THE APPLICATION OF STRATEGIC ADAPTIVE MANAGEMENT IN THE WATER SERVICES SECTOR

Report to the

Water Research Commission

by

JDG Frame, Dr JK Clifford-Holmes, Dr K Winter & J Davies

Amanzi Obom Consulting cc

Report No. 1123b/1/17

ISBN 978-1-4312-0943-9

January 2018

Obtainable from

Water Research Commission

Private Bag X03

Gensina, 0031

orders@wrc.org.za or download from www.wrc.org.za

DISCLAIMER

This report has been reviewed by the Water Research Commission (WRC) and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the WRC, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Printed in the Republic of South Africa

EXECUTIVE SUMMARY

South Africa is a rapidly urbanising developing country that faces uniquely complex water management challenges. Water scarcity (augmented by climate change and population growth), a resource-intensive economy and the legacy of Apartheid all contribute to these challenges, one of the most significant of which is the lack of access to water-based services, particularly among lower-income sectors. Increasing demand for potable water, sanitation services and stormwater services from a growing population places significant pressure on already stressed local governments, whose mandate it is to deliver adequate basic services in an equitable, efficient and sustainable manner. The challenges that local governments face in this regard are driven by various interacting factors. These challenges have amounted to a significant barrier with regards to the effective implementation of the country's national water legislation, which aligns with the holistic principles of Integrated Water Resource Management (IWRM). Rather than an integrated approach, water management has largely followed a "top-down", technocratic paradigm which has resulted in institutional fragmentation, the over-regulation of water services and a growing level of discontent among citizens.

Given these challenges, there is an unmistakeable need (at least at a policy and planning level) to shift toward an alternative, systems-orientated approach to urban water management, in order to deal with problems in both the quantity and quality of the water provided by water-based services. Thus, the objectives of this study were to provide a "proof of concept", or evidence, that demonstrates that Strategic Adaptive Management (SAM), or an adaptation thereof, can be applied, theoretically and practically, to water services in South Africa. They study aimed to test the foundational theories, concepts, principles, processes and practices (both implicit and explicit) of SAM and provide reasons as to why SAM is more effective than adaptive management (AM) by detailing how SAM has addressed the major barriers to AM. Then the extent of commonalities and cross-cutting themes between water services and the two domains where SAM has been successfully used (i.e. park management and catchment management) was examined, and documented municipal applications of SAM in South Africa were explored.

This study considers SAM to be a framework through which a number of powerful theories can be integrated and argues that the SAM approach (albeit non-explicitly) brings an organisation to a more associative phase of development, as stakeholders become collaborators or partners in governance, planning and management. Drawing on Reeler's (2007) Threefold Theory of Change and Snowden and Boone's (2007) Cynefin framework, SAM aims to match each theory of change to its corresponding problem context, as is appropriate at different stages of the management cycle. Thus, in shifting to a new phase of development, the organisation does not discard the valuable aspects of the previous phase. For example, SAM recognises that the "rational" phase is effective at managing simple and complicated projects, which is a quality that should not be lost in the "associative" phase,

which is more effective at dealing with complex projects. In setting this direction for change, the SAM process remains flexible and learning-centred, so as to build resilience to unexpected change.

The literature review identified the main challenges in the water services sector. These include the persistence of departmental "silos" and the fragmentation that undermines integration and collaboration; over-regulation; financial and capacity constraints and political and managerial flux. Together, these issues all result in lack of accountability.

The concept of AM was then introduced and evidence of the successful application of SAM in park management and water resources management was described.

It was evident from the literature that SAM has significantly addressed the barriers to AM through the adoption of theories, concepts, principles, processes, and practices that are being utilised in effective organisations, including in business. In addition, it provides solutions to overcome "silos" and fragmentation by building integration and collaboration into its process. Key to the effectiveness of SAM is the emphasis on developing generative leadership, the building of trust between all stakeholders, the importance of the vision (desired future) and strategy being developed and owned by stakeholders, the central role that values play in driving the behaviour of stakeholders and "structures" that guide decision making, and finally the institutionalisation of the management process, in this case, SAM.

Based on the conclusions from the literature review, SAM could be useful in municipalities and has a significant probability of succeeding, especially in contexts that are relatively stable and functional. However, SAM is not a "silver bullet" – a direct or effortless solution to the problems being faced in water services. Rather, it is argued that an adapted and improved version of SAM has the potential to act as a process for overcoming the challenges of traditional management and operationalising a paradigm shift to improve the delivery of water services.

Further, the examination of an adapted SAM simulation applied to water services, in particular, Water Sensitive Design in the City of Cape Town, indicated the following:

- The SAM process is best commenced at the adaptive planning phase as this is where the visioning (desired future state) takes place and stakeholders co-create the vision.
- The SAM process is scalable. It might be easier to only include internal stakeholders initially. This enables incremental testing of the process.
- SAM is flexible enough to allow for incremental adoption as this is a natural process that happens with new practices and technology.
- SAM has the potential to be cascaded horizontally and vertically across the organisation as confidence in the process is built. This happens when a department that has adopted SAM engages other departments in a SAM process.

This study thrust concludes that it would be worthwhile to further explore the applicability of SAM in the water services context by implementing a pilot project that would plan Water Sensitive Design, with a view to its progressive implementation.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF BOXES

ABBREVIATIONS

AG	Adaptive Governance
AM	Adaptive Management
AP	Adaptive Planning
APP	Adaptive Planning Process
AWARD	Association for Water and Rural Development
CMA	Catchment Management Agency
CSRM	Catchment, Stormwater and River Management
I(U)CMA	Inkomati (Usuthu) Catchment Management Agency
IDP	Integrated Development Plan
IWRM	Integrated Water Resource Management
KNP	Kruger National Park
LSRV	Lower Sundays River Valley
MSI	Municipal Support Initiative
SA	South Africa
SAM	Strategic Adaptive Management
SANPAD	South Africa Netherlands Research Programme for Alternatives in Development
SANParks	South African National Parks
SUDs	Sustainable Urban Drainage Systems
TOC	Theory of Change
V-STEEP	Values – Social, Technical, Environmental, Economic and Political Factors
WSA	Water Service Authority
WSC	Water Sensitive City
WSD	Water Spatial Design
WSDP	Water Services Development Plan
W& S	Water and Sanitation
WSUD	Water Sensitive Urban Design

1. INTRODUCTION

South Africa is a rapidly urbanising developing country that faces uniquely complex water management challenges. Water scarcity (augmented by climate change and population growth), a resource-intensive economy and the legacy of Apartheid all contribute to these challenges, one of the most significant of which is lack of access to water-based services, particularly among lower-income sectors (Armitage et al., 2014; DWA, 2013; SAHRC, 2014). The increasing demand for potable water, sanitation services and stormwater services from a growing population places significant pressure on already stressed local governments, whose mandate it is to deliver adequate basic services in an equitable, efficient and sustainable manner.[1] The challenges that local governments face in this regard are driven by various interacting factors, as discussed in the following section. These challenges have amounted to a significant barrier with regards to the effective implementation of the National Water Act, the country's national water legislation (RSA, 1998), which aligns with the holistic principles of integrated water resource management (IWRM). Rather than an integrated approach, water management has largely followed a "top-down", technocratic paradigm which has resulted in institutional fragmentation, the over-regulation of water services and a growing level of discontent among citizens (SAHRC, 2014).

The objectives of this study were to provide a "proof of concept" or evidence that demonstrates that Strategic Adaptive Management (SAM), or an adaptation thereof, can be applied to water services in South Africa (SA), and to examine whether SAM could be practically applied to water services. The study aimed to test the foundational theories, concepts, principles, processes and practices (both implicit and explicit) of SAM and provide reasons as to why SAM is more effective than adaptive management by detailing how SAM has addressed the major barriers to adaptive management. Another objective was to examine the extent of commonalities, overlaps and cross-cutting themes between water services and the two domains where it has been successfully used, i.e. park management and catchment management, and to document municipal applications of SAM in SA.

Given the challenges facing the water sector, there is an unmistakeable need (at least at a policy and planning level) to shift toward an alternative, systems-oriented approach to urban water management, in order to deal with problems of both the quantity and quality of water and water-based services (Armitage et al., 2014). In this study, many of the existing issues in urban water management are attributed to a failure by decision makers to recognise the appropriate theory of change that is needed to address a particular type of problem. Drawing on Reeler's (2007) "Threefold Theory of Change" and Snowden and Boone's (2007) Cynefin framework, it is argued that projectable, emergent and transformative change processes are differentially applicable to simple, complicated, complex and chaotic problems (or problem

[1] As expressed in the White Paper on Local Government (RSA, 1998b) and legislation such as the Municipal Structures Act (RSA, 1998a) and the Municipal Systems Act (RSA, 2000).
.

contexts). Further, it is asserted that certain organisational forms (i.e. pioneering, rational, integrative or associative organisations) are more adept at dealing with complexity than others (Reeler et al., 2009).

Strategic Adaptive Management (SAM) is considered as a framework through which the above theories can be integrated and applied in water services. We argue that the SAM approach (albeit not explicitly) brings an organisation to a more associative phase of development, as stakeholders become collaborators or partners in governance, planning and management. In doing so, however, it aims to match each theory of change to its corresponding problem context, as is appropriate at different stages of the management cycle. Thus, in shifting to a new phase of development, an organisation does not discard the valuable aspects of the previous phase. For example, the rational phase is effective at managing simple and complicated projects, which is a quality that should not be lost in the associative phase, which is more effective at dealing with complex projects. In setting this direction for change, the SAM process remains flexible and learning-centred, so as to build resilience to unexpected change (Pollard & du Toit, 2007).

In order to prove the theory that SAM is useful in the context of water services, this study applied SAM in the municipal planning sphere, which, it is argued, is the most appropriate place to introduce SAM. The application of SAM is specifically considered in the context of Water Sensitive Urban Design (WSUD). WSUD aims to consider the environmental, social and economic effects of urban water management infrastructure and governance on the entire urban water cycle (Wong & Eadie, 2000) and is therefore a holistic approach that aligns with the philosophies of both IWRM and SAM (Pollard & du Toit, 2011). The City of Cape Town's Catchment, Stormwater and River Management (CSRM) branch, which is the unit responsible for WSUD, is used as an exemplar to prove the validity of our argument.

The next section discusses, in more detail, the challenges being faced in water services in SA. The concept of SAM is then introduced and linked to the Threefold Theory of Change and the Cynefin framework, followed by a brief description of the different phases of organisational development. The latter is important to consider, given that water services can largely be conceptualised as being in a "rational" phase of development – " '*left-right-left-right!' Organisations in this phase are independent, more conscious and well organised*" (Reeler et al., 2009). This is different to catchment management agencies (CMAs), the context in which SAM was originally intended to be applied, which are more aligned with the characteristics of pioneering organisations; "*this phase is like a flowering patch – messy but fresh with new energy. It's flexible, but dependent on the pioneer, who is seen as a parental figure*" (Reeler et al., 2009). These differences warrant the modification of SAM for the context of water services, which this report addresses by making the implicit aspects of SAM more explicit.

Based on the above argument, Section 4.9 discusses the ways in which SAM has addressed the weaknesses of conventional adaptive management. The concept of WSUD is then introduced and the challenges of implementing WSUD in SA are discussed, along with an

overview of how the philosophy and operating principles of SAM might be used to address these challenges. In testing this theory, a framework to link the different steps of SAM's adaptive planning process to WSUD is then provided. The aim of this is to provide a theoretical example of how SAM (or our "adapted" version thereof) could be used at a planning level for WSUD, with the recognition that this framework would be more fully established by stakeholders when developing a strategic plan in reality. Finally, this report outlines a broad framework for a proposed strategic adaptive planning process (which includes workshops) that could, in the future, be carried out with a municipality to pragmatically test the applicability of SAM in WSUD.

2. OVERVIEW OF PROBLEMS IN SOUTH AFRICA'S WATER SERVICES SECTOR

South Africa's water sector and, more specifically, its water services sector (Clifford-Holmes, 2015a), currently faces dire and complex challenges, with recent drought-related news headlines serving to augment the critically concerning nature of the country's "service delivery crisis" (SAPA, 2014; Stoddard, 2016). The roots of this crisis have been linked to multiple issues which have led to the failure by local authorities to deliver water and sanitation services. The issues most commonly cited in the literature (e.g. Alexander, 2010; Booysen, 2007; Clifford-Holmes, 2015; DWA, 2013; Koelble & LiPuma, 2010; The World Bank, 2011) can be summarised as follows:

- A lack of financial means and the misuse or misallocation of funds by corrupt politicians;
- Insufficient infrastructural capacity, coupled with poor maintenance of infrastructure;
- A shortage of technical skills and overall human capacity shortages;
- Local political conflict;
- A lack of proactive planning and the consequent adoption of a "fire-fighting" approach to respond to service delivery needs;
- A lack of accountability for service provision among municipal officials;
- A general culture of unresponsiveness within municipal departments.

In an attempt to assist better planning and management in the water services sector, there has been an explosion of technocratic tools ranging from spatial development frameworks, water services development plans (WSDPs), water safety plans, wastewater risk abatement plans and other such planning mechanisms. However, this over-regulation has failed to result in significant improvements in the sector. Instead, many officials treat these mechanisms as "tick-box" exercises, often outsourcing them to external consultants and thereby failing to secure the participation and buy-in of municipal employees, councillors, residents and other important stakeholders.

The problems being faced in the water services sector are especially troubling if one considers South Africa's forward-thinking water legislation, which has been internationally acclaimed for its ambition to align with the ideologies of integrated water resource management (IWRM) (Pollard & Du Toit, 2008; Schreiner, 2013). The introduction of IWRM, which can be traced to the 1977 United Nations Water Conference (Engle et al., 2011), is seen as a progressive step toward addressing the complexity of water governance and the failure of conventional management techniques, as IWRM recognises the role of cross-scalar interactions in dynamic, complex adaptive systems, and addresses the need for consensus building through multidisciplinary stakeholder engagement (Thomas & Durham, 2003). In doing so, it emphasises the imperative of finding a balance between resource sustainability, social needs and economic development (Butterworth et al., 2010), a goal that the South African government intends to realise in a manner that is both equitable and efficient (RSA, 1997; RSA, 1998a; Rogers & Luton, 2011).

Failure to accomplish the objectives of IWRM, coupled with an overall lack of success in addressing systemic issues in municipalities through national government interventions, has led critics to argue that the institutional design of local government is fundamentally flawed (Koelble & Siddle, 2014). In turn, various strategies have been proposed that target a revision of the institutional framework within which water governance takes place (DWA, 2013). However, such structural adjustments are unlikely to result in meaningful progress unless local government bodies proactively strive to build stakeholder consensus, identify common objectives and uphold shared values, key to which is an organisational culture of learning and adaptive decision making (Allen et al., 2011; Loftin, 2014; Rogers et al., 2000).

SAM is a new approach to management which embodies the above principles (Rogers & Luton, 2011) and it is therefore argued that this approach – rather than onerous technical requirements – may offer potential solutions to the "wicked"[2] problems confronting the country's water services sector. This is because, rather than simply rearranging existing silos (which optimise only parts of the system to the detriment of others and thus the organisation as a whole), SAM offers an approach that adapts the way the overall organisation functions in reality. This is as a complex adaptive system, wherein multiple "parts" work together to make up the whole. It thus enables collaborative action that drives an organisation towards a shared future state through consensus building and effective leadership. The SAM process is particularly unique in that it encompasses three theories of change: projectable change, emergent change and transformative change (Reeler, 2007). When the appropriate "theory of change" is matched with and applied to a particular type of problem, it results in change that is much more likely to be successful. SAM, in its current form, has not made the use of these theories explicit. We therefore propose that it be adapted to explicitly include these theories, so as to provide guidance that is more suited to the unique nature of the water services context.

[2] Clifford-Holmes (2015) argues that South Africa's service delivery crisis is illustrative of what Rittel and Webber (1973) referred to as a "wicked problem": one that is complex, interdependent, multi-causal, difficult to define and evasive of a simple or single solution.

3. INTRODUCTION TO ADAPTIVE MANAGEMENT

Holling (1978) defines adaptive management (AM) as "*an integrated, multidisciplinary and systematic approach to improving management and accommodating change by learning from the outcomes of management policies and practices*" (cited in Medema et al., 2008). In other words, AM emphasises learning and subsequent behavioural adjustments based on the accumulation of knowledge gained through the management process (National Research Council, 2004; Gunderson, 2015; Stankey et al., 2005), explained in more simplistic terms by Bormann et al. (1994) as "learning to manage by managing to learn." In practice, this approach has largely taken the form of a simple action learning cycle – "plan, do, check, act".

The emphasis placed on more adaptive management processes has spiralled upward in recent years (Rist et al., 2013), so much so that "*the term has reached buzzword status*," (Loftin, 2014: 20). even if the method itself has not (Allen & Gunderson, 2011; Eberhard et al., 2009). The strong endorsement of AM from a range of stakeholder groups motivates the question of "why" this approach is purportedly required, particularly as the traditional "command-and-control" approach to management, which generally seeks linear relationships between cause and effect, has been highly effective in the past (Stirzaker et al., 2010).

As an entry point to answering this query, one can draw on Crowell's (1989: 60) observation that changes in the way that society thinks about the world "*occur when our understandings of the world become inconsistent with emerging descriptions of reality*". Over the last century, the importance of technology in society has increased, and with this the gap between science and philosophy has shrunk (Cilliers, 2000). This convergence has led to novel insights into the interfaces between different fields, with new "ways of knowing" having progressively shaped both science and policy (Folke, 2007). Of particular significance in this regard has been the growth in understanding of the human and natural world not as independent, competing entities but rather as a linked "social-ecological system" (SES) (Berkes et al., 2000). More recently, SESs have been referenced using overlapping terms such as "socio-technical system" (Geels, 2004) and even "human-technology-environment" system (Pahl-Wostl, 2007), which indicates the spread of a "systems thinking" paradigm (Richmond, 1993) beyond ecological and social science contexts to fields such as engineering (e.g. de Bruijn & Herder, 2009). However, regardless of the term used or the specific discipline in which it is applied, each concept essentially reflects a more holistic understanding of the blurred boundaries between the ecological, technological (including the production, diffusion and use of technology) and human components of society (such as knowledge, culture and formal or informal institutions) (Smith et al., 2013).

This perspective of coupled systems has motivated a paradigm shift toward complexity, the theory of which asserts that phenomena do not exist in an environment that is bounded by simple Newtonian laws of "cause and effect"; but rather in one that is open, self-organising and able to adapt to new needs or information (Cilliers, 2000; Comfort, 1994; Marion, 1999). Complex systems are irreducible to their (multiple) individual parts, as these on their own are simple and unable to affect change – rather, it is the interactions and interdependencies

between these parts that make the system dynamic (Cilliers, 2000; Urry, 2005). In ecological contexts, dynamism is understood to heighten a system's resilience, or, in other words, its ability to absorb disturbance and persist, without being significantly altered (Holling, 1973, 2001; Smith et al., 2013). This "ecological resilience" arises as a result of the increased potential for innovation, which in turn builds a system's adaptive capacity, i.e. its ability to evolve and implement change (Folke, 2006; Smit & Wandel, 2006). Conversely, stability in a system leads to vulnerability, i.e. the susceptibility to incur harm (Adger, 2006) and thus its exposure to risk, which implies that even small disturbances can have dramatic social and/or ecological impacts (the "butterfly effect") (Levin et al., 1998; Thietart & Forgues, 1995). This is an important point for traditional, hierarchical organisations to consider, as the "command-and-control" management approach that is commonly used means that they are unable to adapt and are, as a result, vulnerable to changing circumstances. For example, the state of California did not have plans to recharge groundwater. As a result, this water source was depleted during the severe drought. Perhaps nothing could have been done to recharge the groundwater but, for sustainability, the use of boreholes and well points should have been managed. Cilliers (1998: 4) therefore argues that "there has to be a constant flow of energy to maintain the organisation of the system to ensure its survival. Equilibrium is another word for death".

However, whilst stability in complex systems can equate to fragility, this is not necessarily the case – rather, it depends on what degree of order or unrest is required for a system to avoid catastrophe and function optimally. Holling (1973) thus differentiates "ecological resilience" from "engineering resilience", where the latter emphasises the achievement of a "failsafe design" through constancy, efficiency and predictability rather than persistence, change and unpredictability (Gunderson et al., 2002). This engineering-based understanding of resilience is predominant in policy and practice discourses, as it equates with the ability of a system (such as a city or region) to maintain or recover its infrastructure and institutions following a disaster or unexpected event (UNISDR, 2012; Wallace & Wallace, 2008). Turok (2014) explains that, whilst a degree of engineering resilience is necessary in such systems, it can be problematic, as a lack of dynamism and creativity may lead to institutional inertia – a condition whereby vested interests or historically defined, path-dependent worldviews reinforce prevailing norms, even when they become inappropriate in contemporary contexts. In such situations, institutional "lock-in" may result, where business-as-usual arrangements cause long-term stagnation and eventual system decline as opposed to resilience (Evans, 2011; Martin, 2012). Equally, whilst dynamism creates the potential for innovation, it may inhibit the development of adaptive capacity by causing critical thresholds or "tipping points" to be breached.

This is shown in situations of institutional flux, where "lock-in" may occur due not to insufficient dynamism, but to the incapacity of a highly stressed system to break free from a vicious cycle of instability that reinforces internal problems and keeps participants in a constant "fire-fighting" mode (Clifford-Holmes, 2015; Clifford-Holmes et al., 2015). In light

of the above, it is necessary to find the appropriate balance between stability and dynamism. It is argued that SAM offers a framework through which such a balance can be achieved.

4. LITERATURE OVERVIEW

4.1 Strategic Adaptive Management

Strategic Adaptive Management (SAM) is a South African derivative of conventional adaptive management (AM) that Rogers (2002) defines as: "*a process of managed learning which steers strategic action to achieve desired ecosystem end points. It hinges on the axiom that ecosystems are 'complex dynamic systems.'* " As suggested in this definition, the intellectual history of SAM – like AM – is rooted in the paradigm of complexity (the whole is more than the sum of its parts) and the related concepts of unpredictability, vulnerability, adaptive capacity, resilience and emergence (Cilliers, 2000). However, SAM was developed in response to what Biggs and Rogers (2003) refer to as the "implementation credibility crisis" facing classic AM, which has been made evident by the fact that, whilst there has been a broad conceptual uptake of AM, its practical application has been somewhat less successful (Medema et al., 2008).

Various barriers to the implementation of AM have been cited in the literature, including both technical issues and those which arise from institutional complexity (Lee, 1993; Medema et al., 2008; Susskind, 2010; Walters, 1997; Williams & Brown, 2016). Technical barriers are associated with problems such as vague or ambiguous problem framing, a lack of directed leadership, difficulties in understanding or translating scientific results into applied formats, and limitations in the degree to which AM is applicable across scales (Allen & Gunderson, 2011; Levine, 2004; Williams & Brown, 2016). Institutional barriers refer to the "soft" (or non-structural) elements of AM including governance, culture and socio-political capacity (Staub & Moreau-Le Golvan, 2012), which are linked to issues such as a lack of long-term commitment to AM as a result of political or managerial flux, a narrow focus on expert-driven science which precludes non-experts from effective learning and engagement throughout the process, and conflict or power struggles owing to divergent perceptions, values or operational philosophies (Failing et al., 2004; Loftin, 2014; McLain & Lee, 1996; Rogers, 1998; Stirzaker et al., 2011).

The development of the SAM concept was initiated in the mid-1990s by a group of natural resource managers and scientists whose aim was to use the approach to support river and catchment management and the implementation of the new South African water legislation (Rogers & Biggs, 1999; Rogers & Bestbier, 1997). Coupled with this intent was the "serendipitous" convergence of various opportunities for innovation, which led to the concept being pioneered in the following places:

- Kruger National Park (see Pollard & du Toit, 2007);
- South African National Parks (SANParks) more broadly (see Freitag et al., 2014);
- The Inkomati Catchment Management Agency (see Rogers & Luton, 2011) (now the Inkomati-Usuthu Catchment Management Agency).

4.1.1 Evidence of successful application of SAM

In Freitag et al. (2014), the authors describe how SAM developed and matured over the course of 20 years in order to become a practice central to park management, both across SANParks more broadly and the Kruger National Park (KNP) more specifically. The authors account for what Ohlsson et al. (2006) refer to as "windows of opportunity" that supported innovation. In particular, KNP became a "platform for change" (Freitag et al., 2014: 1), which was helped by the fact that SANParks Scientific Services is based inside of KNP.

Around 2006, SAM was incorporated into SANParks national frameworks and policies, as seen in SANParks' "Coordinated Policy Framework Governing Park Management Plans" (SANParks, 2006), which stated the following: "*SANParks uses Strategic Adaptive Management (SAM) to attain its biodiversity custodianship mandate whilst ensuring maximum learning to continually improve understanding of ecosystems*" (*ibid*, p.13). However, Freitag et al. (2014: 8) note that, as of 2014, "*SAM is not yet internalised across all pillars of SANParks' business or all constituent parks under its care... and SAM remains primarily confined to the conservation decision-making domain*."

Over the same time as SAM was being developed and further applied inside of SANParks, it was also being promoted internationally – specifically via the Freshwater Task Force of the IUCN [International Union for Conservation of Nature]'s "World Commission on Protected Areas". Outcomes of the task force included published guidelines for the "effective conservation of freshwater ecosystems" employing SAM (see Kingsford & Biggs, 2012). A generic version of SAM was posited in this guideline, as displayed in Figure 2 below, which shows a structured decision-support framework that had developed out of the experimental forms of SAM employed in SANParks and in the catchment management of the Inkomati River.

