, quality and reliability of water. Conservation and other measures to manage demand shall be actively promoted as a preferred option to achieve these objectives. **Principle 15:** Water quality and quantity are interdependent and shall be managed in an integrated manner, which is consistent with broader environmental management approaches. **Principle 16:** Water quality management options shall include the use of economic incentives and penalties to reduce pollution, and the possibility of irretrievable environmental degradation as a result of pollution shall be prevented. **Principle 17:** Water resource development and supply activities shall be managed in a manner which is consistent with the broader national approaches to environmental management. **Principle 18:** Since many land uses had a significant impact upon the water cycle, the regulation of land use shall, where appropriate, be used as an instrument to manage water resources within the broader integrated framework of land use management. **Principle 19:** Any authorisation to use water shall be given in a timely fashion and in a manner which is clear, secure and predictable in respect of the assurance of availability, extent and duration of use. The purpose for which the water could be used shall not arbitrarily be restricted. **Principle 20:** The conditions upon which authorisation was granted to use water shall take into consideration the investment made by the user in developing infrastructure to be able to use the water. **Principle 21:** The development and management of water resources shall be carried out in a manner which limits to an acceptable minimum the danger to life and property due to natural or manmade disasters.
Water Institutions

Principle 22: The institutional framework for water management shall, as far as possible, be simple, pragmatic and understandable. It shall be self-driven and minimise the necessity for State intervention. Administrative decisions shall be subject to appeal. **Principle 23:** Responsibility for the development, apportionment and management of available water resources shall, where possible and appropriate, be delegated to a catchment or regional level in such a manner as to enable interested parties to participate. **Principle 24:** Beneficiaries of the water management system shall contribute to the cost of its establishment and maintenance on an equitable basis.
Water Services
Principle 25: The right of all citizens to have access to basic water services (the provision of potable water supply and the removal and disposal of human excreta and waste water) necessary to afford them a healthy environment on an equitable and economically and environmentally sustainable basis shall be supported. **Principle 26:** Water services shall be regulated in a manner which is consistent with and supportive of the aims and approaches of the broader local government framework. **Principle 27:** While the provision of water services is an activity distinct from the development and management of water resources, water services shall be provided in a manner consistent with the goals of water resource management. **Principle 28:** Where water services were provided in a monopoly situation, the interests of the individual consumer and the wider public must be protected, and the broad goals of public policy promoted.