As recounted in Rogers and Luton (2011), SAM was the integral process through which the first coherent catchment management strategy for the Inkomati Catchment Management Agency (ICMA) was developed. The challenging context within which this strategy was developed makes the resulting strategy more impressive. The strategy was developed over the course of six months, without drawing on consultants but with significant ongoing stakeholder engagement. This work formed the basis for a framework for applying SAM to catchment-scale Integrated Water Resource Management (IWRM) in South Africa (as summarised in Figure 3 and reported on in a subsequent Water Research Commission study (Rogers & Luton, 2011)). The application of SAM within the ICMA was not confined to the development of the catchment management strategy. The ICMA is one of the organisations and contexts within which SAM has been operationalised into an "adaptive operational water resources management framework", led by Brian Jackson and reported on in his masters' thesis (Jackson, 2014, in particular, pp.81-87).

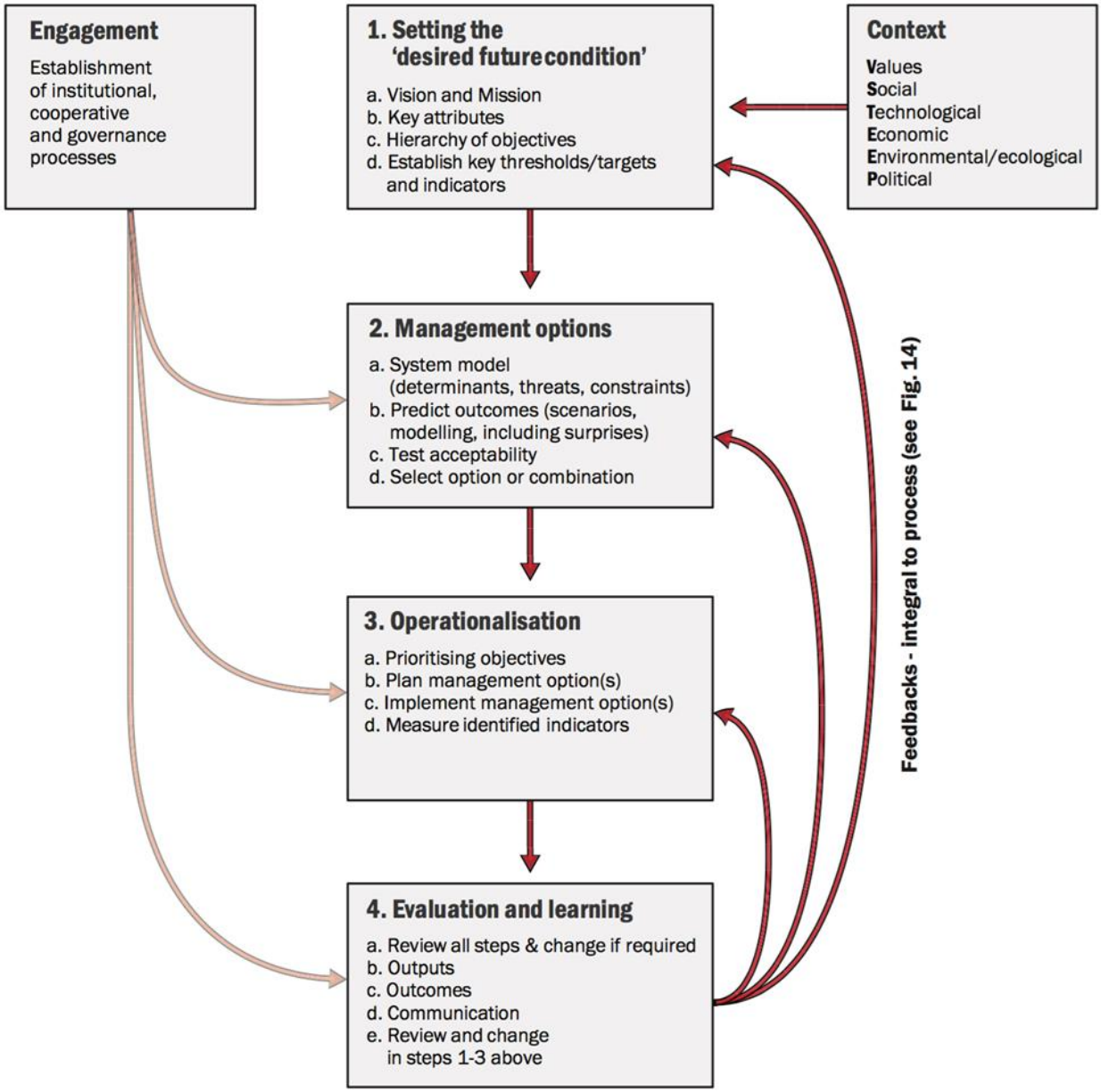

Figure 1: Generic strategic adaptive management (SAM) process, shown as a four-stage process. Reproduced from Kingsford & Biggs (2012:19).

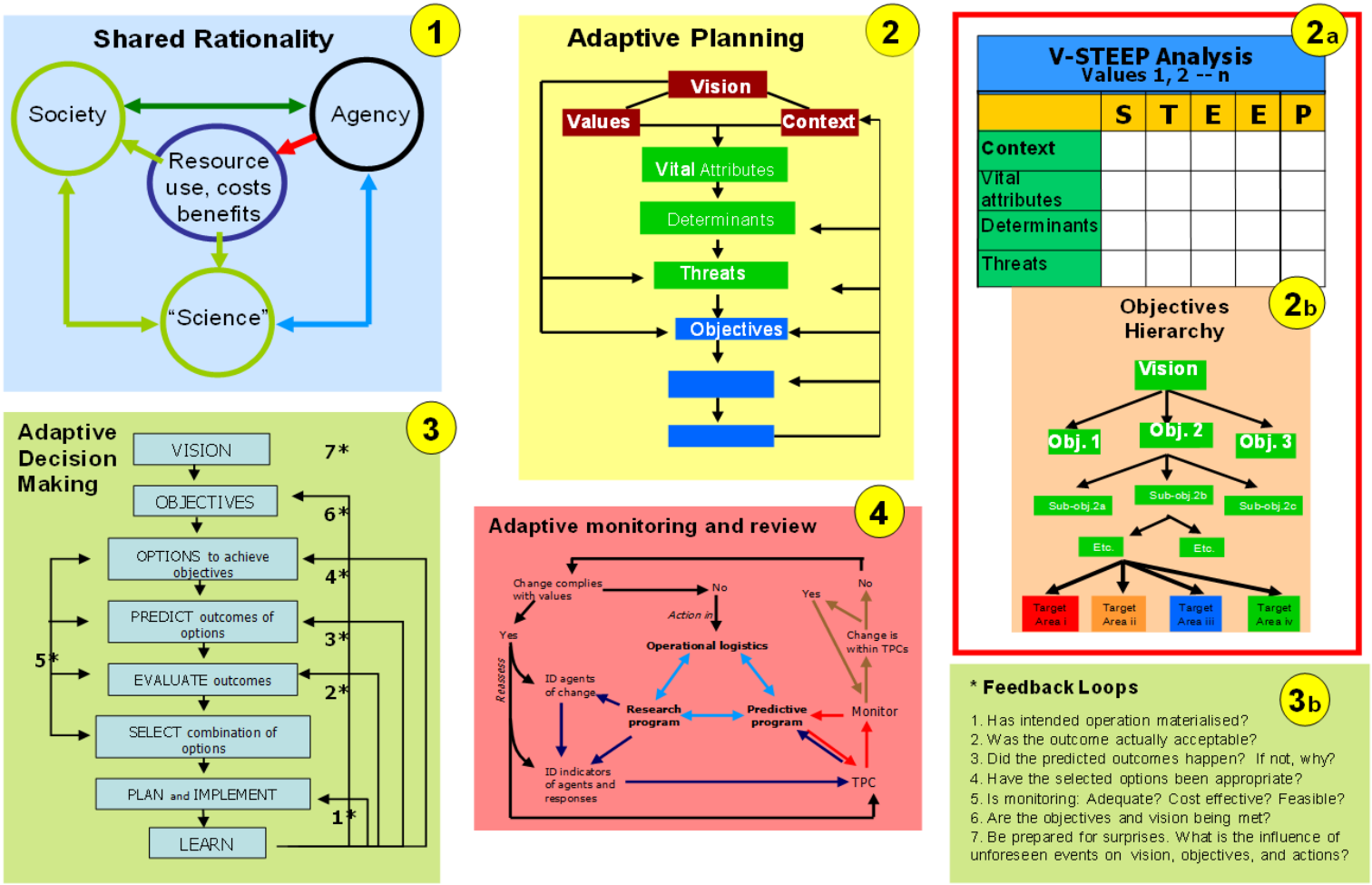

Figure 2: The strategic adaptive management process (Rogers & Luton, 2011).

4.1.2 Understanding the SAM process

The frameworks displayed in Figures 1 and 2 vary in their level of detail, the terminology that they use and their general structure. However, each depicts the primary stages that make up the SAM process. Following Roux and Foxcroft (2011), these stages are conceived here to include the following: (1) *adaptive planning*; (2) *adaptive implementation* and (3) *adaptive evaluation*, each of which are interrelated and are themselves comprised of various sub-processes, as depicted in Figure 3. The implementation of these various steps is an ongoing, cyclical process comprised of iterations and feedbacks throughout, which is indicated in Figure 4 by the arrows that re-join the process once the initial phase of evaluation and learning has taken place. Novellie et al. (2016) suggest that another step – "*adaptive governance*" – is required in addition to adaptive planning and management, arguing that "unless the governance system is itself adaptive then adaptive management has little chance of achieving either legitimacy or success."

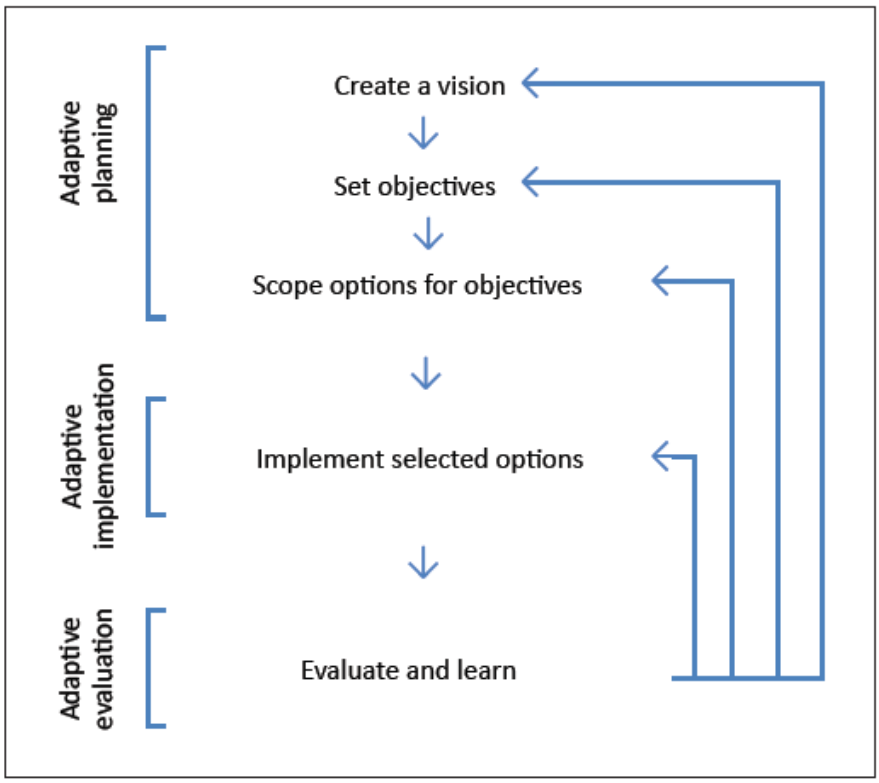

Figure 3: The basic stages and sub-processes that comprise a strategic adaptive management framework. Reproduced from Roux & Foxcroft (2011: 2).

Importantly, all of the steps in the SAM process should be designed and carried out in a manner that is not prescriptive or bureaucratic, but flexible and stakeholder-centred so as to enable management actions to be facilitated with both foresight and purpose (Roux & Foxcroft, 2011). There are two key principles that feed into and influence the overall process,

these being: (a) recognising the *context* within which decision making takes place; and (b) *engagement*, which refers to the establishment of institutional and governance processes that are inclusive, facilitated, consensus-oriented and learning-centred (Kingsford & Biggs, 2012). The emphasis placed on learning and flexibility allows the SAM process to be adaptive in and of itself; adapting and improving the concepts, principles and practices as new knowledge emerges.

4.1.3 Adaptive governance

It is important to introduce SAM at the stage where there is most interest and buy-in to the process, which is the adaptive planning stage. However, Novellie et al. (2016) highlight the importance of considering adaptive governance (AG) which is an underlying process nested within the overall SAM process. Chaffin et al. (2014: 62) broadly define AG to be "*a range of interactions between actors, networks, organisations, and institutions emerging in pursuit of a desired state for social-ecological systems*". AG is therefore the set of social conditions – the co-produced "rules of the game" - that provide the *potential* for complexity and uncertainty to be mediated. This occurs not only through the interactions between various "actors" in the AG sphere, but also through the interactions of these actors in the more structured processes of adaptive planning and management (Chaffin et al., 2014; Novellie et al., 2016). Figure 4 shows the nesting of adaptive planning, management and governance and indicates the interactions and feedbacks that occur between these interlinked processes.

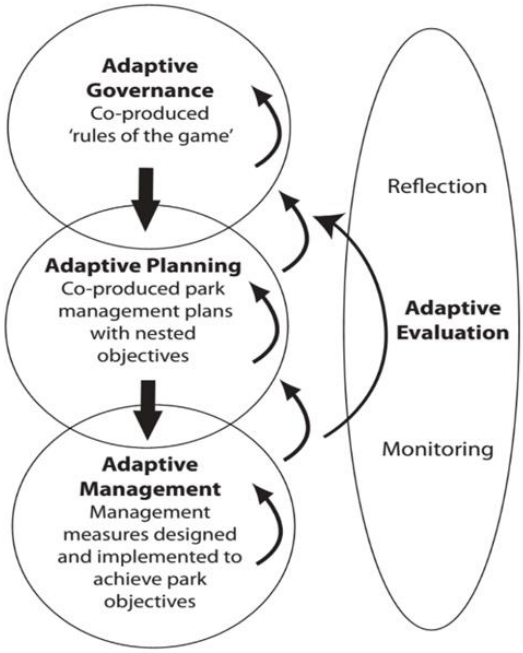

Figure 4: The four adaptive processes of strategic adaptive management. Straight arrows indicate sequential links, curved arrows indicate feedbacks. Reproduced from Novellie et al. (2016).

4.1.4 Adaptive planning

The adaptive planning process (APP) of the overall SAM framework has increasingly been understood as critical for its successful implementation (Roux & Foxcroft, 2011). This stage involves three sub-processes, including: creating a vision, setting objectives, and scoping options to achieve the objectives.

Rogers & Luton (2011) propose that, prior to establishing a common vision or setting a "desired future condition", it is necessary to develop a "shared rationality" (step 1 in Fig. 3). The aim of this step is to reach consensus on a broad problem, frame this problem in an appropriate way and agree on the tasks that need to be undertaken. This is done to ensure that all stakeholders understand and agree on the issues that are to be focused on, and the process going forward. A shared rationality is developed through an interactive, collaborative process of communication that engages stakeholders from diverse backgrounds, and with different values, interests and/or priorities.

4.1.4.1 Creating a vision

This step entails the mutual creation of a vision that depicts the desired condition of the system to be managed. This is a "future building" exercise that focuses on the central question of "where do you want to be?", the objective of which is to establish foresight and commitment from stakeholders, and to ensure that all parties are working towards a common goal (Kingsford & Biggs, 2012; Rogers & Bestbier, 1997). Initially, an "ideal" vision is identified, based on what Reeler (2007) calls "projectable change" (explained in section 4.2.3). Whilst this projected vision provides guidance to and energises the process, Figure 6 illustrates how it is likely to evolve as new information and needs emerge and an improved understanding of the context develops. The vision of a desired future must therefore always be seen as a draft – a work in progress – rather than a rigid endpoint. It lends itself to incremental adoption. It understands and recognises that adopting knew knowledge and new ways of doing things takes time and is not adopted by everyone all at once. The approach herefore allows choice in adopting new values, knowledge, concepts, principles and practices. This is because it recognises that people are the primary driver of change, and structures and frameworks (such as the objectives hierarchy) are helpful guides to achieve the desired future state.

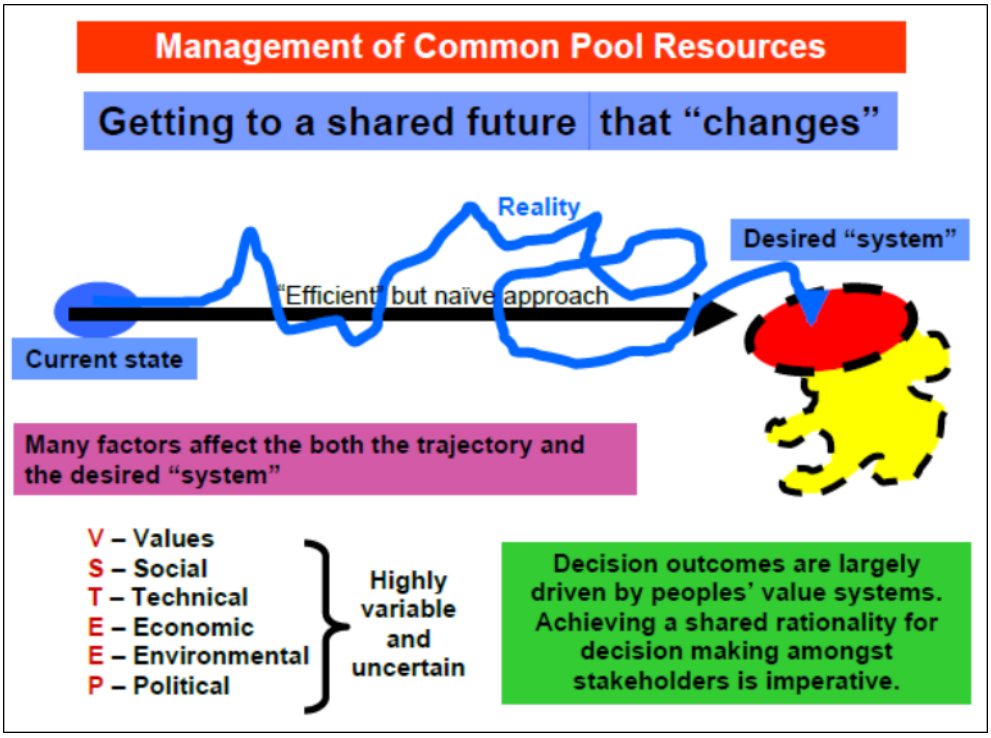

Figure 5: Process of getting to a shared future that changes, highlighting how variable and uncertain V-STEEP factors affect management targets and trajectories. Reproduced from Rogers & Luton (2011).

In creating a vision, it is essential to recognise the *context* within which decision making takes place, as "*an accurate picture of current reality is just as important as a compelling picture of a desired future*" (Rogers & Luton, 2011). This "current reality" is defined, in part, by the various attributes of the complex system to be managed, and stakeholders must determine which of these features are of vital concern in terms of achieving the overall vision.

To capture these key attributes and understand the management context as thoroughly as possible, a "V-STEEP" framework is used (Pollard et al., 2008). This acronym stands for *Values - Social, Technological, Ecological, Economic and Political* factors. These are the few most important characteristics of the complex system and they therefore play a key role in its management. As shown in step 2a of Fig.2, a list of V-STEEP attributes is accompanied by a description of the determinants of, and threats to, the vital attributes. A determinant is a factor or process that ensures the persistence of a vital attribute. Threats are factors within, or outside, a system that undermine its values and inhibit the pursuit of the vision. Threats and constraints are also factors or processes that inhibit ecosystem determinants or vital attributes (Rogers & Luton, 2011).

Each of these factors is important to consider, as they will affect the efficacy of management and planning and hence the outcome of decisions. These factors are not independent of one another but interact in various ways; for instance, the technological aspects of planning may depend not only on the availability of or access to technology, but on the socio-political and legislative setting in which technical decision making takes place (Kingsford & Biggs, 2012).

A narrow focus on one aspect of a complex issue may lead to a failure to address its root cause. In South Africa, for example, Koelble & LiPuma (2010: 566) found that "*the problem of non-delivery [of municipal services] is located not so much in demographic shifts or a general lack of funding, but in a lack of state capacity and the unwillingness of the central state to enforce the rules of the law-books on its own operatives in local government*." By building an understanding of the V-STEEP context, SAM helps people and organisations to improve outcomes as it enables them to have a more insightful and empowering view of reality. This enables individuals and groups to understand what the real problems are and therefore to find the appropriate solutions.

Each component of the management context is underlain by the specific value system to which stakeholders subscribe, as values drive decision making and behaviour and ultimately the achievement of the desired future. Blackmore et al. (2013) recognise that there are essentially two broad sets of values, each of which correlates loosely with a particular "side" of an individual's identity. *Intrinsic* value sets (for example, understanding, appreciation, benevolence and environmental concern) relate to one's "civic" side, whilst *extrinsic* values (such as self-interest, financial gain and power) are associated with one's "consumer" identity. Although people might be exposed to the same information on a regular basis, this information is processed and prioritised differently according to an individual's personal values, or indeed those of the organisation as a whole. Hence, a realisation of the overall shared vision ultimately depends on the explicit articulation and prioritisation of these values, which themselves are shaped by factors such as history, experience and culture (Rogers & Luton, 2011; Wise et al., 2014). These intrinsic or "invisible" aspects of governance are often overlooked (Leck & Roberts, 2015), yet they are essentially at the core of decision-making processes as they inform the degree to which stakeholders will buy in to the management agenda and thereby remain committed to achieving a stated goal in practice (Blackmore et al., 2013). Values therefore form the basis for deciding on the overall vision of the organisation, or of the specific management process in question (Biggs et al., 2011; Roux & Foxcroft, 2011).

Acknowledging divergent values as a key and consistent driver of the management context means opening up the "black box" of decision making (Biesbroek et al., 2015), which requires going beyond simply identifying managerial barriers and prescribing a perceived ideal of what management solutions *should* look like (Roux & Foxcroft, 2011), to confronting the underlying issues that may inhibit (or enable) their success. Barnett et al. (2015) find that many such issues are driven by "path dependency", whereby actors or organisations exhibit "entrained thinking." This occurs when leaders become (at least partially) blinded to new ways of thinking by prior experiences or successes (Snowden & Boone, 2007). Their resistance to change means that they fail to shift to a new management paradigm and decisions continue to align with the "status quo".

Changing unsustainable management pathways is a potentially uncomfortable process, as "*actors will find themselves held accountable for aspects of their work that used to slip beneath the radar, such as the political and relational challenges of implementation*" (Jones, 2011: 68). However, if long-term and socially robust solutions to complex problems are to be

realised, then stakeholders need to take responsibility for reaching consensus, as "*it is ownership of affected parties that will ultimately build the capital and momentum for success*" (Kingsford & Biggs, 2012: 18). SAM enables stakeholders to take such ownership as it empowers people and groups of people to recognise that they are agents in the system to be managed, and they can either act in ways that make the outcome sub-optimal or that maximise mutual benefit. SAM therefore helps people, organisations and stakeholders to manage and create the context within which they work.

4.1.4.2 Setting objectives

In developing a vision, stakeholders must agree on a rational definition of the desired state that can be translated into operational goals or objectives, the setting of which forms the second step of the APP. In turn, these goals must be compatible with the context in which they are to be implemented (e.g. goals must be set in relation to potential resource and capacity constraints), as "*it would serve little purpose to set a 'desired state' in detail so fine that it could not be predicted and was too costly to achieve, monitor and audit*" (Rogers & Bestbier 1997: iii). "Requisite simplicities" are thus used, which refers to a process of simplifying (reducing) a complex problem by discarding some detail, but only to such a degree that the iterative learning process is sufficiently enabled. This principle ensures that people and groups do not get "bogged down" in unnecessary detail that doesn't move them forward. The identification of requisite simplicities is thus a way in which to rigorously advance the understanding of complex problems and develop shared meaning that can be communicated clearly among multiple stakeholders (Holling, 2001; Stirzaker et al., 2010). The use of a requisite simplicity does not suggest that goals should be set in an unambitious manner. Rather, it provides a starting point from which to work toward objectives of increasing rigour.

In practice, an "objectives hierarchy" is formed so as to nest low-level (more detailed) objectives within those that are of a higher (coarser) order (Rogers & Luton, 2011). In general, higher order objectives are framed as "statements of strategic intent" and are therefore aimed at informing upper levels of management. Conversely, lower order objectives are framed in specific spatial and temporal contexts and therefore better serve managers working in day-to-day operations (Rogers & Bestbier, 1997). In addition to a hierarchy of objectives, the vision and its operational goals must be accompanied by a set of specific indicators against which they can be monitored and evaluated. In natural resource management contexts, these indicators have been termed "thresholds of potential concern" (TPCs), and represent the estimated upper and lower limits within which system changes are acceptable. Again, these targeted indicators of the desired "end point" must be situated in relation to the context and, moreover, they must be flexible so as to change with the dynamics of the system (Kingsford & Biggs, 2012). In light of the complex nature of systems in which SAM is applicable, Biggs et al. (2011) argue that a broader concept such as "utility thresholds" is more appropriate than TPCs, as it captures the social element of social-ecological systems. This is of critical concern in SAM processes, which are essentially driven by diverse (and possibly divergent) social preferences, expectations and value systems (Cundill et al., 2012; Rogers & Biggs, 1999; Roux & Foxcroft, 2011)

SAM acknowledges that structured frameworks such as the objectives hierarchy and TPCs are helpful guides to achieve a desired future state. Moreover, it understands and recognises that new knowledge and new ways of doing things take time and are not adopted by everyone all at once. SAM therefore lends itself to incremental adoption, valuing "small wins" that lead to learning, trust building and commitment, and which feed back positively into the process.

4.1.4.3 Scoping options for objectives

The final step in the adaptive planning stage involves the scoping of different management options that would allow the set objectives to be achieved. Through a process of scenario planning, multiple possibilities are analysed in accordance with their expected effectiveness and the severity of the potential consequences with which they might be associated. In conducting this step, stakeholders must provide well-informed and value-based contributions in order to determine the level of risk associated with any perceived trade-offs between the costs and benefits of a decision, as uncertainty alone does not provide sufficient justification for high-risk experimentation (Failing et al., 2004). Finally, a combination of the best possible management options is decided upon, with the recognition that decisions must remain dynamic so as to account for unexpected surprise (Pollard & du Toit, 2007; Roux & Foxcroft, 2011).

4.1.5 Adaptive management/implementation

The adaptive management process involves the operationalisation of the mutually determined objectives, in accordance with the objectives hierarchy. This stage shifts the question being asked from "where do we want to be?" to "what must be done?" (Pollard & du Toit, 2007; Kingsford & Biggs, 2012). To answer this novel query, stakeholders are required to:

- Develop detailed plans for the execution of management actions;
- Allocate the various resources (financial, analytical, human capacity, etc.) that are necessary for these actions to be carried out;
- Implement the detailed action plans;
- Monitor the effects of these actions by linking decision outcomes to the specific indicators (TPCs) and desired end points, as agreed upon during the adaptive planning stage.

4.1.6 Adaptive evaluation

Adaptive evaluation is critical for enabling the "learning by doing" function that is at the core of adaptive management approaches (Rogers & Biggs, 1999; Roux & Foxcroft, 2011). Evaluations should be conducted in accordance with the specific TPC indicators and be coupled with revisions of the management process, the aim being to improve decision making and adjust management plans in relation to the effectiveness of the actions that were taken, and in light of emergent needs, new information or shifts in a system's dynamic properties (Kingsford & Biggs, 2012). Evaluations should further take note of how specific goals have changed as the management process moves toward low-level objectives in the hierarchy, whilst ensuring that new action plans and end points align with the overall strategic vision

(Rogers & Bestbier, 1997). In undertaking the adaptive evaluation stage, Pollard and du Toit (2007: 30) highlight a number of questions that should be asked, including the following:

- Is the monitoring programme adequate, cost effective and feasible?
- Has the intended plan of operation taken shape?
- Were the selected options appropriate?
- Were the predicted outcomes correct? (If not, why not?)
- Was the outcome actually acceptable?
- Even if the predicted outcomes are correct, are the objectives and vision being met?

The answers to these questions should feed back continuously into the management process, which in reality is an ongoing cycle of reflexive learning and adaptation, rather than a step-wise solution for reaching a specific target (Pollard et al., 2011; Roux & Foxcroft, 2011). Through adaptive monitoring and evaluation, SAM produces responsibility and accountability, as this process is in the hands of the people who are part of the "problem", have better insight into the "problem" and need to achieve an output and/or outcome.

There are various ways in which the SAM framework has improved classic forms of AM, as described in section 4.6. However, whilst the SAM process has been applied successfully in the context of natural resource management, there are certain elements of the framework that are implied but need to be made more explicit if the process is to be used effectively in the context of water services. In this regard, the following sections discuss the Threefold Theory of Change (Reeler, 2007), the Cynefin Framework (Snowden & Boone, 2007) and the different phases of organisational development (Reeler et al., 2009).

4.2 The Threefold Theory of Change: Selecting an Appropriate Response to a Context-Specific Problem

A "theory of change" is essentially a comprehensive explanation, using descriptions and illustrations, that shows a series of actions or processes which, when taken, contribute to realising an intended long-term goal in a specific context (Rogers, 2014; theoryofchange.org, n.d.). Rogers (2014) explains that a TOC can be applied at any level of intervention, from events or projects to programmes, policies, strategies and even entire organisations. Theories of change may be developed using carefully defined and tightly planned objectives and actions that are carried out under fixed conditions, or using flexible and adaptive practices and processes that allow for responsiveness to unexpected changes or to emerging issues, decisions and outcomes. Different TOCs therefore have particular characteristics. In the context of social development practice, Reeler (2007) proposes a "Threefold Theory of Change," which seeks to integrate the characteristics of various change theories into three main types: emergent change, transformative change and projectable change, each of which is described in more detail below.

4.2.1 Emergent change

Emergent change "*describes the day-to-day unfolding of life, adaptive and uneven processes of unconscious and conscious learning from experience and the change that results from that*" (Reeler, 2007). Emergence is an inherent characteristic of complex systems (Cilliers, 2000),

hence, emergent change exists in any living system. It occurs from the accumulation of small, possibly unnoticeable changes that result from the various interactions between a system's multiple components. These small changes add up to larger scale changes and the emergence of patterns over time. These patterns differ according to the properties of the system, its degree of complexity and as a result of influences from internal and external stimuli. Reeler (2007) identifies two main forms that processes of emergent change can take:

- "*Less conscious" emergent change* occurs under conditions of high uncertainty where there are no clearly distinguishable relationships, identities, structures or leadership, and under constantly shifting internal and external environments. These conditions make this type of change less predictable and more irregular than "more conscious" emergent change. It is particularly difficult to grasp "less conscious" emergent change as its characteristics tend toward chaos, yet the pattern of change remains in formation, as illustrated in Figure 6.

Figure 6: Pattern of "less conscious" emergent change. Source: adapted from Reeler (2007).

- *"More conscious" emergent change* also occurs under conditions of complexity and uncertainty; however, these conditions are not chaotic. Rather, this type of change occurs in environments that have a higher level of stability and which display less complex and contradictory patterns of emergence, as shown in Figure 7. "More conscious" emergent change processes are better understood as they take place in situations where structure, identity, relationships and leadership are properly formed.

Figure 7: Pattern of "more conscious" emergent change. Source: adapted from Reeler (2007).

Conscious processes of emergent change are underpinned by a cycle of "action learning" (Fig. 8) - the process of planning, doing, reflecting, learning and re-planning. This process champions experiential learning over teaching, and values practitioner over expert knowledge, taking a pragmatic approach to address the problems faced in an organisation or society (Pedler, 2011).

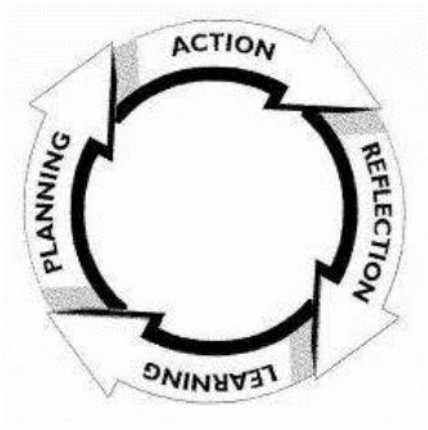

Figure 8: The generic action learning cycle. Source: **Reeler (2007).**

4.2.2 Transformative change

Transformative change occurs, and is necessary, when an individual or system is confronted with a situation of crisis or "stuckness." Reeler (2007) gives the example of a pioneering organisation that grows beyond its existing limits and forms more formal and clearly identifiable structures and relationships. Whereas emergent change is a process of learning, transformative change is centred on *un*learning – of liberating an individual or organisation from the traps of inappropriate ideas, values, behaviour, etc. It does this by uncovering the roots (such as the relationships, identities, structures and systems of leadership) that underpin the crisis or stuckness and inhibit resolution and virtuous development. Processes of transformative change are difficult to read as they require the surfacing of contested, hidden or denied aspects of an individual or an organisation's identity. There is likely to be resistance to change before a turning point is reached and new values, identities, etc. begin to be adopted and the *possibility* for a new situation is created. As shown in Figure 9 transformative change processes are underpinned by the *U-process of change*. This process works not only to surface and address the drivers of, and need for, change, but ensures that there is a common understanding thereof by all who are involved and/or implicated. The success of this process depends on more than just attitudinal change – it requires a genuine will to change and a commitment to the process, however difficult, distressing or uncomfortable it may be.

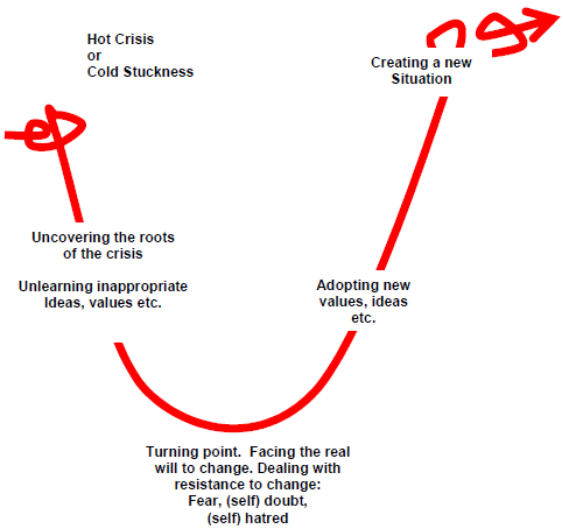

Figure 9: Moving from crisis or stuckness to resolution through a "U-process." Source: Reeler (2007).

4.2.3 Projectable change

Projectable change (Fig.10) occurs when an individual or organisation is "*able to project possible visions or outcomes and formulate conscious plans to bring about change towards these.*" This change occurs through the planning and implementation of projects, and is likely to succeed under more stable and predictable conditions where there is no crisis or stuckness and where a system's problems, needs and opportunities are more clearly identifiable. Projectable change can be undertaken either by: (1) identifying a problem and developing a plan to solve it (a problem-based approach), or (2) by envisioning a desired result and working backwards in order to develop a plan that will allow the result to be achieved (a creative approach). Projectable change is traditionally associated with the use of logframes (logical frameworks), which take a structured approach to planning, implementing and evaluating projects. Logframes highlight the main elements of a project, the links between them and the objectives that they achieve. Whilst this type of approach is generally successful in relatively stable conditions, Reeler (2007) argues that even well-planned projects may encounter unexpected circumstances. Hence, projects should always be seen as a draft, a work in progress, as is suggested in Fig.10.

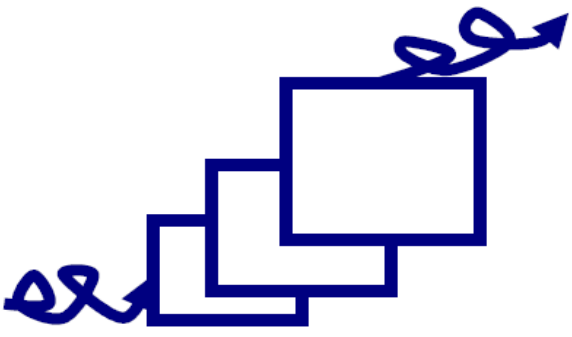

Figure 10: Pattern of projectable change, showing the underlying potential for uncertainty. Source: Reeler (2007).

Emergent change, transformative change and projectable change each have particular characteristics. However, it is important to note that they are not mutually exclusive within a system or process of change. For example, conscious emergent change processes may strengthen identities, structures, relationships and leadership, leading to the identification of new projects and the consequent need for projectable change. Conversely, an emergent change process may encounter a situation of crisis or stuckness, caused for example by internal relationship dynamics or external contextual changes, thus provoking the need for more transformative processes of change (Reeler, 2007). The incorporation of these different theories of change into SAM emphasises that it is not a threatening process, as it does not "straight-jacket" how individuals and groups work. This is because it recognises that change does not happen only in one way, and it values individuals and diversity of people, perspectives, opinions and skills.

4.3. Nature of the Problem Context

Selecting the TOC, or combination thereof, that is most appropriate for tackling a particular problem requires that the nature of the problem context be identified. Snowden and Boone (2007) introduce the Cynefin framework (Fig. 11), in which four main types of operating contexts are identified: simple, complicated, complex and chaotic. Each of these contexts calls for a specific approach to management and requires certain actions to be taken in order to solve a problem. If the operating context does not fall within the domain of the framework, then it is classified as *disordered,* and requires that the situation be deconstructed and each component assigned to one of the four contexts described below.

4.3.1 Simple contexts

Simple problems arise in contexts that are stable, where phenomena are known and cause-and-effect relationships are easily discernible. Management practices are straightforward, with leaders assessing and categorising the facts of a situation and basing their decisions on "best practice" (*sense*, c*ategorise and respond*). Since both managers and employees have access to the information needed to solve a problem, a "command-and-control" leadership style, in which actions are delegated with straightforward directives, is argued to work best. The degree of collaboration and communication that is needed between different levels in a management hierarchy is low, as there is rarely disagreement about what is required. However, Snowden and Boone (2007) caution against falling into a trap of complacency, where leaders are at risk of being blinded to new ways of thinking by past experiences or successes, a condition known as "entrained thinking". This is a dangerous zone because if complacent leaders are faced with an unexpected change or issue, then chaos can ensue. Hence, a change in management style may be needed in order to suit the novel context.

4.3.2 Complicated contexts

Complicated contexts generally have similar conditions to those that are simple. However, whilst complicated problems always have at least one right answer, there may be various

other answers that are equally "right." Complicated problems therefore fall largely in the domain of experts, as, whilst there is a clear relationship between cause and effect, not everybody is able to see or understand it. Decision makers in complicated contexts must investigate multiple possible solutions, make trade-offs and take decisions based on "good" rather than "best" practice (*sense, analyse* and *respond*). As in simple contexts, a complicated system is at risk of becoming chaotic if decisions are subject to entrained thinking, which tends to occur most frequently among experts rather than leaders.

4.3.3 Complex contexts

Complex contexts, rather than assuming order, are inherently unordered and thus uncertain. There is no easy discernible relationship between cause and effect and small impacts can cause large and unexpected changes. Rather than being fact-based, decisions need to be made based on the identification of patterns, which emerge over time through ongoing interactions between a system's components. In this context, leaders who attempt to impose a set course of action in order to solve a complex problem will be unsuccessful. Rather, collaborative and flexible approaches should be adopted, in which leaders take a step back and allow adaptive solutions to be formed through experimentation and learning – an ongoing process of *probing, sensing* and *responding.*

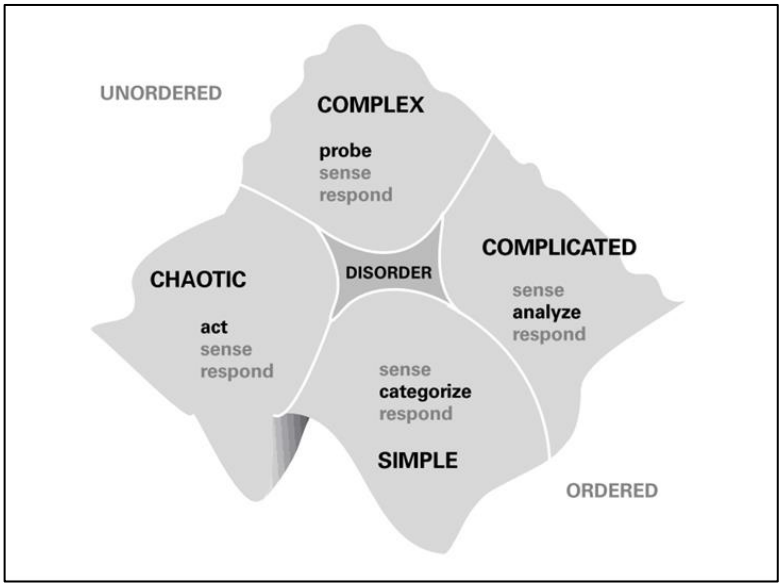

Figure 11: Cynefin framework for ascertaining what the appropriate responses of leaders and managers are in different operational contexts. Reproduced from Snowden & Boone (2007: 4).

4.3.4 Chaotic contexts

In situations of chaos, turbulence reigns, leaving cause-and-effect relationships impossible to determine because the system is in a state of constant flux. In this context, rapid response is

essential. Leaders must therefore act first so as to establish order, and then identify where stability is missing prior to taking action (*act, sense* and *respond*). Before any patterns or solutions to a chaotic situation can be found, it must first be transformed from chaos to complexity.

4.4. Phases of Organisational Development

Reeler et al. (2009) explain that an organisation is similar to a person, in that it goes through a life cycle from birth, through growth, to death and is dependent, independent and interdependent at different stages along the way. In applying this metaphor to organisational development, the authors (*ibid.*) identify four main phases of growth, namely: pioneering, rational, integrative and associative, which are described briefly below.

4.4.1 Pioneering

"*This phase is like a flowering patch – messy but fresh with new energy. It's flexible, but dependent on the pioneer, who is seen as a parental figure*". (Reeler et al., 2009)

The pioneering phase represents the birth of an organisation, in which there is no clear structure, a great deal of experimentation and high levels of flexibility. This is because the "pioneers" are learning about what may work (or not) as they go, and tend to operate in, or be responsible for, multiple different functions rather than having a set position. This pioneering is usually driven by fewer people who have a big vision of what they want to achieve. Hence, they are generally very invested in the success of the organisation and have high levels of motivation and energy. This phase predominantly uses a type of emergent change, which allows the organisation to be relatively adept at dealing with complexity. However, at some point, the organisation typically becomes stuck or faces a crisis. When this occurs, the organisation commonly undergoes a process of transformation and enters into the rational phase.

4.4.2 Rational

" '*Left-right-left-right!' Organisations in this phase are independent, more conscious and well organised*." (Reeler et al., 2009)

As an organisation shifts into a rational phase of development, the approach becomes less experimental and intuitive and more objective and conscious, with a well-defined (projectable) plan of how the organisation's objectives are expected to be achieved. A clear leadership structure is formed and staff are assigned to more specialised functions within the organisation. Operations are guided by policies, systems, procedures and goals, and are subject to a process of monitoring, evaluation and review. Whilst this sense of rationality helps the organisation to rise out of chaos, it often leads to a crisis or stuckness, which occurs as a result of the organisation being unable to deal with complexity and change. These crises can be either "cold" (e.g.: "office politics" and "corridor gossip") or "hot" (e.g. open resistance, conflict and protest action). This occurs when the pioneer's vision is divided among departments and staff begin to lose energy as they experience a feeling of disconnect and disinvestment from the organisation as a whole. They become stuck in their departmental

silos like dissatisfied cogs in a machine, and if they challenge, bend or break the rules then the response is often to enforce compliance. In such situations, a U-process of change is needed in order for the organisation to unlearn what is not working and transform into the integrative phase. This, however, requires leaders and staff to acknowledge the problems, accept the need for change and be willing to undertake the process of change.

4.4.3 Integrative

"Like a good stew, this phase is a mix of the best. Organisations in this phase are interdependent, organised but more flexible."

The integrative phase of organisational development combines the more personal, flexible qualities of pioneering organisations with the efficiency of a rational organisation. This diversity means that the organisation is better able to deal with complexity, as different management approaches can be applied to different types of problems. In this phase, staff are more empowered and are typically arranged in a more decentralised network rather than a hierarchy. This structure enables more fluid communication and collaboration, and the organisation is driven by a common vision, values and operating principles as opposed to policies, rules and procedures. In this phase, crisis or stuckness occurs not from internal disconnects, but from the organisation's isolation from the broader environment and from other (possibly competing) organisations. The challenge is therefore for leaders, who need to be particularly mature and visionary, to let go of their pride and motivate and facilitate collaboration with other organisations.

4.4.4 Associative

"Organisations in this phase are interdependent and better connected to their environment."

In the associative phase, organisations form authentic and creative partnerships that span disciplinary boundaries. Associative organisations recognise that, in a globalised world, we all have a common purpose. They see the need to work interdependently in order to achieve social harmony, justice and sustainable development that will protect our planet and our people both now and in the future. Whilst such organisations have begun to grow and succeed, not many have reached maturity and there is an increasingly urgent need to recognise these values and adopt more associative organisational forms. In doing so, organisations will become increasingly skilled at dealing with complexity as they will be able to work together to find innovative and dynamic solutions to complex problems.

4.5 Building Resilience Through Effective Leadership

The SAM process described above is designed to build resilience in an organisation as it grows and matures over time, and encounters increasingly complex (often unexpected) challenges along the way. However, whilst SAM provides the framework for such change to occur, organisations are unlikely to build resilient structures and outcomes in reality unless the people in the organisation become more resilient. This is because an organisation is made up of its people and their interactions, with structures, frameworks, policies and processes playing a crucial supportive role. SAM thus promotes generative leadership which, through

collaboration, crafts common purpose and values, creating an environment that recognises the role of people and emphasises individual, team and organisational performance. Table 1 (Rogers et al., 2000) compares the different leadership styles, structures and cultures of conventional bureaucracies and adaptive organisations.

Table 1: Contrast of leadership style, organisational structure and organisational culture in conventional bureaucracies and adaptive organisations. Reproduced from Rogers et al. (2000)

Issue	Conventional bureaucracies	Adaptive organisations
Leadership style	Primarily command-and-control Transactional/paper shuffling	Primarily to coordinate and facilitate Generative (designer, teacher, steward)
Structure	Functional hierarchies Vertical communication Work **for** one boss	Dynamic teams with blurred boundaries Horizontal dialogue Work **with** colleagues across boundaries
Culture	Thinking at the top, doing at the bottom Collect data and manage information Follow rules and regulations Internal competition This-is-our-product/empire syndrome Observe and criticise mistakes Rather make no decision than a wrong one View uncertainty, complexity and change as threats	Develop common purpose through collaborative goal setting Generate, codify and transfer knowledge Driven by vision and values Integrated operations across stakeholder-service provider boundaries Enthusiastic sharing of knowledge (trust and openness) Learn and adapt through hypothesis testing and critical reflection Recognise when new knowledge allows you to make the next better decision Treat uncertainty, complexity and change as opportunities for learning and improvement

Whereas conventional bureaucracies are driven by a top-down, "command-and-control" leadership style, adaptive organisations emphasise the importance of leaders who are *designers* of a common purpose and core values, of strategies and structures for guiding decisions and of effective learning processes; *teachers* who help people achieve more accurate, insightful and empowering views of reality and *stewards* for both the people and the vision of the enterprise (Rogers et al., 2000). Associated with traditional command-and-control leadership is the hierarchical structure of the organisation, wherein institutional silos are favoured over interactive departments with blurred boundaries, as in adaptive organisations.

The different structures and cultures that are characteristic of conventional and adaptive organisations mean that the latter is generally more adept at dealing with complexity and change. However, an adaptive organisation will become most resilient if it embraces a diversity of leadership styles, including those which are more traditional. This is because some problems, even in a complex setting, can be dealt with efficiently through a linear approach, namely those in which cause and effect are directly related. Without people who have the ability to deal with such problems, an organisation may lack the degree of "engineering resilience" needed to ensure that its operations run effectively. If more

traditional forms of leadership are combined with a style that is generative and adaptive, then the organisation will be able to deal effectively with all types of problems. Reeler et al. (2009) argue that, in the context of leadership and facilitation, a number of leadership "polarities" exist. Whilst these polarities are opposite, they are not opposing. Rather, they are complementary and when properly understood, they can enhance the effectiveness of an organisation's work. Table 2 provides a brief description of three sets of related leadership polarities, including: Inspiring / Energising; Focusing / Grounding; Supporting / Challenging.

Table 2: Roles and qualities of leadership polarities. Adapted from Reeler et al. (2009)

Focusing (future oriented) Helping people to plan, to find direction and clarity, to think and strategise about how to get to the future they want, to prioritise *Qualities* concentration, thinking, analysing – earth and fire temperament	**Grounding (past oriented)** Helping people to learn from their experience, to value their history, to accept their mistakes and to forgive and be more thoughtful, so that they may more freely learn *Qualities* reflection, calming down, objectivity, forgiveness – water and earth temperament
Inspiring (future oriented) Helping people (communities, organisations) to find inspiring visions or images of the future to guide their work or lives, to find meaning in their work or lives, hope in themselves *Qualities* imagination, creativity, story-telling (future stories) – fire and air temperament	**Energising (present oriented)** Helping people to find energy and motivation in what they are doing now. Helping them to remove those things like sexism and racism, oppressive leadership, or poor working conditions that de-energise *Qualities* openness, lack of prejudice, ability to create rhythm – air and water temperament
Challenging (future oriented) Speaking up, positively confronting what is not working, telling the truth, breaking boundaries, asking tough questions, taking risks *Qualities* courage, respect, positivity, questioning – fire, earth and air temperament	**Supporting (present oriented)** Nurturing, empathising, giving comfort, bringing security and safe spaces *Qualities* empathy, kindness, listening – water and air temperament

It is argued that SAM builds resilience in an organisation as it accommodates different leadership styles as appropriate to the context and uses conscious emergent change (adaptive management/action learning), transformative and projected change in combination at an appropriate stage in the management of an organisation, or where one needs to bring about change either in the organisation and/or the organisation's stakeholders, in order to assist in overcoming problems that may be either simple, complicated, complex or chaotic. When and how it is applied will depend on*:*

1. The phase that the organisation is in (pioneering, rational, integrated, associative);
2. The complexity of the system to be managed;
3. The complexity of the organisation itself.

4.6 Institutionalising SAM

In the context of SAM, "institutionalisation" refers to the process of transforming a bureaucratic, hierarchically structured management system into one that is functional and flexible and wherein SAM is the central operating process of the organisation (Rogers, 2002). It is argued that in order to institutionalise SAM in water services, there would need to be organisational change. This would occur over time by an accumulation of smaller changes, wherein improvements are made in the following: shared rationality, consensus, learning/ unlearning, willingness, trust, sharing of power, ownership, flexibility, integration and the adoption of new values.

Rogers et al. (2000) provide a formal model to guide the institutionalisation of SAM (Fig. 12), central to which are the following five factors which the authors (*ibid.*) argue are critical for success:

1. *Integrated operations,* which refers to inclusivity and the blurring of boundaries between scientists, managers and those who both deliver and receive goods and services;

2. *Strategic knowledge management,* which involves the incorporation of multiple types and sources of knowledge, its creative and strategic codification into usable forms and its transfer to (and absorption by) the recipients;

3. *Joint forum decision making,* which facilitates the decision-making process rather than removing responsibility (or accountability) for decisions from an agency or executive manager;

4. *Common knowledge, purpose and process,* the development of which entails collaborative goal setting and auditing. This process will inevitably require stakeholders to grapple with the challenge of balancing participation, experimentation and flexibility with "command-and-control" management, so as to find a functional and "streamlined" means of operationalising adaptive management;

5. *A nurturing institutional environment* that embraces the philosophy behind SAM, as without such an environment the approach will fail to be institutionalised.

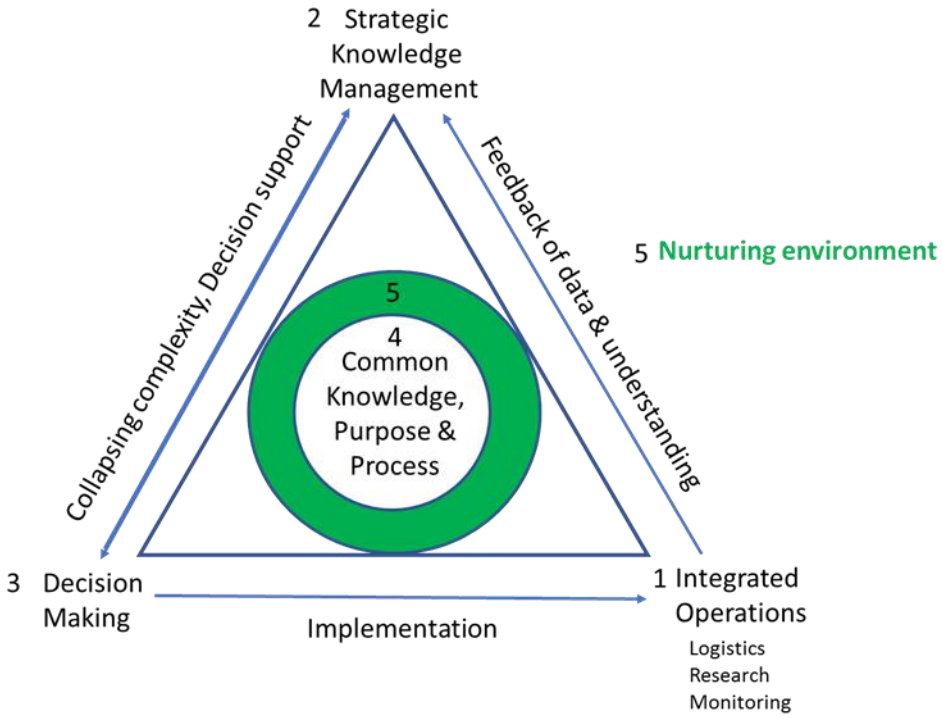

Figure 12: Five factors critical for the successful institutionalisation of a process such as SAM. Source: Adapted from Rogers et al. (2000).

Central to this process is the engagement and empowerment of multiple actors in order to develop common knowledge, purpose and process. This is because SAM is undertaken not only to enable iterative and adaptive learning, but to do so purposefully in collaboration with relevant networks and partners (Roux & Foxcroft, 2011). Given the challenges associated with consensus building in multi-stakeholder decision contexts (Stringer et al., 2006; Reed, 2008), it is imperative that SAM processes be appropriately facilitated by leaders who display both generative (creative) and adaptive leadership qualities, and who suspend the need to be an expert (Rogers et al., 2000; Reed, 2008; Allen et al., 2011; Lonsdale, 2012). Such leadership is important for gaining buy-in "from the top" (Turner et al., 2016), for institutionalising stakeholder participation (Reed, 2008) and, importantly, for enabling the development of a "learning culture" within an organisation, without which a desired future state is unlikely to be achieved (Rogers et al., 2000). Lonsdale (2012) highlights various indicative features of an organisation with a learning culture. These include: welcoming or actively seeking novel ideas, including from outside of the organisation or place; creating (possibly informal) spaces that enable experimentation and collaborative engagement in a way that stimulates debate rather than conflict; and maintaining an ethos of professional development that supports proactive individuals who act as "agents of change" by championing the management agenda. In a South African context, Rogers et al. (2000) note that developing such a nurturing institutional environment means appreciating and respecting the concepts of Ubuntu (I see you, the individual), Simunye (we are one) and Batho Pele (people first).

4.7 Applying SAM in Context

In embodying the above principles and implementing the SAM framework, it is important for decision makers to realize that "strategic management seeks improvement not perfection" (Pollard & du Toit, 2007: 6), and thus for management actions to be considered successful they do not necessarily have to be transformational. Rather, decision makers must distinguish the most achievable "degree of management" (or the requisite simplicity) that is necessary to enable a shift away from a "business-as-usual" approach to decision making, as any purposeful attempt to do so is indicative of adaptive progress (Stirzaker et al., 2010; Kingsford & Biggs, 2012). Moreover, decision makers must remain cognisant of the scale at which SAM is most applicable, as many of the challenges associated with implementing such frameworks stem from the attempt to apply adaptive techniques in decision contexts that are too large or complex to provide traction (e.g. Allan & Curtis, 2005). SAM may therefore be valuable only at critical stages of a management process, rather than as a means by which to address an overall problem (Failing et al., 2004).

As shown in Fig. 13, the ability to collapse complexity to such a degree that decision making can be supported is one of the critical factors for successfully institutionalising SAM (Rogers et al., 2000). However, whilst it is important to ensure that the SAM process does not become overcomplicated, the requisite simplicities that are adopted must be continuously revised in relation to the emergent context. In doing so, appropriate detail must be added throughout the process, where necessary, to ensure that the optimal functional utility of the process is maintained. A requisite simplicity therefore "attempts to discard some detail, whilst retaining conceptual clarity and scientific rigour, and helps us move to a new position where we can benefit from new knowledge" (Stirzaker et al., 2010). Fig. 13 depicts this concept in a graphical form.

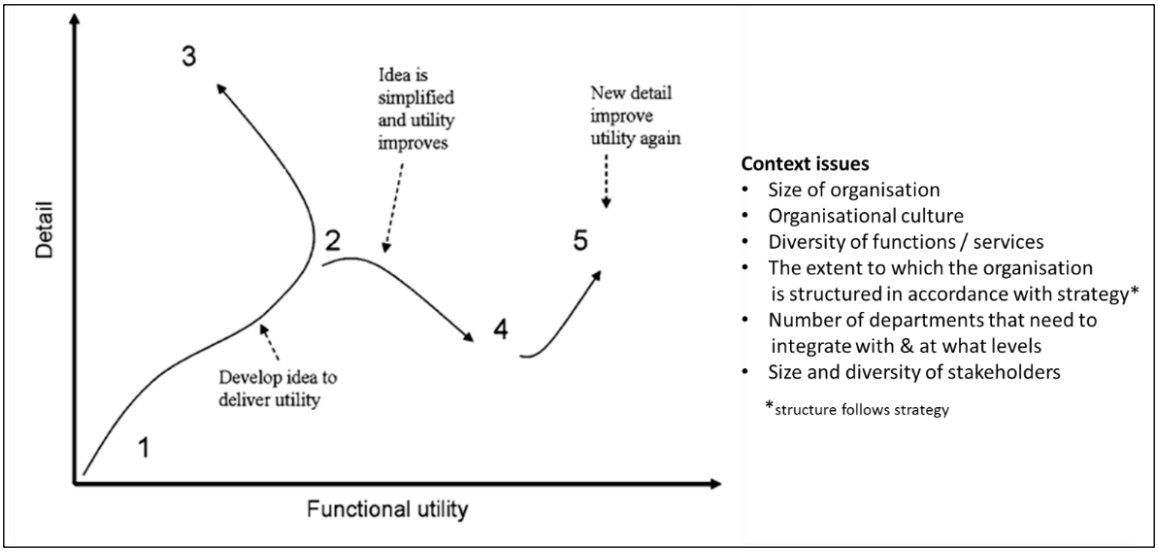

Figure 13: The cycle of adopting requisite simplicities to ensure that SAM retains its utility in the particular context. Adapted from Ward (2005).

4.8 Why is SAM More Effective than AM?

It is argued that SAM is a more inclusive, rigorous and systematic approach to developing an adaptive (emergent) strategy. This is because it is future-oriented and driven by effective leadership from within a framework that is truly adaptive and learning-centred. Moreover, it emphasises the importance of collaborative visioning and scenario planning, provides strategies and structures for guiding decisions and has effective learning processes that explicitly question decisions and identify feedbacks within every stage of the process, rather than simply reflecting on and learning from the overall outcome of management actions (as in general "plan-do-check-act" cycles). Moreover, it recognises that within the process of emergent change, there is likely to be projectable change (for example, through the process of adapting and learning, stakeholders may identify the need to develop a fixed plan for a new project). Similarly, if situations of crisis or stuckness are encountered, then emergent change may first require a process of unlearning through transformative change, the objective of which is to surface the hidden drivers of a problem in order to learn new principles, shift established attitudes and ultimately resolve a situation that is no longer appropriate.

SAM is proactive in recognising the need for transformative change through the explicit development of a shared rationality at the beginning of the process. Further, SAM uses a hierarchical approach in determining management objectives and couples this with scenario planning, which allows potential crises to be anticipated. Moreover, the incorporation of feedback loops into this scenario planning process allows different options to be identified for dealing with the particular crisis that arises. Thus, whilst both AM and SAM set a direction for management, as in projectable change, SAM recognises that this process of change may lead to another destination and therefore uses the appropriate theory of change at an appropriate stage in the process. Hence, "the development of strategies is driven by principles which help one to navigate issues that emerge in complex systems in a flexible way" (Pollard & Du Toit, 2008).

In navigating such issues, SAM recognises that it is not only the nature of the problem, but the nature of the problem *context* that affects decision making and the outcome of management actions. It therefore places an emphasis on understanding this context, which may be simple, complicated, complex or chaotic (Snowden & Boone, 2007). The phase of development that an organisation is in would also affect the ability of the organisation to adapt to change. In order to better understand the problem and the management environment, a "V-STEEP" framework is used. Importantly, SAM recognises that this management and decision-making context (and therefore the process of strategy development and change) is driven by values (the "V" in V-STEEP), particularly those that are deeply held by stakeholders rather than espoused by an organisation or society.

The incorporation of these values into the change process is a key factor that influenced the successful application of SAM in cases such as the ICMA (Rogers & Luton, 2011) and SANParks (Freitag et al., 2014). It is argued that this is because the U-Theory of Change

(although not explicit) was drawn on in situations where the values held by stakeholders were in conflict, or were not appropriate to delivering the desired outcome. SAM therefore ensures that stakeholders form an integral part of the process of deriving management solutions (as is appropriate for different stakeholders at different stages of the process), as this is how new values are learnt and transformation takes place. In this way, SAM becomes institutionalised as it begins to form the central operating process of the organisation, rather than merely superimposing AM on bureaucratic institutional structures. Whilst stakeholders are key in this process of change, SAM acknowledges that appropriate facilitation and generative (creative) leadership is essential for achieving successful outcomes and to foster a learning culture within individuals and the organisation as a whole (Rogers et al., 2000).

Table 3 summarises the major weaknesses of AM that have been identified and explains how SAM (in its original form) addresses these problems. It further highlights where and how our "adapted" version of SAM (i.e. a SAM process that explicitly integrates the theories discussed in Sections 4.2, 4.3 and 4.4) acts to address the weaknesses of AM.

Table 3: Summary of major barriers to adaptive management, showing how SAM addresses these barriers in relation to specific theories, concepts or approaches

No.	Barriers to AM:	How SAM addresses these barriers:	Theory, concept or approach related to SAM
1.	Utilises only one theory of change, namely emergent change or "learning by doing."	Incorporates three theories of change where appropriate, although not explicit, i.e. projectable change, emergent change and transformative change.	Threefold Theory of Change.
2.	Does not have a strategy component.	Future-oriented visioning provides strategic intent whilst explicit goal setting provides operational guidance.	Theory that realised strategy is emergent. Aims to combine positive attributes of pioneering and rational organisations (flexibility and efficiency).
3.	Does not differ significantly from action learning / the "plan-do-check-act" cycle.	Uses strategic visioning, is values-driven and requires feedback and learning within every stage of the process.	Enhancement of emergent change. Uses projected and transformative change where necessary (based on values and feedbacks).
4.	Vague or ambiguous problem framing.	The problem is carefully considered in relation to the context and is conceptualised from different perspectives.	Cynefin Framework - (context may be simple, complicated, complex or chaotic). Phase of organisational development informs context.

No.	Barriers to AM:	How SAM addresses these barriers:	Theory, concept or approach related to SAM
5.	"One size fits all" approach to stakeholder engagement.	Matches the type of stakeholder engagement (inform, consult, involve, collaborate) to the context, as is appropriate for different stakeholders at different stages of the process.	Threefold Theory of Change.
6.	Does not consider the vital attributes of the system.	Uses a "V-STEEP" analysis to carefully consider the system's vital attributes, including an assessment of the determinants of/threats to these vital attributes.	Context is important to strategy development and implementation.
7.	Does not consider the role played by stakeholder's deeply held values, which impact decision making.	The "V" in V-STEEP ensures that stakeholder's deeply held values are incorporated into decision making and therefore strategy development and implementation.	U-Theory of Change.
8.	Not rigorous in ensuring that stakeholders have a common or shared rationality.	Takes a rigorous approach to developing a common understanding of the problem and what needs to be done.	Development of stakeholder buy-in and ownership.
9.	A focus on perfecting models rather than field testing them.	Focus is not on predefined products or procedures but on process and outcome.	Enhancement of emergent change / "learning by doing."
10.	A narrow focus on expert-driven science.	Co-design of research projects by relevant stakeholder groups/agencies. Transdisciplinary approach is practised not preached.	Understanding of context informs degree of collaboration/co-production (threefold theory, Cynefin framework, phase of development).
11.	High cost of gathering information, undertaking large-scale experiments and monitoring.	Emphasises the importance of "overcoming inertia," or, in other words, recognises that, whilst knowledge and understanding will always be incomplete and resources will always be constrained, action is required.	Proactive approach.
12.	Takes a reactive approach to dealing with uncertainty.	Uses scenario planning and identifies different options to address possible scenarios/feedbacks, thereby allowing the process to be adapted as new realities emerge.	Resilience building and proactive approach to identifying the need for transformative change.

No.	Barriers to AM:	How SAM addresses these barriers:	Theory, concept or approach related to SAM
13.	Difficulties in understanding or translating scientific results into applied formats	Emphasises knowledge management, which involves reducing the complexity of a problem in a strategic and creative way in order to improve understanding and thus facilitate more effective decision making.	Requisite simplicity and Threefold Theory of Change.
14.	Limitations in the degree to which AM is applicable across strategic to operational scales	Makes use of an "objectives hierarchy" during the adaptation planning process where higher-order (broader) objectives are framed as "statements of strategic intent" and are therefore aimed at informing upper levels of management. Conversely, lower-order (more detailed) objectives are framed in specific spatial and temporal contexts and therefore better serve managers working in day-to-day operations.	Applicability across scales and for different types of problems.
15.	A lack of directed leadership.	Emphasises generative leadership (designer, teacher, steward) which creates a culture of shared purpose and learning.	Sets a (flexible) direction for organisational change.
16.	A lack of long-term commitment to AM as a result of political or managerial flux.	Aims at institutionalising SAM within the organisation.	Resilient organisational development.
17.	Conflict or power struggles owing to divergent perceptions, values or operational philosophies.	Explicitly aimed at generating co-operative action. Challenges those who disagree to turn their disagreement into hypotheses which form the basis of learning by doing.	U-Theory of Change.
18.	Resistance to change/lack of political buy-in due to uncertainty of future benefits (high risk).	Change from viewing uncertainty, complexity and change as threats to treating them as opportunities for learning and improving.	U-Theory of Change.

4.9 Could SAM be Useful in Municipalities?

4.9.1 Contextual comparison of three domains: park management, water resource management, and the municipal domain of water management:

This section provides a basis for answering the question, "Can SAM be useful in municipalities, given the particularities of the sector?" Firstly, a contextual comparison of three domains is

posited. These three domains are park management, water resource management at a catchment scale, and the municipal domain of water management (as summarised in Table 5 below). Following Table 5, the commonalities between the three domains are reduced into seven cross-cutting themes, with the resulting analysis discussing the implications for applying SAM in the municipal domain given these commonalities.

The criteria used to compare the three domains are structured as a series of questions, which are introduced and defined in Table 4.

Table 4: Defining the comparative criterion

	Comparative criterion	**Definition**
1	What is being managed?	What is substantively being managed? What are the primary roles and responsibilities?
2	By whom?	Who are the managing authorities?
3	For whom?	Who are the interested and affected stakeholders impacted by the management's decisions?
4	With what ambitions?	What are the broad objectives/high-level aims of management within each domain?
5	Within what organisational architecture?	Organisational architecture "encompasses the formal rules that are structured into legislation (i.e. the rules-in-form)" (Clifford-Holmes et al., 2016: 1004)
6	Requirements for co-operative governance?	Given that cooperative governance is a key principle in South African governance across the three spheres of government and government agencies, what are the requirements for cooperative governance within each domain?
7	In how stable an operating environment?	The "stability of operating environment" refers to the operating context of the domain – for example, is the domain required to operate in a context of institutional flux at a national level?

Table 5: Contextual comparison of three domains – park management, water resource management at a catchment scale, and the municipal domain of water management

	Comparative criterion	Park management	Water resource management (catchment scale)	Municipal domain of water management
1	What is being managed?	- Protected areas - Natural resources management *and* conservation, within the context of complex social-ecological systems; - Eco-tourism (with associated socio-economic development mandates).	- Water resources management, within the context of complex social-ecological systems: - Resource management responsibilities pertain to water allocation and licensing, stakeholder engagement, and planning	Multiple functions and services within a broad organisational mandate (i.e. provision of water and sanitation services occurs within the context of developmental local government and broader organisational mandates for technical and community service delivery and local economic development)
2	By whom?	- SANParks; - SANParks Scientific Services; - Oversight from the national Department of Environmental Affairs (DEA)	- Regional offices of the Department of Water and Sanitation (DWS); - Catchment management agencies (if operational) with input from multi-stakeholder catchment management forums	- Municipal councillors (political arm, providing political oversight); - Municipal administrators, including technical staff (responsible for municipal management, including service delivery); - Sector oversight from the Department of Cooperative Governance and Traditional Affairs (CoGTA)
3	For whom?	- Affected stakeholders (such as communities adjacent to parks); - Visitors (as clients)	- Stakeholders (as interested and affected water users, communities, organisations and municipalities, among others)	- Customers (as recipients of municipal services); - Citizens (as interested and affected individuals, communities, organisations and businesses that are supposed to participate in integrated planning in this domain
4	With what ambitions?	Mandate to conserve, protect, control; and manage national parks and other defined protected areas and their biological diversity (i.e. biodiversity);	- Mandate to manage water resources and oversee water use within a water management area (WMA), stipulated as part of the National Water Resource Strategy (NWRS);	- Mandate to ensure provision and regulation of water services and (as of 2014) sanitation services;

	Comparative criterion	Park management	Water resource management (catchment scale)	Municipal domain of water management
		- ambition of making national parks more accessible to tourists in order to ensure conservation remains a viable contributor to social and economic development in rural areas	- Ambition of decentralised decision making at a hydrological unit (namely, a catchment) scale.	- Ambition of assuming responsibility for direct service delivery (previously managed by national government); - Ambition of providing services via accountable, efficient and effective "developmental local government"
5	Within what organisational architecture?	- National Environmental Management: Protected Areas Act of 2003; - A public entity	- Structure, roles and responsibilities of CMAs legislated in the National Water Act of 1998; - DWS is the custodian of South Africa's water resources; - NWRS specifies the objectives for establishing of institutions to undertake WRM and determines the inter-relationship between these institutions	- National Water Act of 1998; - Water Services Act of 1997; - Municipal legislative framework established between 1998 and 2003 (including the Municipal Structures Act, Municipal Systems Act, Municipal Demarcation Act, and Municipal Finances Management Act);
6	Requirements for cooperative governance?	Government departments and agencies directly involved include: - Department of Environmental Affairs; - Department of Water and Sanitation; - South African National Biodiversity Institute.	Government departments: - Department of Environmental Affairs; - Department of Water and Sanitation; - Department of Mineral Resources; - Department of Agriculture, Forestry and Fisheries;	Government departments and spheres include: - Department of Cooperative Governance and Traditional Affairs; - Department of Water and Sanitation; - National Treasury; - The relevant provincial government; - District municipality [where applicable]; Other agencies and state-owned entities include: - Regional water boards [where applicable]; - South African Local Government Association;

	Comparative criterion	Park management	Water resource management (catchment scale)	Municipal domain of water management
7	In how stable an operating environment?	Stable: - SANParks is an established organisation that evolved out of the National Parks Board (as it was pre-1994); - SANParks was re-conceptualised post-1994 but continued to operate established parks (adding 360,000 ha since then)	Periods of semi-stability and (as of 2016) instability: - Roles and responsibilities previously assigned by DWS to CMAs were threatened to be rescinded) -WMAs revised over the course of the NWRS 2 (2013-14) and number of WMAs reduced from 19 to 9	Much instability within the domain: - Outside of the established metropolitans and the Category B1 municipalities, much of the municipal sphere is in-flux (examples include national turnaround programmes such as "Local Government Turnaround Strategy" and "Back-to-Basics")

4.9.2 Commonalities and cross-cutting themes

In summary, the following commonalities are cross-cutting themes between the three domains:

1. Diverse stakeholders are interested in and affected by the decisions made in each of the three domains;
2. There is a diversity of aims, which are sometimes conflicting, requiring trade-offs to be made;
3. There are integrative requirements throughout each of the three domains (including within governance, planning and management levels);
4. The operating environment is characterised by uncertainty (*of varying types and to varying degrees*);
5. All three domains operate within politically complex contexts (*of varying degrees*);
6. There are significant human capacity constraints, especially with regards to technical skills in water resource management and municipal water and sanitation services;
7. There is institutional flux (*to varying degrees*), which also particularly affects the water resource management and municipal water and sanitation services domains.

Focusing on the domains of water resource management at the catchment scale and municipal water management, it is noteworthy that the principles of equity, historical redress and decentralisation are central to both the legal frameworks governing water and the legal frameworks governing local government in post-Apartheid South Africa. However, as argued in Clifford-Holmes (2015):

"In spite of some significant equity, sustainability and efficiency milestones in the South African water sector being met, there is wide acknowledgement of the challenges facing successful implementation of water policy and achieving integrated management of water in South Africa. Some of the key challenges include:

- The failure to establish regional institutions for water resource management – called catchment management agencies (CMA) – with only two out of the then 19 water management areas having CMAs by 2012 (Rogers & Luton, 2011);
- The difficulty inherent in converting Apartheid-era irrigation boards, which functioned primarily to service commercial agriculture for the white South African population, into democratic water user associations (Brown, 2011; Kemerink, Mendez, Ahlers, Wester & van der Zaag, 2013);
- Ongoing leadership challenges in the Department of Water Affairs at both the ministerial and senior management levels (Goldin, 2010; Schreiner, 2013);
- Ensuring aquatic ecosystems have the flow, water quality and structure necessary to sustain ecosystems;

- The failure to link IWRM to water service delivery in local government, despite the fact that frameworks for doing so were explicitly devised (e.g. Haigh, Fox, & Davies-Coleman, 2010). This failure is especially evident in small municipalities in rural settings, which struggle to fulfil their constitutional mandate for "developmental local government" (including integrated planning), when compared to better equipped metropolitans and large cities (Siddle & Koelble, 2012)." (Clifford-Holmes, 2015: 2-3)

4.9.3 Implications for applying SAM in the municipal domain

4.9.3.1 Implication 1

The cross-cutting themes illustrate that, contextually, there is significant overlap in the operating environments of the three domains, suggesting that SAM could indeed be applicable in the municipal domain.

4.9.3.2 Implication 2

The municipal domain of water management is demonstrably complex, requiring a high degree of cooperative governance across government departments and other entities. There are many requirements for integrated management in this domain and competition for scarce resources to be allocated across and between different municipal functions is endemic. SAM arguably offers a pragmatic and lean decision-making framework and set of practices that can be used to bring diverse stakeholders through a process that allows for integrated, systemic, and adaptive management. Such a framework is required in the municipal domain.

4.9.3.3 Implication 3

It is evident that SAM benefits from being piloted in relatively stable contexts. The implication for applying SAM in the municipal domain is that SAM should be piloted in a reasonably well-functioning municipality.

4.9.3.4 Implication 4

It is also evident that SAM benefits from being piloted inside of windows of opportunity (as noted in the KNP and ICMA cases) where the timing allows for institutional support. The implication for applying SAM in the municipal domain is that the SAM pilot should ideally be undertaken at a time in which there is institutional support and a particular, time-sensitive objective to be met or problem to be addressed. For example, the current drought and associated "water crisis" can be viewed as a window of opportunity, as there is a need to build awareness of climate change and shift the way in which municipalities traditionally provide water services.

The outcome of this section is that SAM is evidently not a "silver bullet", but the implications of the contextual comparison suggest that SAM is indeed applicable in the municipal domain. In order to provide a proof of concept, a focusing topic needs to be selected, which is taken forward in the following sections of this report.

4.10 Are There Documented Municipal Applications of SAM?

In our first deliverable (K5/1123: Literature Review V3.2), we provided evidence of various adaptive initiatives (both "hard" and "soft") that have been applied in South Africa's water sector, including adaptive initiatives related to risk assessment and management, supply-side and demand-side initiatives (following Staub & Moreau-Le Golvan, 2012). In addition to considering adaptive measures and initiatives more generally, broad frameworks, approaches and tools for adaptive governance and management, including some of the more structured adaptive management approaches that have been developed and/or applied in the water sector, were highlighted. These cases are summarised in Table 6 (Appendix 1) of this report.

In addition, it is argued that there have been at least two cases of application of SAM in the municipal sphere, which are described in detail below.

4.10.1 About the SANPAD project and the use of SAM within the municipal sphere as part of this project (2011–2014)

4.10.1.1 Introduction

The first structured application of SAM described here was undertaken within the context of a larger action research project in an Eastern Cape municipality, as reported in Clifford-Holmes' (2015) doctoral thesis entitled "Fire and Water: A Transdisciplinary Investigation of Water Governance in the Lower Sundays River, South Africa". The following description is largely drawn from Clifford-Holmes' (2015) thesis with further post-hoc analysis drawn from Clifford-Holmes et al. (2016).

4.10.1.2 About the broader project

In April 2011, a water research project began in South Africa with the aim of testing a transdisciplinary approach to engaging "wicked" water problems. This project was funded by the South Africa Netherlands Research Programme for Alternatives in Development (SANPAD) and was entitled "From policy to practice: enhancing implementation of water policies for sustainable development" (Palmer et al., 2014).

The SANPAD project aimed to use a range of theories, methods, approaches and practices in novel ways to test their usefulness in breaching barriers that were impeding the implementation of IWRM in South Africa. Three case studies that accounted for different governance levels and biophysical scales were selected. These case studies investigated estuary mouth management in the Great Brak; transboundary catchment management in the Inkomati catchment, using strategic adaptive management, and local water governance in the Lower Sundays sub-catchment of the Eastern Cape. The SANPAD project had particular action research ambitions that were aimed at addressing problems in the case studies themselves, striving to:

- Loosen problem spaces that have many interdependent, controversial, complex and uncertain elements;
- Co-create knowledge with stakeholders and problem-holders;
- Enable and empower action and mobility (Clifford-Holmes, 2015: 2-4).

4.10.1.3 About the Eastern Cape case study

The Lower Sundays case study was initiated with the support of the Eastern Cape regional water board, Amatola Water, which also played a role as one of Rhodes University's research partners. The SANPAD project provided a basis for collaboration between the two institutions, with the research project providing funding and the water board contributing in-kind support and personnel time. The research team requested that Amatola Water propose an intractable problem that their organisation was facing, which the research team could investigate. The research participants at Amatola Water selected their organisation's involvement in water services in the Sundays River Valley Municipality, which is briefly introduced here.

The Sundays River Valley Municipality (SRVM) is located in the Eastern Cape Province of the Republic of South Africa (see Figure 14 below). As Clifford-Holmes (2015: 4-5) noted,

"The municipality contains a relatively small population of 54 500 people, distributed among urban settlements of around 5 000–10 000 people each (Statistics South Africa, 2014). As of 2010, 47% of the population subsisted on a household income of less than R800 per month (approximately US$80), with unemployment estimated at 44% (SRVM, 2010a). Almost half of the municipal population is therefore reliant on social grants from national government and on receiving free basic services (including water and sanitation) from local government. Over a third of South African municipalities are of a similar size and socio-economic character to the SRVM. The majority of the populated and economically active parts of the SRVM fall within the Lower Sundays River sub-catchment, constituting the [biophysical] area referred to as the 'Lower Sundays River Valley' in this [doctoral] study."

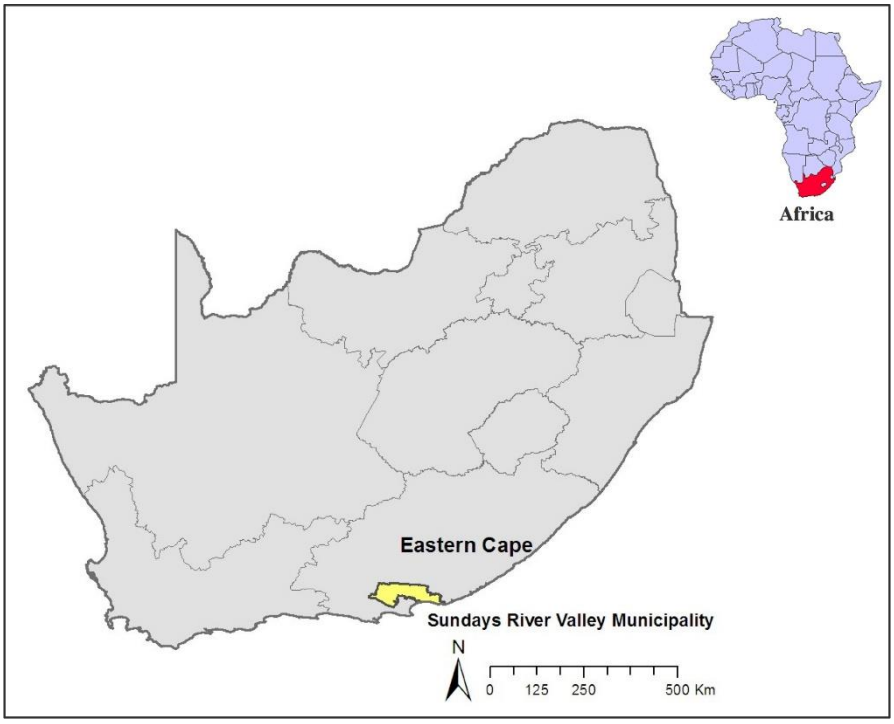

Figure 14: Map of the Sundays River Valley Municipality, shown as located within the Eastern Cape Province of the Republic of South Africa. Source: reproduced from Clifford-Holmes (2015:5).

4.10.1.4 The application of Strategic Adaptive Management (SAM) within the SRVM case study of the SANPAD project

One of the initial research tasks of the SANPAD project was to host two multi-stakeholder workshops in the Lower Sundays River Valley (LSRV), using a strategic adaptive planning process, following the SAM practice developed by Rogers and Luton (2011). The first workshop (held in October 2011) included representatives from two primary research partners – Amatola Water and the SRVM – in addition to SANPAD project researchers who facilitated the workshop. The SANPAD team included Kevin Rogers and Rebecca Luton, who had facilitated the SAM process in the ICMA, as reported in Rogers and Luton (2011). The workshop was designed around the second major phase of the SAM process (*ibid.*), namely an adaptive planning process. A collaborative V-STEEP analysis and constructing an objectives hierarchy was undertaken as part of this workshop. A short, four-page report was produced out of this workshop, summarising the workshop outcomes into the categories displayed in Box 1.

Box 1: Summary of workshop outputs of the adaptive planning process

- Issues that need attention
- Vision/desired future
- Values/principles to guide decision-making
- 'STEEP' context of water management in the SRVM:
  - Social
  - Technical
  - Economic
  - Environmental
  - Political
- Vital attributes
- Determinants
- Threats and constraints (*to the vital attributes and the desired future*)
- Objectives

A wider group of stakeholders was then invited to participate in the second, follow-up workshop (held in November, 2011), which built on the outcomes of the first workshop. This workshop included representatives from community organisations, DWA, Amatola Water, and the Lower Sundays River Water User Association (L-WUA), in addition to representation from the political and management arms of the SRVM. The facilitators of the workshop elicited problem formulations from the multiple stakeholders in attendance, and then synthesised these problem formulations into a picture of water service-related issues in the LSRV. This synthetic picture contained four interrelated issues, namely,

1. Bulk water supply and storage;
2. Treatment of raw water to potable water, and related concerns about water quality;
3. Reliable and safe distribution of potable water to households;
4. Wastewater (sewage) treatment works and the associated effects on human and environmental health.

Financial management was seen as a multi-faceted issue that was part of each of the above issues. The workshop facilitators described these issues as "knots" – i.e. interrelated and interdependent, such that attempts to unravel one knot lead to tightening of other knots elsewhere. The only way out of such a "knotty" problem is through time, patience, and consistent effort expended towards loosening and eventually unknotting the set of problems (see Box 2 and Rhodes University (2013) for further details).

Box 2: Further description of the "knots" metaphor. Drawn from Clifford-Holmes (2015: x1).

> The Latin root of the word complexity is *complexus*, meaning woven, braided, or entwined together (Morin, 1992). One of the key metaphors employed in this study developed out of the recognition of complex systems. The metaphor is that of a knotted ball of fishing line, which symbolises a tangled web of relations and variables. Attempts to loosen a knot in one place frequently cause knots to tighten in other places. This knotted ball is multi-causal, and intractable in its entirety, and yet it is possible to loosen, to develop adaptive pathways, and to find ways of working that lead toward social and political stability, rather than creating the conditions for instability.

4.10.1.5 Analysis of the use of SAM within the SRVM

In addition to beginning the adaptive management intervention in the SRVM, this period of research was focused on building relationships and social capital with the range of stakeholders involved in the SANPAD project. The workshops provided an ideal starting point, partly assisted by the fact that the workshops were run over a total of four days, providing participants time to engage one another socially.

The second workshop was a particularly important point in the action research intervention in the SRVM. Out of this workshop, knot 1 – bulk water supply and storage – was identified

and selected as the key focal issue for Clifford-Holmes' research (with other researchers examining aspects of knots 3 and 4, described further in Rhodes University (2013: 83-4)). Knot 2 was not investigated as part of the SANPAD project, except in relation to bulk water storage and distribution.

As such, in this workshop, the facilitators enabled both the participants and the core action research team of the SANPAD projects to gain a systemic overview of key water challenges in the LSRV. The use of the strategic adaptive planning phase of the SAM process was integral in this regard. Follow-up workshops drew from the SAM framework but did not explicitly use SAM procedures and protocols to engage municipal participants. Nonetheless, the outcomes of the adaptive planning process were consistently used and referred back to over the course of the remainder of the action research process.

4.10.2 About the RESILIM-O project and the use of SAM within the municipal sphere as part of this project (2013 – present)

4.10.2.1 Introduction

The second structured application of SAM described here (the Municipal Support Initiative) is nested within the context of a larger action research project in the Olifants catchment, which, as of February 2017, is ongoing.

4.10.2.2 About the broader project

The RESILIM-O research programme, funded by the United States Agency for International Development: Southern Africa, focuses on water security as a unifying thread in building resilience. RESILIM-O's overarching objective is to improve the transboundary management of the Limpopo River Basin to enhance the resilience of people and ecosystems. The RESILIM-O research programme is implemented by the Association for Water and Rural Development (AWARD). AWARD has a specific focus on the Olifants River Basin (*hence* RESILIM-**O**), which is a major tributary of the Limpopo River and is an international watercourse shared by South Africa and Mozambique (Clifford-Holmes, Pollard et al., 2016) – see Figure 15. RESILIM-O has an explicit aim of building water resource protection and is built on social learning and systems thinking.

4.10.2.3 SAM at the municipal level within RESILIM-O

The Municipal Support Initiative (MSI) is a sub-project of the RESILIM-O programme implemented by AWARD. The MSI is described as a *capacity-building campaign to support catchment resilience in municipalities in the Olifants*. As a capacity-building initiative, the MSI focuses on improving the preparedness and responsivity of local government (as an institution) to deal with natural resource degradation and climate change vulnerability. As a professional learning process, the MSI aims to supports practitioners in municipalities through workplace support, tool development and application. At the time of this report being compiled (May 2016 – February 2017), the MSI was providing support to municipalities in the following areas:

- The management of wastewater treatment works;
- Land-use planning;
- Integrated climate change adaptation;
- Disaster risk reduction.

One of the challenges in working with municipalities as part of RESILIM-O is the large number of local and district municipalities that the Olifants River (and its main tributaries) flows through (as shown in Figure 15).

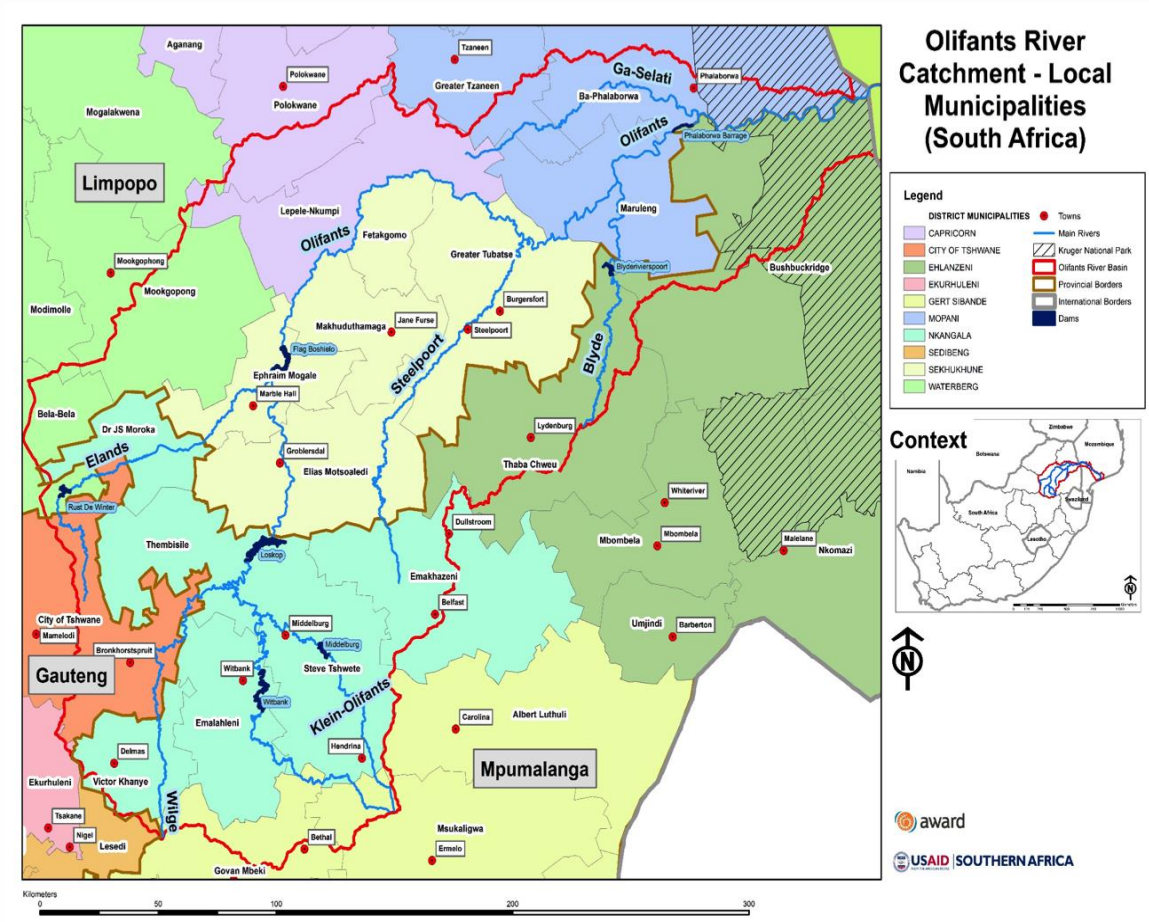

Figure 15: Map of the Olifants catchment showing the local and district municipalities in the catchment in relation to the Olifants River and its main tributaries. Source: reproduced from AWARD.

When designed as part of RESILM-O, the MSI aimed to work with the following stakeholders:

- Two district municipalities;
- Eight local municipalities;
- Traditional authorities;

- The Limpopo Department of Economic Development, Environment and Tourism (LEDET)
- The national Department of Environmental Affairs (DEA).

The significant difficulties in developing a stable working relationship with the target municipalities (including simply developing a Memorandum of Understanding between AWARD and each municipality) led to the MSI being downscaled to working with two local municipalities in the Limpopo province of SA, namely Maruleng Local Municipality and Ba-Phalaborwa Local Municipality (with plans underway to work with Mopani, the relevant district municipality) (AWARD, 2016). The fact that AWARD is the implementing agent for RESILIM-O is particularly relevant for this WRC study on applying SAM to municipalities. The directors of AWARD (Sharon Pollard and Derick du Toit) have been involved in the development of SAM both for catchment management and for park management in SA, but have additional experience in municipal initiatives. The MSI aims to incorporate SAM principles and practices into municipal planning and management (as part of a larger attempt at capacity building within municipalities).

Given the ongoing nature of this project, there is little documentation on MSI available, which complicates evaluating the success of SAM as part of the programme at this stage.

5. SUMMARY AND CONCLUSIONS FROM LITERATURE

This literature review identified the main challenges in the water services sector. These include the persistence of departmental "silos" and the fragmentation that undermines integration and collaboration; over-regulation; financial and capacity constraints and political and managerial flux. Together, these issues all result in lack of accountability.

The literature review has introduced the concept of adaptive management and described evidence of the successful applications of SAM in park management and water resources management.

The literature review then detailed the foundational theories, concepts, principles, processes, and practices (both implicit and explicit) of SAM. With regards to the implicit theories, the Threefold Theory of Change, the nature of the problem context (Cynefin Framework), the phases of organisational development, the role of generative and adaptive leadership for building resilience, and the importance of strategic knowledge management were described. Thereafter, the reasons as to why SAM is more effective than AM were explored by detailing how SAM addresses the major barriers to AM. After a comparative examination, it was concluded that there are significant commonalities and cross-cutting themes between water services and the two domains where it has been successfully used (i.e. park management and catchment management).

It was evident from the literature that SAM has significantly addressed the barriers to AM through the adoption of theories, concepts, principles, processes, and practices that are being utilised in effective organisations, including in business. In addition, it provides solutions to overcome "silos" and fragmentation by building integration and collaboration into its process. Key to the effectiveness of SAM is the emphasis on developing generative leadership, the building of trust between all stakeholders, the importance of the vision (desired future) and strategy being developed and owned by stakeholders, the central role that values play in driving the behaviour of stakeholders and "structures" that guide decision making and, finally, the institutionalisation of the management process, in this case, SAM.

Generative leaders are stewards of the vision and mission of the organisation and therefore remain resilient in the face of obstacles and complexity, such as is found in water services due to over-regulation and political and management flux. They therefore build more resilient, capacitated and focused organisations. The practices of SAM, including the feedback loops and adaptive monitoring and evaluation, engender purpose in the stakeholders and ensure a broader base of responsibility and accountability for achieving the vision and mission of the organisation.

Further aspects of SAM that support the pursuit of the vision and mission of the organisation and enable an effective strategy to be implemented include the following:

- It is grounded in the real world where change happens through different mechanisms (emergent, projected and transformative change processes).

- Stakeholders determine and agree on the system's vital attributes in the social, technical, environmental, economic and political (STEEP) context and construct objectives based on these vital attributes.
- A rigorous approach is taken to ensure that there is a diversity (in terms of needs and disciplines) of stakeholders, and that these stakeholders have a common understanding of the problem and the context and therefore act in ways that progressively solve the problem and manage and change the context.
- There is an emphasis on moving forward even when understanding and knowledge is incomplete and resources are constrained. This enables the strategy to be implemented progressively as understanding and knowledge grows.
- The development and planning of different scenarios enables management to change direction as and when new realities emerge.
- Although SAM is designed to operate in complex contexts, complexity is reduced as required to ensure timeous and effective decision making.
- An objectives hierarchy enables stakeholders at all levels to understand how they can contribute to achieving the high-level objectives and therefore work towards the desired future.

Based on these conclusions from the literature review, SAM could be useful in municipalities and has a significant probability of succeeding, especially in contexts that are relatively stable and functional. However, SAM is not a "silver bullet" – a direct or effortless solution to the problems being faced in water services. Rather, it is argued that an adapted and improved version of SAM has the potential to act as a process for overcoming the challenges of traditional management and operationalising a paradigm shift to improve the delivery of water services.

6. IS SAM POTENTIALLY APPLICABLE IN A MUNICIPAL PLANNING CONTEXT?

To demonstrate the applicability of SAM whilst working within resource constraints, the focus has been narrowed down to municipal planning. Planning (as opposed to operational management or higher-level governance) is an ideal "place" at which to introduce SAM (Fig.16). Whilst adaptive governance is essential to the longer-term effectiveness of SAM (Novellie et al., 2016), it is difficult to introduce SAM at this more strategic level as transforming the "rules of the game" requires that an incremental approach is taken to institutionalise SAM over time. The argument for introducing SAM at a policy and planning level in water services is substantiated by the success of SAM in the case of SANParks, where the approach was introduced at a middle management level (Freitag et al., 2014; Pollard & du Toit, 2007; Roux & Foxcroft, 2011).

The options for applying SAM to various municipal planning contexts, such as the upgrading of informal settlements and urban design have been considered. Running a SAM process has been considered in Knysna municipality as well as the City of Cape Town. However, the Catchment, Stormwater and River Management (CSRM) branch within the City of Cape Town's Water and Sanitation Department has been selected as a case study for the application of SAM. The field of "Water Sensitive Urban Design" (WSUD) at the municipal scale has been selected, looking specifically at CSRM's planning process for implementing and mainstreaming WSUD. This selection is based on a number of reasons, which are described below.

1. CSRM, which sits at a planning level, already acknowledges the value and importance of WSD. However, whilst the branch recognises that a paradigm shift is needed in order to move towards a more "water sensitive" city, the current "silo" institutional arrangement means that the branch requires support in order to initiate this shift.
2. Following the above point, various aspects of WSUD are already included in CSRM's Water Services Development Plan (WSDP). In turn, WSUD is included in the City's integrated development plan.
3. CSRM is the branch that is best positioned for driving the WSUD agenda.
4. Whilst CSRM faces various challenges in relation to the implementation of WSUD (see section 4.4), it is a relatively capacitated branch working within a capacitated municipality. CSRM is therefore likely to be more equipped to handle change in comparison to a smaller, less capacitated municipality.
5. The location of CSRM in Cape Town makes the logistics of working with this branch easier.
6. A recent restructuring within the Informal Settlements, Water and Waste Services Directorate means that the Water and Sanitation Department and its various branches, including CSRM, are in a phase of organisational redesign. These changes provide a timely opportunity to introduce SAM, which could have a significant impact on the redesign process.

7. Given that CSRM is now located under the Department of Water and Sanitation, it can play a key role in influencing the shift toward a more water sensitive city at both a planning and management level. In doing so, it would be necessary to determine how to integrate their planning and operations with that of other services such as Roads (for stormwater management) and Solid Waste, using the leadership style described in section 4.5.
8. CSRM has clearly designated roles for planning and operations. This is contrary to the upgrading of informal settlements, where political dynamics and the more urgent need to deliver multiple services simultaneously make the responsibility for planning less clear.
9. Given the above point, informal settlement upgrading tends more toward the operational sphere of adaptive management. On the other hand, Urban Design functions at a "higher" (more strategic) level, thus tending more towards adaptive governance, making it a more difficult case to manoeuvre. CSRM sits in the middle, within adaptive planning, which is the ideal place to start (Fig. 16).
10. There is buy-in and enthusiasm from the leaders of the CSRM team, which is a necessary entry point for the success of SAM.

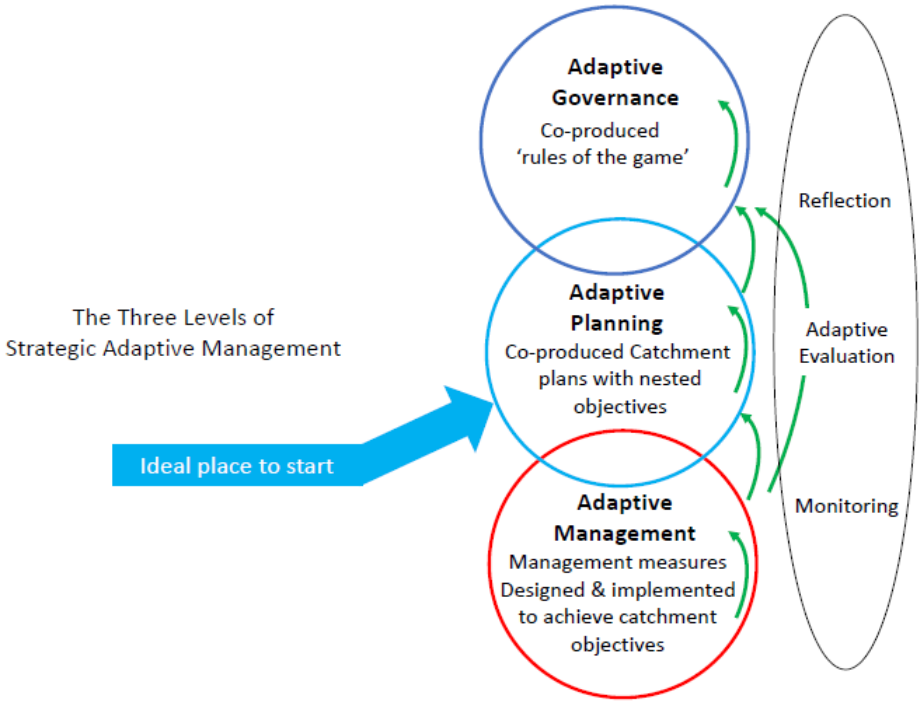

Figure 16: The three 'levels' of SAM as described by Novellie et al. (2016), showing that Adaptive Planning is the ideal place to introduce the SAM process in an organisation.

7. CAN SAM BE APPLIED TO THE CHALLENGES OF WSD?

Cities worldwide need to transition from water supply, sewered and drained cities to the more sustainable concept of water sensitive cities as depicted in Figure 18 (the framework for the transition in urban water management from Water Supply City to Water Sensitive City).

7.1 What is WSUD?

WSUD, also known as Water Sensitive Design (WSD), is an integrated, holistic approach to urban water management that incorporates various disciplines (including urban planners, landscape architects, engineers and ecologists) to find solutions to complex urban water management problems (Donofrio et al., 2009). WSUD aims to consider the environmental, social and economic effects of urban water management infrastructure and governance on the entire urban water cycle (Fig.17)[3] (Wong & Eadie, 2000). The major components of this cycle include: (1) potable water supply, (2) wastewater management and (3) stormwater management (wsud.co.za, n.d.).

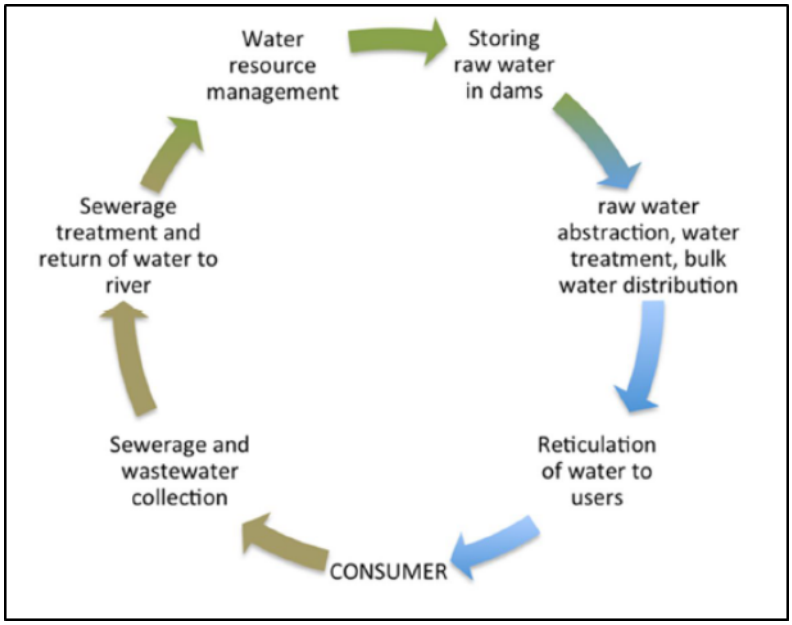

Figure 17: Generic urban water cycle, with surface water and dams as a primary source of supply. Source: adapted from DWAF (2003).

The "WSUD South Africa" website (wsud.co.za, n.d.) identifies various aims of WSUD. Overall, these are understood to include the following:

[3]Note that this generic urban water cycle is problematic because of the following: it does not include any water re-use capacities and excludes other forms of supply than dams (e.g. groundwater, rainwater harvesting, and desalination).

- Managing the urban water cycle in such a way that there is no wastage of water and natural ecosystems are protected;
- Integrating water management with urban design so that places in the city are more green and attractive, thus allowing people to be more "in touch" with water and resulting in benefits such as a reduced urban heat island effect.

In practice, the principles of WSUD can be incorporated into the planning and design of urban areas in a variety of ways, including overall *site design* (primarily applicable in "greenfield" (new) sites), as well as *source control* and *treatment control*, which are measures that can be applied to both new sites and to retrofits of existing "brownfield" developments (Donofrio et al., 2009). The approach taken will depend on the specific context, the need to address a particular problem (e.g.: flooding or pollution) and the availability of resources.

7.2 Conceptual Basis of WSD

The philosophy of WSD is a product of the global transition towards systems thinking and sustainable development, wherein the world is seen as a complex "social-ecological" (or "social-technical") system, and we endeavour to manage natural resources for the benefit of both current and future generations. The principles of WSUD were developed in response to the increasingly frequent failures and sub-optimal outcomes of the "linear" approach ("source, treat, transport, distribute, collect, treat and dispose") that is favoured in the traditional urban water management paradigm. This paradigm is driven by "command-and-control" techniques and a mindset of resource abundance, wherein:

- Urban stormwater and wastewater are viewed as a nuisance rather than as a valuable or useful resource;
- The focus of urban water management is on providing highly efficient drainage systems to rapidly collect and remove wastewater and stormwater runoff using a combination of underground pipes and linear "engineered" overland flow paths;
- Environmental degradation is prevalent due to increased volumes and rates of stormwater runoff, coupled with a dramatic increase in water borne pollution such as litter, sediments, heavy metals and nutrients;
- the social, cultural and economic impacts of urban water management infrastructure are rarely considered in the design and planning of urban areas.

Coupled with the failures of this conventional paradigm was the growing recognition of the need to build resilience in the water sector to the impacts of climate change, urbanisation and population growth (Armitage et al., 2014; Wong & Brown, 2008; Wong & Eadie, 2000).

The WSUD philosophy and principles for practice, whilst developed internationally, were first published in Australia by Whelans et al. (1994) who established a set of guidelines that aimed to address the severe urban water management problems relating to water quality,

quantity and drainage in the west of the country (Armitage et al., 2014; Wong & Eadie, 2000). Increasingly, South Africa is facing similar problems (Armitage et al., 2014). Shifting to a new paradigm requires that practitioners begin changing their values, principles and practices. Importantly, stormwater and wastewater need to be treated as an integral and valuable component of the urban water cycle. Moreover, the traditional compartmentalisation (both physical and institutional) of water supply, sanitation and stormwater services needs to be restructured in an integrated manner that values complexity rather than system boundaries. Such an approach to management is fundamental to the transition from "water-wasteful" to "water-sensitive" cities (Fig. 18).

The notion of "water sensitive cities" (WSC) was first introduced by Wong & Brown (2008), who describe such places as "more sustainable urban water cities" that are characterised by three "pillars of practice", including the following:

1. *Cities as Catchments*: access to a diversity of water sources underpinned by a diversity of centralised and decentralised infrastructure;
2. *Cities Providing Ecosystem Services*: provision of ecosystem services for the built and natural environment;
3. *Cities Comprising Water Sensitive Communities*: socio-political capital for sustainability and water sensitive decision making and behaviours.

Armitage et al. (2014) suggest that most formal areas in SA would fit Wong and Brown's (2008) description of a "drained" city. Whilst there is an increasing understanding of the need to transition to a paradigm of water sensitivity, SA has faced various challenges in operationalising this shift in practice, as described in the following section.

7.3 What are the Challenges of Implementing WSUD in SA?

WSUD aligns with the principles of South Africa's new water legislation, as it promotes an integrated and holistic approach to water management. WSUD therefore presents a key opportunity for change in SA cities and municipalities. It has the potential to support local governments in their mandate to deliver water and water-related services to municipal citizens. However, despite its multiple benefits, WSUD has generally not been mainstreamed in an urban planning context in SA. Where aspects of WSUD (most notably, sustainable urban drainage systems) have been included in policies and planning documents (e.g. in the City of Cape Town, as described by Haskins in 2012), various issues have acted as barriers to its implementation.

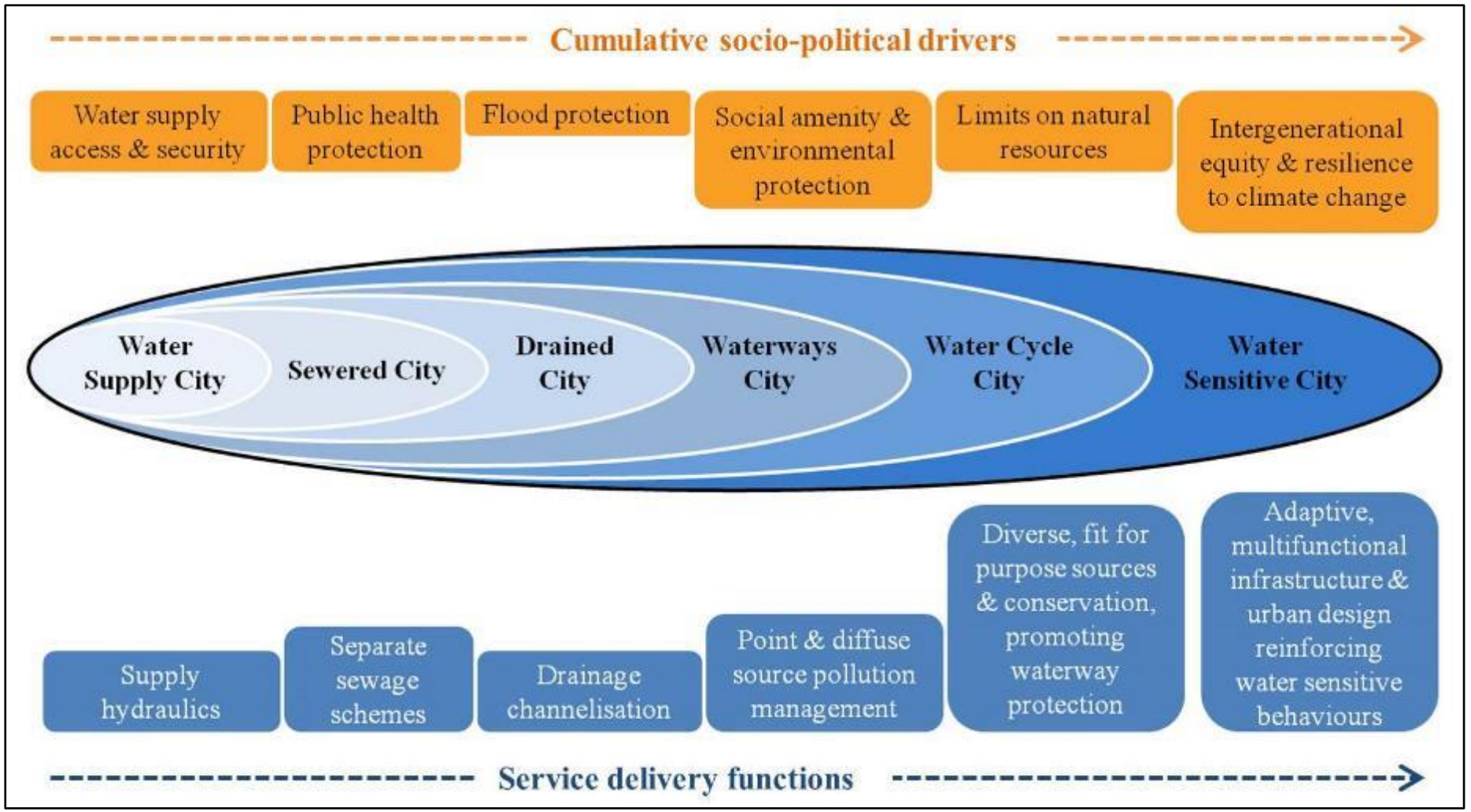

Figure 18: Framework for the transition in urban water management from Water Supply City to Water Sensitive City. Reproduced from Armitage et al. (2014).

In a case study analysis of SA's four major metropolitan municipalities (Cape Town, eThekwini, Johannesburg and Tshwane), Fisher-Jeffes et al. (2012) found that different water-related functions tend to be housed in different departments, with a department of water and sanitation (W & S) being responsible for water supply and treatment whilst stormwater management is linked closely to roads and transport. This is because stormwater is viewed as a threat, or at least a nuisance, to the infrastructural integrity of roads. Authorities therefore aim to dispose of stormwater as quickly as possible through the use of "hard" drainage systems, which highlights the persistence of a traditional, technologically-driven urban water management paradigm (Wong et al, 2000).

The lack of integration between W & S and stormwater has compounded the financial pressure that is already experienced by local authorities, who receive very limited budgets for delivering a range of essential basic services. This pressure is felt most acutely in stormwater departments, as whilst municipalities charge consumers for W & S services, stormwater has to compete with other important services (such as housing and healthcare) for budget allocations. Stormwater services therefore tend to be chronically underfunded (Fisher-Jeffes & Armitage, 2013). The financial discrepancies between the two water management functions, wherein W & S services generate an income whilst stormwater management generates only costs, has resulted in the former holding a greater degree of power within the municipal structure. This, in turn, has led to a degree of enmity between departments and poor communication and integration has meant that there is a general lack of awareness about new projects being undertaken in the same city, which diminishes systemic learning that occurs (Fisher-Jeffes et al., 2012).

In addition to institutional challenges, Fisher-Jeffes et al. (2012) highlight the various socio-political and technical issues that act as barriers to the implementation of WSUD. These primarily involve the tendency for municipalities to differentially prioritise service delivery functions, due not only to financial constraints but to a severe lack of human resources capacity, coupled with insufficient time to thoroughly look into alternative water management options. As a result, there is a lack of understanding around WSUD, which is a broad concept that can be difficult to grasp. As WSUD is generally "unknown" in the South African context, it presents a higher degree of risk for municipalities, who tend to favour more prudent, "tried and tested" methods of service delivery. Decision makers also have reservations regarding the adoption of novel approaches such as WSUD due to the additional costs and time that may be required to make this transition. This is a major concern for municipalities, as many already operate in a "fire-fighting" mode and are under constant pressure to provide services as quickly as possible to growing urban populations (Clifford-Holmes, 2015a). By embracing the philosophy of WSUD, SA can begin to address the failures of current practices and transition toward a more sustainable approach to urban water management. It is argued that SAM provides the framework through which cities and municipalities can begin planning and managing urban areas in a water-sensitive way, and implement the principles of WSUD.

7.4 Progression Toward Water Sensitive Cities

In order to better understand the process of transitioning from a Water Supply City to a Water Sensitive City (Fig. 19), it is useful to conceptualise the shift in relation to the Threefold Theory of Change, the Cynefin Framework and Phases of Organisational Development, as described in sections 4.2, 4.3 and 4.4.

Figures 20, 21 and 22 map the general process of organisational change and the process of transitioning to a WSC onto the Greiner Curve (Greiner, 1998). This model, which has become one of the fundamental tools for companies and management consultants dealing with growth, illustrates how organisations are able to deal with complexity (and thus build resilience to change) as they grow in size and maturity over time. When organisations are in a "pioneering" phase of organisational development, they are able to adequately deal with complexity. This is because they generally have no clear structure and are thus able to be flexible and creative, whilst making sense of how they relate and respond to different problem contexts (be they chaotic, simple, complicated or complex). Given that this phase of development is "messy and fresh with new energy" (Reeler et al., 2009), the predominant type of change is emergent change, albeit unconscious.

Catchment management agencies (such as the ICMA, where Rogers & Luton (2011) tested SAM as a framework for implementing IWRM), can generally be conceptualised as being in the pioneering phase. This is because the establishment of CMAs, which are a product of SA's new water legislation (RSA, 1998b), is still underway and has turned out to be more complex and demanding than anticipated, as this process requires the development of an entirely new set of organisations and institutions (Herrfahrdt-Pahle, 2010). As pioneering organisations mature, a "crisis" or "stuckness" is at some stage encountered. When a tipping point is reached, they begin to seek clearer direction and structure, thus entering into the rational phase of development.

Water Service Authorities (i.e. municipalities) are predominantly rational. This is because they are more structured than CMAs and systemised in separate departments, which are highly regulated and operate in accordance with rules, policies and procedures. In this context, the response to staff challenging or breaking the rules is often to intensify these rules and enforce compliance. Such a top-down, linear way of thinking and acting has assisted municipalities to efficiently transition from a "Water Supply City" to a "Drained City". However, the longer-term consequence of this approach is a reduction or stagnation in organisational effectiveness, as it is likely to lead to resistance and even higher levels of absenteeism or turnover (Reeler et al., 2009). As shown in Figs. 20, 21 and 22, the more rational an organisation becomes the less able it is to deal with complexity. This is partially because rational organisations attempt to apply only projected change, in which problems are seen as "simple" or "complicated" and are therefore expected to have a linear relationship between cause and effect. This approach is not effective for dealing with complexity as "authoritarian, command-and-control bureaucracies respond too slowly to survive in changing environments" (Rogers et al., 2000). Rational organisations thus tend to reach a

state of crisis when they encounter unexpected circumstances or when staff begin to feel stuck in their departmental silos, demotivated and disconnected from the organisation as a whole.

The problems being faced in the water services sector in SA is indicative of the state of crisis that can occur when rational organisations fail to adapt to increasingly complex circumstances. It is argued that this service delivery crisis has reached a tipping point and that to begin shifting toward a new paradigm of urban water management (and thus transforming from a Drained City to a Water Conservation City) a "U" process of change is needed. Given that municipalities do already display some aspects of adaptive management and, by association, "more conscious" emergent change (e.g. the implementation of monitoring and evaluation processes and the inclusion of WSUD in policy documents), it is suggested that they are slowly approaching the turning point where resistance to change (as a result of entrenched mental models and bureaucratic processes) is met with the real will to change. Figure 20, 21 and 22 show that the change from one organisational form to the next is marked by a crisis. However, the extent of these crises can be reduced by listening to the voices of innovators and early adopters who are grounded in the reality of the difficulty of making these changes.

At this turning point, there are increasing levels of decentralisation and attempts at co-ordination, which allows organisations to begin handling complexity more effectively. However, decentralisation and coordination alone are unlikely to work unless there is paradigm change in management, in which dynamic teams, driven by generative leaders, work across departmental boundaries and collaborate to achieve a common vision (see Table 1, section 4.5). The difficulties in shifting to a new urban water management paradigm in SA highlights the need for such support. SAM, through the rigorous development of a shared rationality and the use of a V-STEEP framework, provides an opportunity for the organisational context (both in terms of the phase of the organisation itself and its operating environment) to be understood through a complexity lens. In turn, complex adaptive systems can be better managed as collaboration improves and organisations shift toward an integrative phase of development.

Through ongoing and iterative processes of "learning by doing," organisations can begin to understand that chaotic, simple, complicated and complex problems may occur at any stage of a management cycle. SAM allows organisations to be prepared for such a range of circumstances by allowing managers to apply projected, emergent and transformative change as needed. This flexibility builds resilience to unexpected change by enabling organisations to better deal with complexity. Through ongoing adaptation and application of the SAM approach, organisations can begin forming alliances and entering into a more associative phase of development, in which the vision of a WSC is within reach.

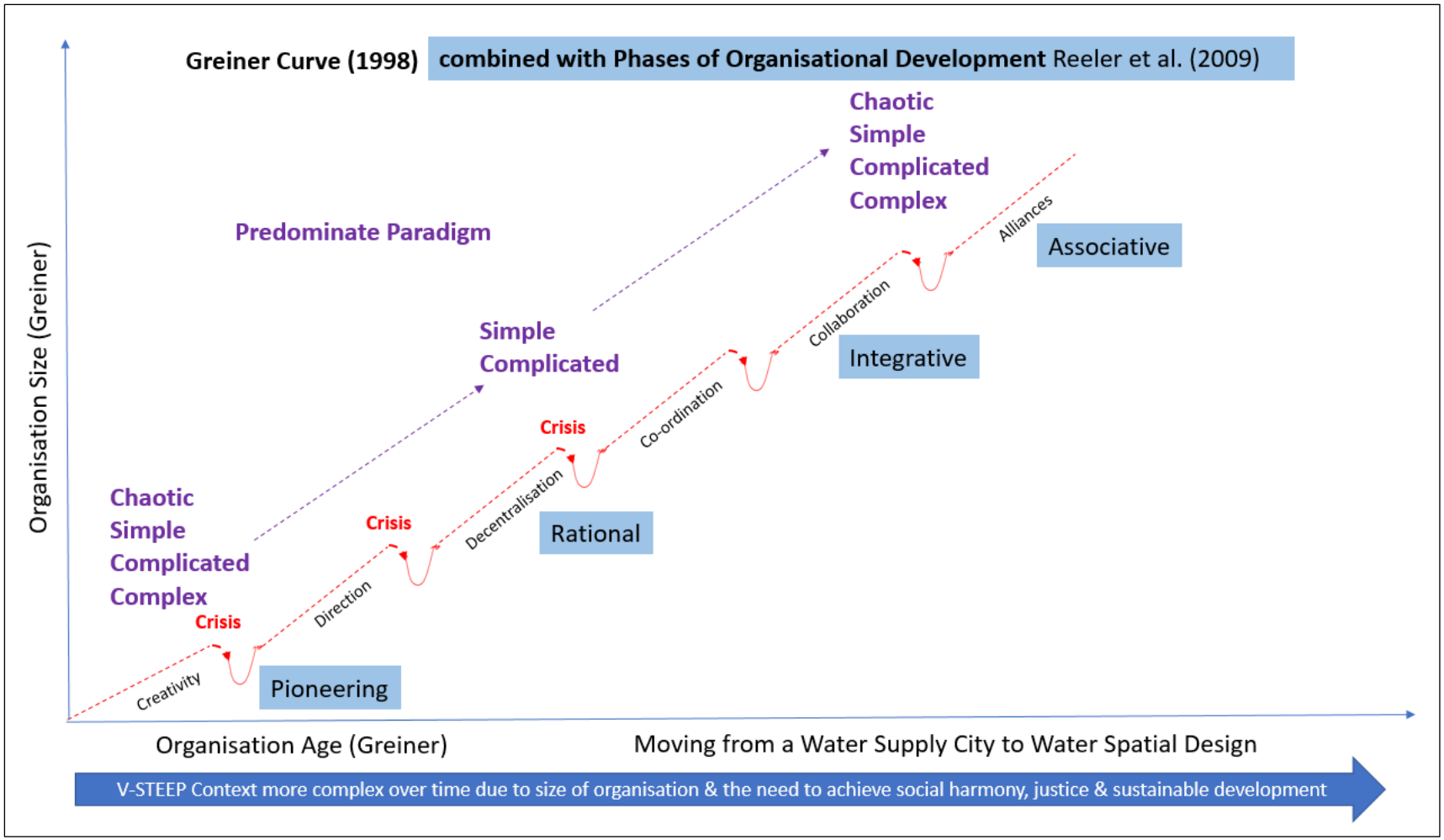

Figure 19: Process of organisational change mapped onto the Greiner Curve (Greiner, 1998), showing the phases of organisational development and the predominant change paradigm (chaotic, simple, complicated, complex) used along the way. Source: Authors' own.

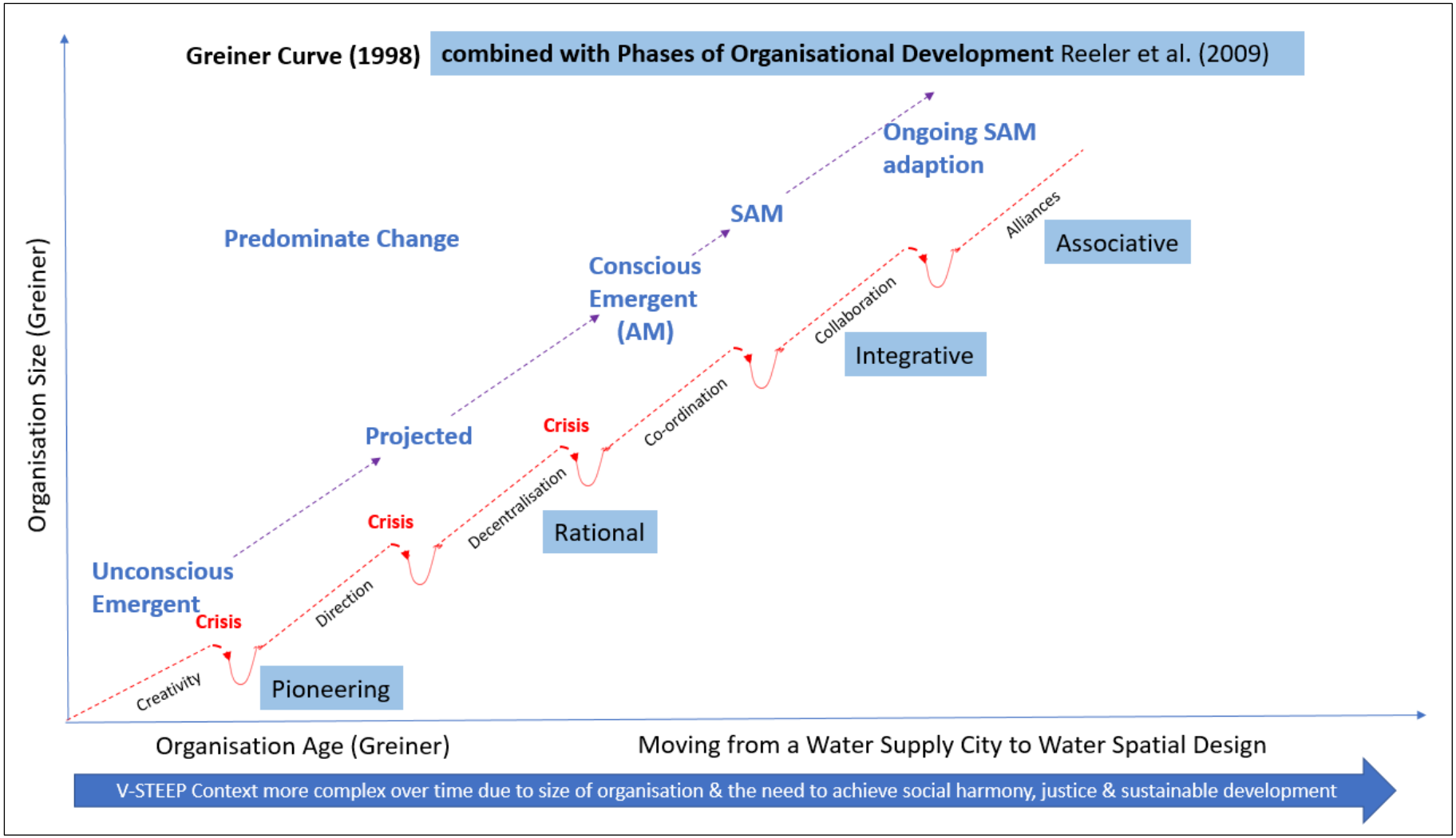

Figure 20: Process of organisational change mapped onto the Greiner Curve (Greiner, 1998), showing the phases of organisational development and the predominant theory of change (projected, emergent etc) used along the way. Source: Authors' own.

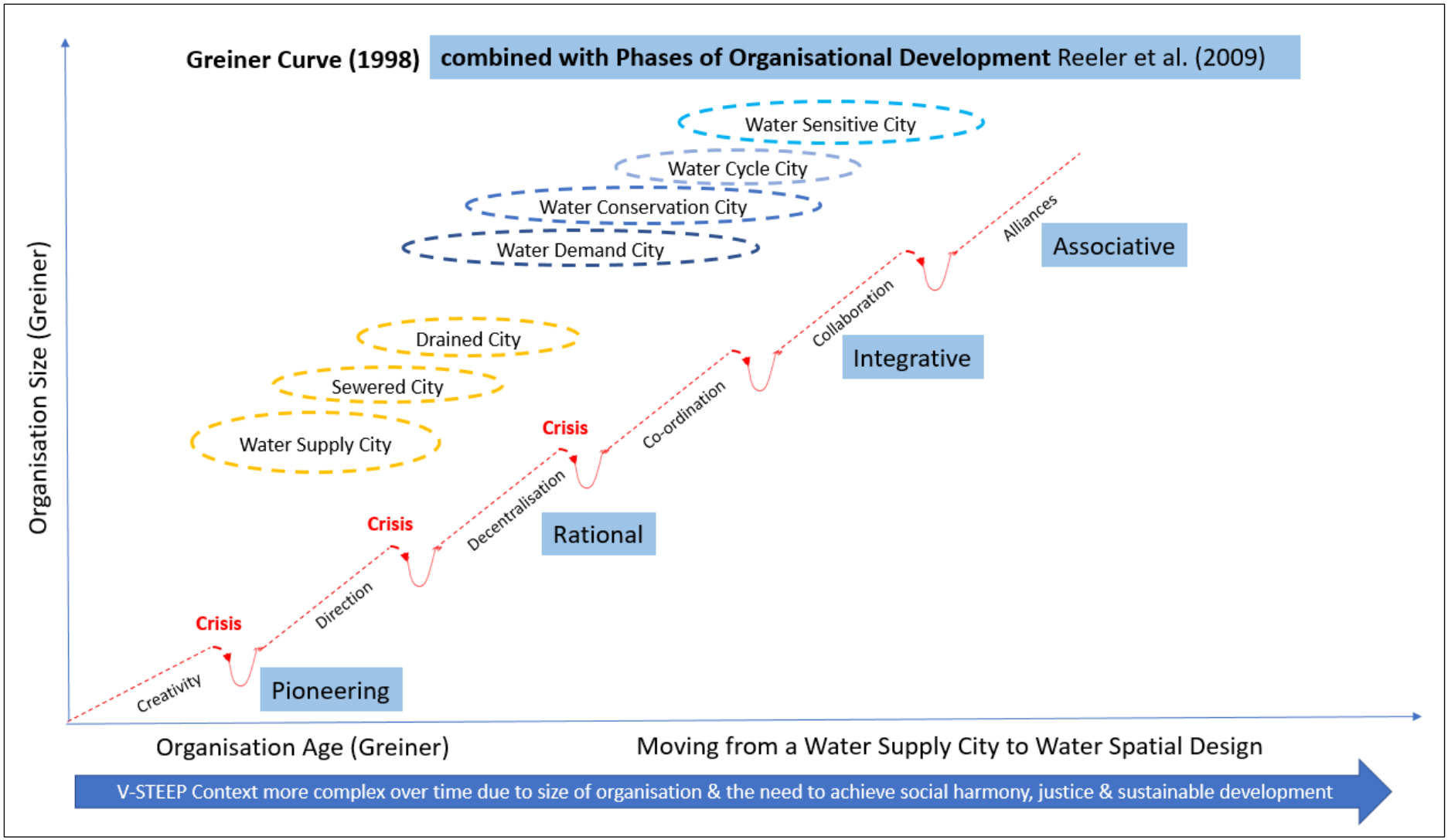

Figure 21: Process of transitioning to a WSC mapped onto the Greiner Curve (Greiner, 1998), showing the phases of organisational development. Source: Authors' own.

The model depicted in Figs. 20, 21 and 22 is visualised as being descriptive rather than normative, and therefore does not assume that the transition from a pioneering to an associative organisation (or from a Water Supply to a Water Sensitive City) is straightforward. In this light, binding CMAs and water services to particular phases of organisational development is difficult, and in fact there is a significant degree of overlap in terms of their organisational characteristics. In the case of CMAs, the organisation is generally rather chaotic/complex due to its novelty. Moreover, the "system to be managed" by CMAs (i.e. the catchment) is a complex socio-ecological system where cause-and-effect relationships are difficult to determine and constantly shifting. However, there is also a degree of rationality in CMAs as they are concerned with only one major resource (water) and are overseen by one national authority (DWS). Whilst stakeholders are diverse, they all have an interest in and aim to protect one resource (water). Similarly, financial planning in the context of CMAs is more rational as it takes place in a homogenous organisation, wherein the main concern is around water and any other focuses are therefore fairly aligned to this.

WSAs, on the other hand, are rational in terms of their regulatory structure (i.e. they are systemised and regulated with rules, policies and procedures), and also in the sense that water infrastructure is complicated rather than complex when considering a water supply, sewered and drained city. Hence, if problems arise, cause-and-effect relationships can be determined and solved by engineers. However, planning, transitioning to and managing a water sensitive city is complex. In addition, the municipal environment (the "system to be managed") in which WSAs operate is highly complex – there are multiple different departments that are overseen by multiple provincial and national authorities. WSAs are pressurised by a diverse set of stakeholders who have an interest in various different resources and services, the provision of which is also the responsibility of the municipality. This complexity is illustrated in Fig. 22, which shows the primary institutional arrangements influencing local water authorities in SA (Clifford-Holmes et al., 2016). Financial planning in the context of WSAs is also complex as there is a high level of competition for resources with other departments, which have diverse objectives and are differentially prioritised in budget allocations.

There are various other factors that need to be considered in relation to this argument, as discussed in Section 4.10. However, the main point is that the phase of development (or characteristics thereof) of an organisation, and the context in which planning and management takes place, influence the ability of organisations to deal with complexity and build resilience to change.

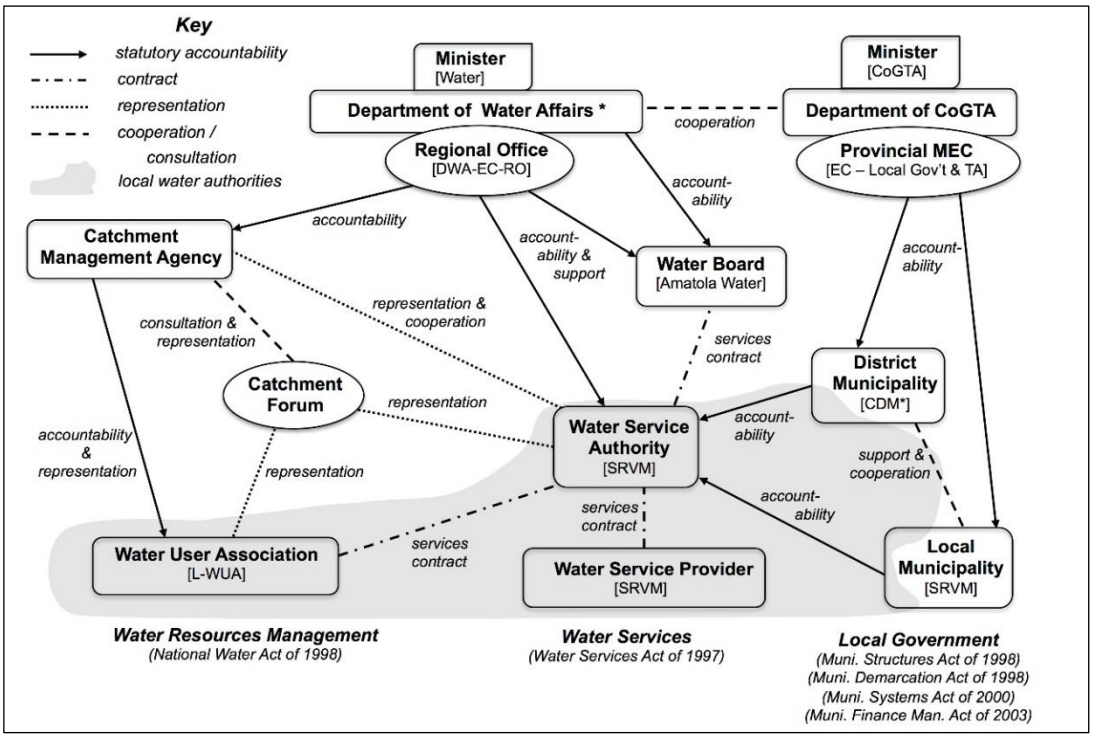

Figure 22: Primary institutional arrangements influencing local water authorities in SA, with the established institutions relevant to the LSRV case study (described in section 4.11.1) identified in square brackets. Reproduced from Clifford-Holmes et al. (2016).

8. PROPOSED SAM IMPLEMENTATION PROCESS

In order to pragmatically test the applicability of SAM to WSUD, it is proposed that the CSRM branch in the City of Cape Town be engaged in a process of strategic adaptive planning with the aim of developing a Water Spatial Design Strategy.

Three main questions should be asked when deciding on the design of the SAM process:

1. **At what level (governance, planning or management) should the SAM process begin?**

One could start the SAM process at any level (AG, AP or AM) as there are components of the other levels in each one, and feedbacks to the other levels can therefore be designed into the process. However, experience has shown that it is most effective to commence with the adaptive planning process.

2. **What level in the organisation (corporate, service or unit) will commence the SAM process?**

One could start at the IDP level, the urban planning level or the water planning level. In the case of the City of Cape Town, WSUD has been incorporated into the IDP and the WSDP. However, as the Water and Sanitation Department, and specifically CSRM, is arguably responsible for leading the process, it is argued that it makes sense to begin with CSRM.

3. **Where should the boundary for the initial application of the process be drawn (internal to the service, internal to the organisation or all stakeholders)?**

Whilst in theory one could commence with the entire stakeholder base (i.e. those within the organisation and those external to the organisation) this would not be in line with incrementally testing and growing the SAM process in the context. It is therefore prudent to start the SAM process with CSRM leading and drawing in key internal stakeholders. Whether workshops are first conducted with CSRM on their own, or other internal stakeholders are drawn in immediately, still needs to be determined.

The first step in the process would be an orientation workshop where CSRM (and possibly key internal stakeholders) will be presented with the need for, the purpose of, and the proposed process for the development of the strategy. Incorporated in the workshop will be an explanation of adaptive planning and how it is nested within SAM. This process will require appropriate leadership (e.g. a champion from within the municipality) and facilitation, as described in Section 4.5. Fig. 24 depicts a high-level version of a generic adaptive planning process. A more detailed version of this process is included in Appendix 2.

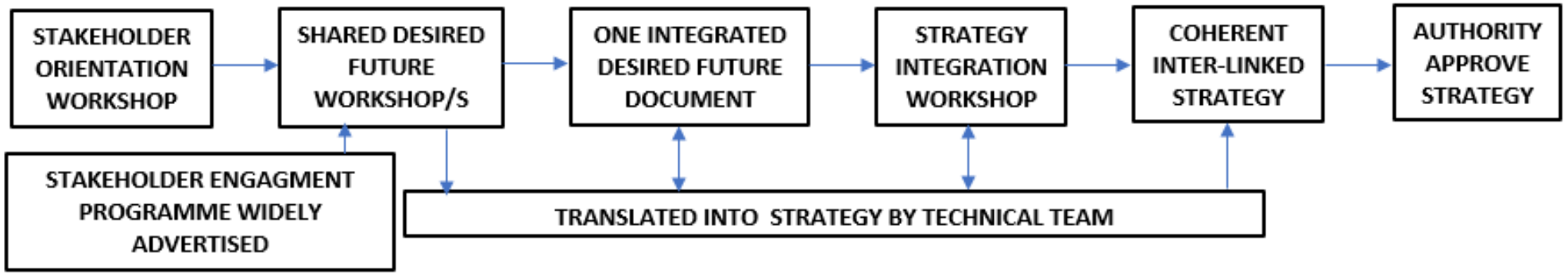

Figure 23: High-level version of a generic adaptive planning process. Source: Adapted from Rogers and Luton (2011).

8.1 Pre-planning and Preparation 1

Prior to undertaking an initial stakeholder orientation workshop (and/or empowerment workshop/s), a series of actions need to be completed to prepare for the process.

i. Firstly, a stakeholder database should be developed. Stakeholders should include all major decision makers, actors and sectors that have the potential (either negative or positive) to affect, or be affected by, the decision outcomes in question.

ii. Once this is developed, a decision must be taken as to where to draw the boundary for the first phase of the SAM process.

iii. A further decision then needs to be taken as to who to inform that the intention is to involve all stakeholders in the process as it is rolled out. In line with the principle of incrementally testing and learning from the application of SAM in the municipal context, it is unlikely that a decision to inform all stakeholders will be made as this would raise expectations that it may not be possible to meet, at least in the short term.

iv. Invitations to a stakeholder orientation workshop must then be distributed via email, fax or hand delivery and followed up via phone calls or personal visits. Care will be taken in managing the stakeholder invitation process as it is critical that stakeholders are valued from the beginning.

v. A stakeholder orientation document must then be sent to those individuals who have accepted the invitation. This document will clearly frame the topic and define the goals and objectives of the workshop.

vi. Finally, the stakeholder engagement programme must only be widely advertised to all interested and affected parties.

8.2 Stakeholder Orientation Workshop

An initial workshop should be held to present key stakeholders with the need for, purpose of and proposed process for developing a WSUD strategy. The aim of this step is to reach consensus on a broad problem, frame this problem in an appropriate way and agree on the tasks that need to be undertaken. In doing so, it is important to situate WSUD in relation to broader sustainable development objectives and the overall vision of the WSUD concept, namely more healthy, resilient and liveable cities. In this way, a broader grouping of stakeholders will recognise that WSUD is part of achieving their objectives, thus increasing the potential for stakeholder participation and buy-in. This is essential as there is a tendency to jump on a new “bandwagon” without adequately explaining how a new concept ties in with, and enhances, existing concepts and strategies.

Once there is sufficient understanding of the SAM process and of WSUD, a shared rationality must be developed among stakeholders, who describe their understanding of the STEEP system. This should be done through a process of communication that engages stakeholders from diverse backgrounds, and with different values, interests and priorities. This communication will take the form of dialogue, which is a tool that prompts stakeholders to listen to and understand other viewpoints without arguing or becoming defensive.

8.3 Pre-planning and Preparation 2

Based on the information obtained in the stakeholder orientation workshop, a foundational STEEP information document should be developed by the technical team and distributed to stakeholders via email, fax or hand delivery.

8.4 Visioning (Desired Future) Workshop/s

A visioning workshop or visioning workshops should be held with stakeholders, the first step in the APP. This process allows them to collaboratively:

i. "Paint a picture" of a shared desired future;

ii. Articulate what values will drive them to this desired future;

iii. Agree on the STEEP context they will need to manage and create;

iv. Determine the "vital attributes" of the system to be managed;

v. Decide on the determinates of the vital attributes (the determinates maintain or enhance the vital attributes);

vi. Decide on the threats or the constraints to the vital attributes (these diminish the vital attributes);

vii. Agree on objectives based on the determinates and threats/constraints;

viii. Order the objectives into an objectives hierarchy.

How far the visioning workshop/s get in the eight-step process outlined above will be determined by time constraints and what the stakeholders agree to. As part of the process, participants will be made aware and agree that all information from the workshop will be translated and incorporated into the strategy document by a technical team. It is essential at this stage of the process for the facilitators to ask themselves if sufficient trust in the process is being developed (i.e. are people feeling that their concerns/issues are being heard and incorporated into the process?)

8.5 Pre-planning and Preparation 3

The outcomes of the visioning workshops, or the outcome of the one visioning workshop, must be documented and distributed to all stakeholders, including those who were not able to be there.

How the next step in the process is configured will depend on whether it was necessary to have one or more than one visioning workshop and how far down the eight-step process the visioning workshop/s went. In the case of more than one visioning workshop, the different outcomes from each visioning workshop will be integrated into one document, which describes the desired future of the City of Cape Town in terms of WSUD, and sent to all stakeholders.

Individual invitations to the strategy workshop (one visioning workshop) or strategy integration workshop (more than one visioning workshop) will be sent out via email, fax or hand delivery, and followed up via phone calls or personal visits.

8.6 Strategy Workshop or Strategy Integration Workshop

A. Strategy workshop

A workshop should then be held with the stakeholders to present them with the document compiled by the technical team, which describes a desired future for WSUD in the City of Cape Town.

B. Strategy integration workshop

Another workshop should then be held with the stakeholders to present them with the integrated document compiled by the technical team, which describes an integrated desired future for WSUD in the City of Cape Town.

In both cases (A&B), consensus-driven changes should be made to the document. Any comments, concerns and proposed changes that are raised in this regard will be discussed and unpacked, the aim being to negotiate around any competing or controversial changes that are proposed. Changes are then decided upon, with the objective being to build stakeholder consensus whilst maintaining technical and legal standards, practical viability and overall "usability". The decisions that are made around the strategy changes are based on their level of alignment with the vision and objectives. Ensuring that decisions are filtered through these indicators provides a means of justifying the final content of the strategy document.

8.7 Strategy Development Process

Following the final workshop, an "integration matrix" of stakeholder-driven objectives and strategic action programmes should be developed. Stakeholder desires are then translated into a coherent, interlinked WSUD strategy, and WSUD sub-strategies are developed using the integration matrix. Those stakeholders whose suggested changes are not incorporated into the strategy will be sent a letter detailing the reasons for excluding their suggestions. This is done

to ensure that participants know clearly why their proposed changes were not made and to indicate that there will always be an opportunity to raise the issues again when the strategy comes up for revision. This enables people's inputs to be valued but prevents the process being unnecessarily delayed by late changes. If explained upfront, it will hopefully ensure that stakeholders prepare more thoroughly at the beginning of the process. Finally, the strategy is submitted to and approved by the relevant authority.

8.8 The Spread and Maturation of SAM in Water Services

Through ongoing repetitions, the SAM process can eventually become the central operating practice of the organisation. This occurs as internal departments gain confidence in the process and begin applying it to their engagements with external departments. These departments then learn how to apply SAM to their own operations and share their experiences with others, and so on. This is illustrated in Fig. 24, which shows how SAM can spread through an organisation, both horizontally and vertically, and mature over time as governance networks that are driven by the SAM approach begin to form. Such multi-level governance structures are important, as stakeholder and policy coordination is required to ensure that planning and management actions at the local level are not restricted by the higher-level institutional processes in which they are embedded. Failing to achieve coordination between these different scales may result in maladaptation due to conflicting goals, decisions or actions.

It has been argued that the ideal place at which to introduce SAM in an organisation is at a planning level. However, it is important to remember that adaptive planning is only one component of an overall SAM process, which in reality occurs in phases of adaptive planning, adaptive management and adaptive governance. Moreover, each of these phases is interlinked through ongoing processes of monitoring and evaluation (refer to Fig. 5). Thus, whilst the horizontal and vertical implementation of SAM across an organisation tends to happen iteratively as different departments begin to build confidence in the process (Fig. 24), AP, AM and AG can run simultaneously. This is because once AP is started, it begins to influence AM and then questions around the rules of the game (AG) start to be raised. This is illustrated in Fig. 25 which shows how these three processes overlap, thus emphasising that within each sphere, components of the other spheres exist. The effectiveness of AP, AM and AG progressively improves as the number of "adopters" of SAM increases.

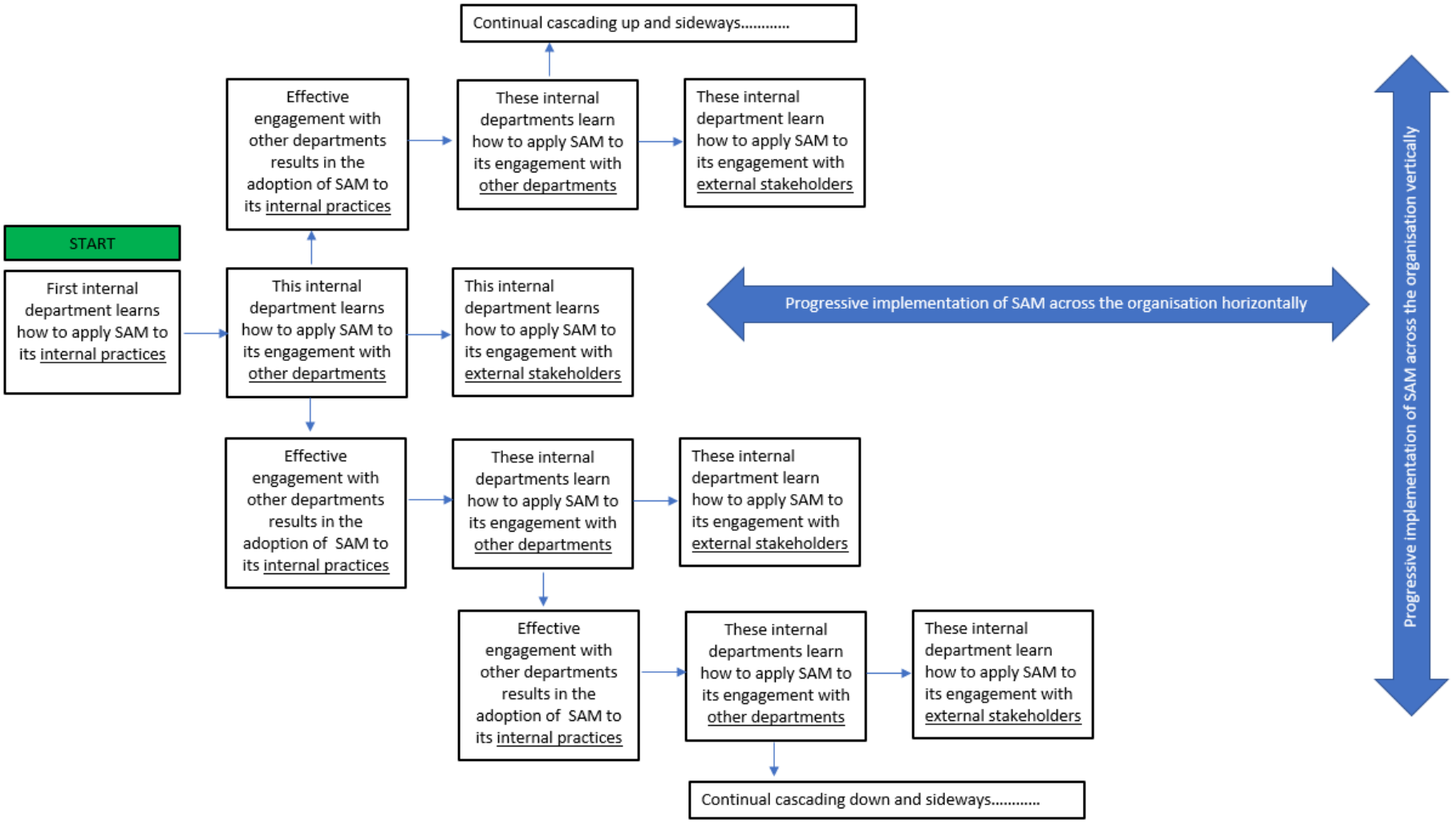

Figure 24: Horizontal and vertical cascading of SAM through internal and external departments by iteratively building confidence in the process. Source: Authors' own.

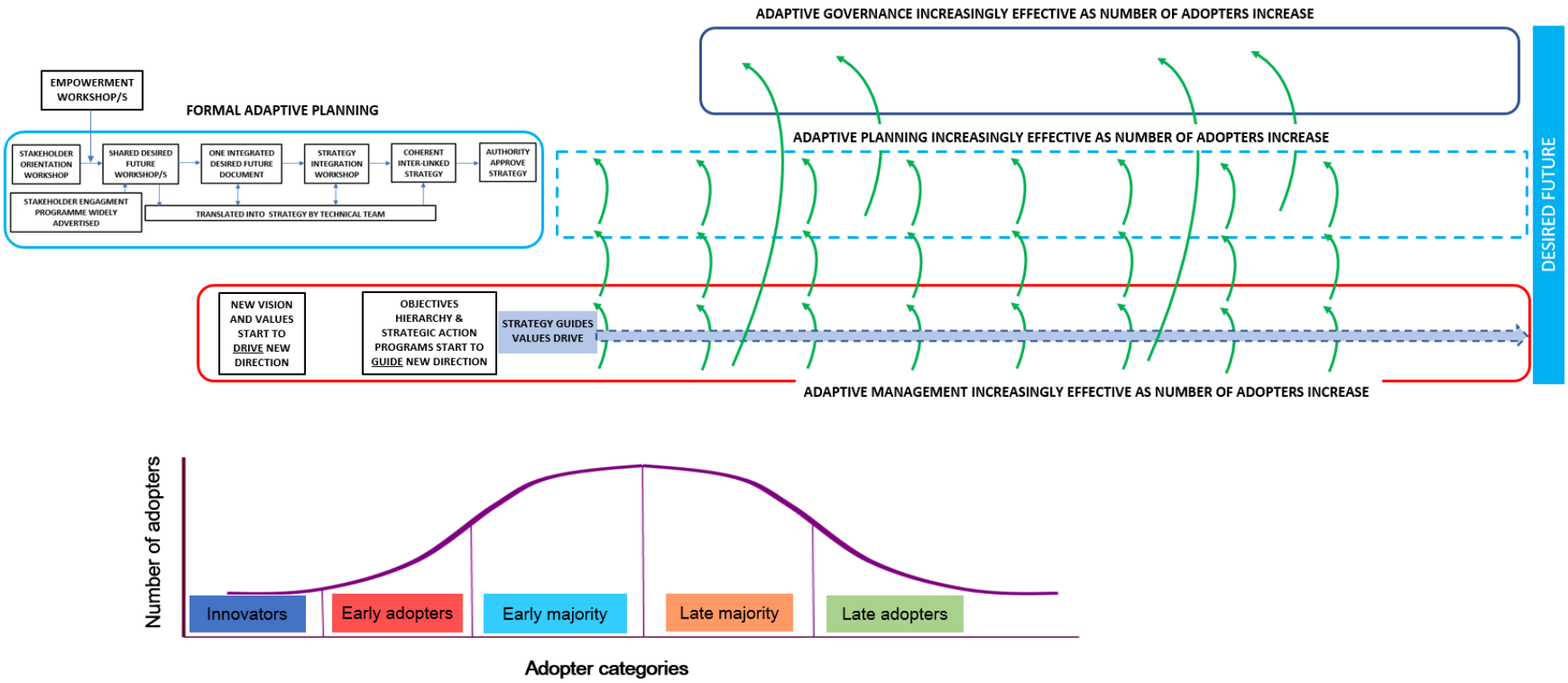

Figure 25: Diagram showing the overlaps between AP, AM and AG. These processes can run simultaneously as within each sphere, components of the other spheres exist. The effectiveness of AP, AM and AG progressively improves as the number of "adopters" of SAM increases. Source: Authors' own.

9. CONCLUSION

The objectives of this study were, firstly, to provide a "proof of concept" or evidence that demonstrates that Strategic Adaptive Management, or an adaptation thereof, can be applied to water services in South Africa and, secondly, to examine whether SAM could be practically applied to water services.

A comprehensive examination of the literature has demonstrated that SAM could be useful in water services in municipalities, and has a significant probability of succeeding, especially in contexts that are more stable and functional. SAM provides solutions to overcome key challenges that exist in water services. For example, it overcomes "silos" and fragmentation by building integration and collaboration into its process. Key to the effectiveness of SAM is the emphasis on developing generative (and adaptive) leadership, the building of trust between all stakeholders, the importance of the vision (desired future) and strategy being developed and owned by stakeholders, the central role that values play in driving the behaviour of stakeholders and "structures" that guide decision making and, finally, the institutionalisation of the management process – in this case, SAM.

Generative leaders remain resilient in the face of obstacles and complexity (such as that which is found in water services due to over-regulation and political and managerial flux), and therefore build more resilient, capacitated and focused organisations. The practices of SAM, including the feedback loops and processes of adaptive monitoring and evaluation, engender purpose in stakeholders and ensure improved responsibility and accountability (another water services challenge) for achieving the vision and mission of the organisation.

Further aspects of SAM that support the pursuit of the vision and mission of the organisation and enable an effective strategy to be implemented are contained in Section 5 – "Summary and Conclusions from Literature."

Based on the evidence that SAM has a significant probability of succeeding in the water services context, a pilot project was identified. To work within resource constraints, it was decided that the focus should remain on the municipal planning context. This decision was based on experience in other contexts, which has shown that the planning function is the ideal place to commence the SAM process. After considering alternative options, the planning function for Water Sensitive Design (WSD) in the City of Cape Town was chosen as a pilot.

WSD was chosen because it requires a significant shift in how the urban water cycle is planned and managed and how water is incorporated into the design of urban areas. Since the concept is largely untested in the South African context and involves decentralised operational control, it poses a greater risk. WSD needs close collaboration and integration between various disciplines (including urban planners, landscape architects, engineers and ecologists) to find solutions to complex urban water management problems. No matter how often a municipality is restructured, there will always be a need for integration and collaboration across departments. It was therefore concluded that SAM is ideally suited to overcoming the challenges of planning (and later) implementing WSD.

This report concluded by outlining a process as to how SAM would be implemented and how it is anticipated that it would spread and mature, in order to demonstrate that there are practical steps that can be taken to implement SAM in the WSD context.

10. REFERENCES

Adger, W. N. (2006). Vulnerability. *Global Environmental Change*, *16*(3), 268–281. http://doi.org/10.1016/j.gloenvcha.2006.02.006

Alexander, P. (2010). Rebellion of the poor: South Africa's service delivery protests – a preliminary analysis. *Review of African Political Economy*, *37*(123), 25–40. http://doi.org/10.1080/03056241003637870

Allen, C. R., Fontaine, J. J., Pope, K. L., & Garmestani, A. S. (2011). Adaptive management for a turbulent future. *Journal of Environmental Management*, *92*(5), 1339–1345. http://doi.org/10.1016/j.jenvman.2010.11.019

Allen, C. R., & Gunderson, L. H. (2011). Pathology and failure in the design and implementation of adaptive management. *Journal of Environmental Management*, *92*(5), 1379–1384. http://doi.org/10.1016/j.jenvman.2010.10.063

Armitage, N., Fisher-jeffes, L., Carden, K., Winter, K., Naidoo, V., Spiegel, A., … Coulson, D. (2014). Water Sensitive Urban Design (WSUD) for South Africa: Framework and Guidelines. WRC Report No. TT 588/14. http://doi.org/10.13140/2.1.3042.5922

Association for Water and Rural Development (AWARD). (2016). *Progress Report: Quarter 3 2015-2016*. Resilience in the Limpopo Basin (RESILIM) programme funded by USAID, under AID-674-A-13-00008.

Barnett, J., Evans, L., Gross, C., Kiem, A., Kingsford, R., Palutikof, J., … Smithers, S. (2015). From barriers to limits to climate change adaptation: path dependency and the speed of change. *Ecology and Society*, *20*(3). http://doi.org/10.5751/ES-07696-200304

Berkes, F., Folke, C., & Colding, J. (2000). Linking Social and Ecological Systems: Management practices and social mechanisms for building resilience. *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience*. Cambridge: Cambridge University Press. Retrieved from http://www.cambridge.org/us/academic/subjects/life-sciences/ecology-and-conservation/linking-social-and-ecological-systems-management-practices-and-social-mechanisms-building-resilience

Biesbroek, R., Dupuis, J., Jordan, A., Wellstead, A., Howlett, M., Cairney, P., … Davidson, D. (2015). Opening up the black box of adaptation decision-making. *Nature Climate Change*, *5*(6), 493–494. http://doi.org/10.1038/nclimate2615

Biggs, H. C., & Rogers, K. (2003). An Adaptive System to Link Science, Monitoring and Management in Practice. In J. Du Toit, K. H. Rogers, & H. C. Biggs (Eds.), *The Kruger experience: Ecology and management of Savanna heterogeneity*. USA: Island Press.

Biggs, H., Ferreira, S., Freitag-Ronaldson, S., & Grant-Biggs, R. (2011). Taking stock after a decade: Does the "thresholds of potential concern" concept need a socio-ecological revamp? *Koedoe*, *53*(2), 1–9. http://doi.org/10.4102/koedoe.v53i2.1002

Blackmore, E., Underhill, R., McQuilkin, J., & Leach, R. (2013). Common Cause for Nature: Values and Frames in Conservation, 180.

Booysen, S. (2007). With the ballot and the brick: The politics of attaining service delivery. *Progress in Development Studies*, *7*(February 2004), 21–32. http://doi.org/10.1177/146499340600700103

Bormann, B. T., Cunningham, P. G., Brooks, M. H., Manning, V. W., & Callopy, M. W. (1994). Adaptive ecosystem management in the Pacific Northwest. *General Technical Report, PNW-GTR-34*, 32. Retrieved from http://www.treesearch.fs.fed.us/pubs/8965

Butterworth, J., Warner, J., Moriarty, P., Smits, S., & Batchelor, C. (2010). Finding practical approaches to integrated water resources management. *Water Alternatives*, *3*(1), 68–81.

Chaffin, B. C., Gosnell, H., & Cosens, B. A. (2014). A decade of adaptive governance scholarship: Synthesis and future directions. *Ecology and Society*, *19*(3). http://doi.org/10.5751/ES-06824-190356

Cilliers, P. (1998). *Complexity and Postmodernism: Understanding Complex Systems*. Routledge.

Cilliers, P. (2000). What Can We Learn From a Theory of Complexity? *Emergence*, *2*(1), 23–33. http://doi.org/10.1207/S15327000EM0201_03

Clifford-Holmes, J. K. (2015a). *Fire and Water: a Transdisciplinary Investigation of Water Governance*. Rhodes University.

Clifford-Holmes, J. K. (2015b). *Fire and Water: A Transdisciplinary Investigation of Water Governance in the Lower Sundays River, South Africa*. PhD thesis, Rhodes University, South Africa.

Clifford-Holmes, J. K., Palmer, C. G., de Wet, C. J., & Slinger, J. H. (2016). Operational manifestations of institutional dysfunction in post-apartheid South Africa. *Water Policy*, 1–17. http://doi.org/10.2166/wp.2016.211

Clifford-Holmes, J. K., Pollard, S., Biggs, H., Chihambakwe, K., Jonker, W., York, T., … Slinger, J. H. (2016). Resilient by design: a modelling approach to support scenario and policy analysis in the Olifants River Basin, South Africa. In *Conference Proceedings of the 2016 International Conference of the System Dynamics Society. 17-21 July 2016, Delft, the Netherlands*.

Clifford-Holmes, J. K., Slinger, J. H., Mbulawa, P., & Palmer, C. G. (2015). Modes of Failure of South African Local Government in the Water Services Sector. *Conference Proceedings of the 33rd International Conference of the System Dynamics Society, 19-23 July 2015*, 1–17.

Comfort, L. K. (1994). Self-Organization in Complex Systems. *Journal of Public Administration Research and Theory*, *4*(3), 393–410.

Council, N. R. (2004). Adaptive management: Theories, frameworks, and practices. *Adaptive Management for Water Resources Project Planning*, 19–32.

Crowell, S. (1989). A New Way of Thinking : The Challenge of the Future. *Educational Leadership*, *47*(1). Retrieved from http://www.ascd.com/ASCD/pdf/journals/ed_lead/el_198909_crowell.pdf

Cundill, G., Cumming, G. S., Biggs, D., & Fabricius, C. (2012). Soft systems thinking and social learning for adaptive management. *Conservation Biology*, *26*(1), 13–20. http://doi.org/10.1111/j.1523-1739.2011.01755.x

de Bruijn, H., & Herder, P. M. (2009). System and actor perspectives on sociotechnical systems. *IEEE Transactions on Systems, Man, and Cybernetics Part A:Systems and Humans*, *39*(5), 981–992. http://doi.org/10.1109/TSMCA.2009.2025452

Department of Water Affairs and Forestry. (2003). Strategic framework for water services, (September), 73. Retrieved from https://www.dwaf.gov.za/Documents/Policies/Strategic Framework approved.pdf

Donofrio, J., Kuhn, Y., Mcwalter, K., & Winsor, M. (2009). Water-Sensitive Urban Design : An Emerging Model in Challenges Facing Our Cities : Aging. *Environmental Practice*, *3*(11), 179–189. http://doi.org/10.10170S1466046609990263

Doug Reeler, Blerk, R. Van, Taylor, J., Paulsen, D., & Soal, S. (2009). *People to people: Creating and working with relationships in organisations*. *The Barefoot guide to working with organisationis and social change*.

DWA. (2013). National water resource strategy: Water for an equitable and sustainable future. Pretoria, South Africa: Department of Water Affairs. http://doi.org/10.1017/CBO9781107415324.004

Eberhard, R., Robinson, C. J., Waterhouse, J., Parslow, J., Hart, B., Grayson, R., & Taylor, B. (2009). Adaptive management for water quality planning - from theory to practice. *Marine and Freshwater Research*, *60*(11), 1189–1195. http://doi.org/10.1071/mf08347

Engle, N. L., Johns, O. R., Lemos, M. C., & Nelson, D. R. (2011). Integrated and adaptive management of water resources: Tensions, legacies, and the next best thing. *Ecology and Society*, *16*(1). http://doi.org/19

Evans, J. P. (2011). Resilience, ecology and adaptation in the experimental city. *Transactions of the Institute of British Geographers*, *36*(2), 223–237. http://doi.org/10.1111/j.1475-5661.2010.00420.x

Failing, L., Horn, G., & Higgins, P. (2004). Using expert judgment and stakeholder values to evaluate adaptive management options. *Ecology and Society*, *9*(1). http://doi.org/13

Fisher-Jeffes, L., & Armitage, N. P. (2013). Charging for stormwater in South Africa. *Water SA*, *39*(3), 429–436. http://doi.org/10.4314/wsa.v39i3.13

Fisher-Jeffes, L., Carden, K., Armitage, N., Spiegel, A., Winter, K., & Ashley, R. (2012). Challenges Facing Implementation of Water Sensitive Urban Design in South Africa. *7th Conference on Water Sensitive Urban Design*, (January), 1–8.

Folke, C. (2006). Resilience: The emergence of a perspective for social-ecological systems analyses. *Global Environmental Change*, *16*(3), 253–267. http://doi.org/10.1016/j.gloenvcha.2006.04.002

Folke, C. (2007). Social-ecological systems and adaptive governance of the commons. *Ecological Research*, *22*(1), 14–15. http://doi.org/10.1007/s11284-006-0074-0

Freitag, S., Biggs, H., & Breen, C. (2014). The spread and maturation of strategic adaptive management within and beyond South African national parks. *Ecology & Society*, *19*(3), 25. http://doi.org/10.5751/ES-06338-190325

Geels, F. W. (2004). From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory. *Research Policy*, *33*(6–7), 897–920. http://doi.org/10.1016/j.respol.2004.01.015

Greiner, L. (1998). Evolution and Revolution as Organizations Grow - Harvard Business Review. *Harvard Business Review*, *76*(3), 55–68. http://doi.org/10.1111/j.1741-6248.1997.00397.x

Gunderson, L. (2015). Adaptive Management of Social-Ecological Systems. http://doi.org/10.1007/978-94-017-9682-8

Gunderson, L., Holling, C. S., Pritchard, L., & Peterson, G. . (2002). Resilience. *Encyclopedia of Global Environmental Change*, *2*, 530–531.

Haskins, C. A. (2012). Cape Town's sustainable approach to urban stormwater management, (January), 1–16. Retrieved from http://www.capetown.gov.za/en/CSRM/Documents/CTsustainableApproachToUrbanStormwaterManagement.pdf

Herrfahrdt-Pahle, E. (2010). Introducing Catchment Management: The case of South Africa. Bonn: German Develoopment Institute.

Holling, C. S. (1973). Resilience and Stability of Ecological Systems Author (s): C . S . Holling Source : Annual Review of Ecology and Systematics , Vol . 4 (1973), pp . 1-23 Published by : Annual Reviews Stable URL : http://www.jstor.org/stable/2096802 REFERENCES Linked r, *4*(1973), 1–23.

Holling, C. S. (1978). Adaptive Environmental Assessment and Management. *International Series on Applied Systems Analysis*, 402.

Holling, C. S. (2001). Understanding the complexity of economic, ecological, and social systems. *Ecosystems*, *4*(5), 390–405. http://doi.org/10.1007/s10021-001-0101-5

Jackson, B. (2014). *An Adaptive Operational Water Resources Management Framework For The Crocodile River*. MSc Hydrology thesis, Centre for Water Resources Research, University of KwaZulu-Natal.

Jones, H. (2011). Taking responsibility for complexity. *Overseas Development Institute*, (August), 72. http://doi.org/10.1080/13032917.2011.631418

Kingsford, R. T., & Biggs, H. C. (2012). *Strategic adaptive management guidelines for effective conservation of freshwater ecosystems*. *IUCN WCPA Freshwater Taskforce …*. http://doi.org/10.1016/j.biocon.2010.09.022.We

Kingsford, R. T., & Biggs, H. C. (2012). *Strategic adaptive management guidelines for effective conservation of freshwater ecosystems in and around protected areas of the world. IUCN WCPA Freshwater Taskforce …*. IUCN WCPA Freshwater Taskforce, Australian Wetlands and Rivers Centre, Sydney. http://doi.org/10.1016/j.biocon.2010.09.022.We

Koelble, T. a., & LiPuma, E. (2010). Institutional obstacles to service delivery in South Africa. *Social Dynamics*, *36*(3), 565–589. http://doi.org/10.1080/02533952.2010.518002

Koelble, T. a., & Siddle, A. (2014). Institutional complexity and unanticipated consequences: the failure of decentralization in South Africa, *21*(6), 1117–1133. http://doi.org/10.1080/13510347.2013.784270

Leck, H., & Roberts, D. (2015). What lies beneath: Understanding the invisible aspects of municipal climate change governance. *Current Opinion in Environmental Sustainability*, *13*, 61–67. http://doi.org/10.1016/j.cosust.2015.02.004

Lee, K. N. (1993). *Compass and gyroscope: integrating science and politics for the environment*. Washington, D.C.: Island Press.

Levin, S. A., Barrett, S., Aniyar, S., Baumol, W., Bliss, C., Bolin, B., … Ehrlich, P. (1998). Resilience in natural and socioeconomic systems. *Environment and Development Economics*, (2), 221–262.

Levine, J. (2004). Adaptive management in river restoration: theory vs. practice in western North America. *Water Resources Collections and Archives*, 1–28. Retrieved from https://escholarship.org/uc/item/1611w85p

Loftin, M. K. (2014). Truths and governance for adaptive management. *Ecology and Society*, *19*(2). http://doi.org/10.5751/ES-06353-190221

Marion, R. (1999). The Edge of Organization. *Emergence*, *1*(2), 114–119.

Martin, R. (2012). Regional economic resilience, hysteresis and recessionary shocks. *Journal of Economic Geography*, *12*(1), 1–32. http://doi.org/10.1093/jeg/lbr019

McLain, R., & Lee, R. (1996). Adaptive Management: Promises and Pitfalls. *Environmental Management*, *20*(4), 437–48. http://doi.org/10.1007/BF01474647

Medema, W., McIntosh, B., & Jeffrey, P. (2008). From Premise to Practice: a Critical Assessment of Integrated Water Resources Management and Adaptive Management Approaches in the Water Sector, *13*(2), 1–18. Retrieved from papers2://publication/uuid/336A1387-25BA-4DF8-81A6-8E7159C902B2

Morin, E. (1992). From the Concept of System to the Paradigm of Complexity. *Journal of Social and Evolutionary Systems*, *15*(4), 371–385.

Novellie, P., Biggs, H., & Roux, D. (2016). National laws and policies can enable or confound adaptive governance: Examples from South African national parks. *Environmental Science and Policy*, *66*, 40–46. http://doi.org/10.1016/j.envsci.2016.08.005

Ohlsson, P., Gunderson, L. H., Carpenter, S. R., Ryan, P., Lebel, L., Folke, C., & Holling, C. S. (2006). Shooting the Rapids : Navigating Transitions to Adaptive Governance of Social-Ecological Systems. *Ecology And Society*, *11*(1).

Pahl-Wostl, C. (2007). Transitions towards adaptive management of water facing climate and global change. *Water Resources Management*, *21*(1), 49–62. http://doi.org/10.1007/s11269-006-9040-4

Palmer, C. G., de Wet, C., Slinger, J., Linnane, S., Rogers, K. H., Linnane, S., … Fox, H. (2014). *Developing a guide to research practice that engages with difficult water resource problems.* Report to the Water Research Commission (WRC Report T18138 K8-992-1), Gezina, South Africa.

Pedler, M. (2011). *Action Learning in Practice* (4th ed.). Surrey: Gower.

Pollard, S., Biggs, H., & du Toit, D. (2008). *Towards a Socio-Ecological Systems View of the Sand River Catchment, South Africa: An Exploratory Resilience*. Retrieved from http://www.wrc.org.za/knowledge hub documents/research reports/tt-364-08.pdf

Pollard, S., & du Toit, D. (2011). Towards Adaptive Integrated Water Resources Management in Southern Africa: The Role of Self-organisation and Multi-scale Feedbacks for Learning and Responsiveness in the Letaba and Crocodile Catchments. *Water Resources Management*, *25*(15), 4019–4035. http://doi.org/10.1007/s11269-011-9904-0

Pollard, S., & Du Toit, D. (2008). Integrated water resource management in complex systems: How the catchment management strategies seek to achieve sustainability and equity in water resources in South Africa. *Water SA*, *34*(6), 671–679.

Pollard, S. R., & du Toit, D. R. (2007). *Guidelines for strategic adaptive management - experiences from managing the rivers of the Kruger National Park.* Ecosystems, Protected Areas and People (EPP) Project, UNEP GEF No. GF/27-13-03-4679. United Nations Environmental Programme, Nairobi, Kenya.

Ramalingam, B., Jones, H., Reba, T., & Young, J. (2008). *Exploring the science of complexity: Ideas and implications for development and humanitarian efforts*. Working Paper 285. Overseas Development Institute, London.

Reeler, D. (2007). A Three-fold Theory of Social Change and Implications for Practice, Planning, Monitoring and Evaluation. Centre for Developmental Practice.

Reeler, D., Van Blerk, R., Taylor, J., Paulsen, D., & Saal, S. (2009). *Barefoot Guide to Working with Organisations and Social Change*. South Africa: The Barefoot Collective.

Republic of South Africa (RSA). (1997). *Water Services Act (Act No. 108 of 1997). Government Gazette no. 18522*. Pretoria: Department of Water Affairs and Forestry.

Republic of South Africa (RSA). (1998a). *Local government: Municipal Structures Act (Act no. 117 of 1998).*

Republic of South Africa (RSA). (1998b). *National Water Act (Act No. 36 of 1998). Government Gazette no. 19182*. Pretoria: Department of Water Affairs and Forestry.

Republic of South Africa (RSA). (1998c). *White Paper on Local Government*. Pretoria.

Republic of South Africa (RSA). (2000). *Municipal Systems Act (Act No. 32 of 2000). Government Gazette no. 21776*. Pretoria.

Rhodes University. (2013). *Engaged Research*. Report produced by the Communications & Marketing Division of Rhodes University, Grahamstown, South Africa.

Richmond, B. (1993). Systems thinking: critical thinking skills for the 1990s and beyond. *System Dynamics Review (Wiley)*, *9*(2), 113–133. http://doi.org/10.1002/sdr.4260090203

Rist, L., Felton, A., Samuelsson, L., Sandström, C., & Rosvall, O. (2013). A new paradigm for adaptive management. *Ecology and Society*, *18*(4), 1–63. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-84891868926&partnerID=40&md5=96ef724dd63e5d49a586b19f3bbf4678

Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a General Theory of Planning Dilemmas in a General Theory of Planning. *Policy Sci*, *4*(2), 155–169.

Rogers, K. (1998). Managing science/management partnerships: a challenge of adaptive management. *Ecology and Society*, *2*(2), 5.

Rogers, K., & Biggs, H. (1999). Interacting indicators, endpoints and value systems in strategic management of the rivers of the Kruger National Park. *Freshwater Biology*, *41*, 439–451. http://doi.org/10.1046/j.1365-2427.1999.00441.x

Rogers, K. H. (2002). Operationalizing Multi-Party Strategic Adaptive Management (Sam) of the Sabie River. Water Research Commission.

Rogers, K. H., & Luton, R. (2011). Strategic Adaptive Management As a Framework for Implementing Integrated Water Resource Management in South Africa: Report to the Water Research Commission. *WRC Report No. KV 245/10*. Gezina.

Rogers, K., Roux, D., & Biggs, H. (2000). Challenges for catchment management agencies: Lessons from bureaucracies,business and resource management. *Water SA*, *26*(4), 505–511.

Rogers, P. (2014). Theory of Change. *Methodological Briefs: Impact Evaluation*. Retrieved from http://devinfolive.info/impact_evaluation/ie/img/downloads/Theory_of_Change_ENG.pdf%5Cnhttp://www.unicef-irc.org/publications/747

Rogers & Bestbier, R. (1997). *Development of a protocol for the definition of the desired state of riverine systems in South Africa.* Pretoria: Department of Environmental Affairs and Tourism. http://doi.org/10.1017/CBO9781107415324.004

Roux & Foxcroft, L. C. (2011). The development and application of strategic adaptive management within South African National Parks Strategic adaptive management in SANParks. *Koedoe*, *53*(2), 1–5. http://doi.org/10.4102/koedoe.v53i2.1049

SAHRC. (2014). Report on the Right to Access Sufficient Water and Decent Sanitation in South Africa. South African Human Rights Commission. Retrieved from http://www.gov.za/sites/www.gov.za/files/report_right_access_water_sanitation2014_a.pdf

SANParks. (2006). *Coordinated Policy Framework Governing Park Management Plans*. *SANParks*. South African National Parks (SANParks) internal planning.

Schreiner, B. (2013). Viewpoint-why has the South African national water act been so difficult to implement? *Water Alternatives*, *6*(2), 239–245.

Smit, B., & Wandel, J. (2006). Adaptation, adaptive capacity and vulnerability. *Global Environmental Change*, *16*(3), 282–292. http://doi.org/10.1016/j.gloenvcha.2006.03.008

Smith, H. M., Ugarelli, R., Zouwen, M. van der, Allen, R., Gormley, A. M., & Segrave, A. (2013). Risk , vulnerability , resilience and adaptive management in the water sector. *Trust*. Retrieved from https://riunet.upv.es/bitstream/handle/10251/46625/Risk__vulnerability__resilience_and_adaptive_management_in_the_water_sector.pdf?sequence=1

Snowden, D. J., & Boone, M. E. (2007). A Leader's Framework for Decision Making A Leader's Framework for Decision Making. *Harvard Business Review*, *85*(11), 68–76, 149. http://doi.org/10.1109/MCDM.2007.369449

Stankey, G. H., Clark, R. N., & Bormann, B. T. (2005). Adaptive Management of Natural Resources : Theory , Concepts , and Management Institutions. *Forestry Sciences*, *Gen. Tech.*, 73.

Statistics South Africa. (2014). Sundays River Valley Municipality.

Staub, M., & Moreau-Le Golvan, Y. (2012). Catalogue of European adaptive initiatives of the water sector to face climate change impacts (updated 2012 release). In *"PREPARED Enabling Change" project (funded by the European Commission, project no.244232)*. Retrieved from http://www.prepared-fp7.eu/viewer/file.aspx?fileinfoID=163

Stirzaker, R., Biggs, H., Roux, D., & Cilliers, P. (2010). Requisite simplicities to help negotiate complex problems. *Ambio*, *39*(8), 600–607. http://doi.org/10.1007/s13280-010-0075-7

Stirzaker, R. J., Roux, D. J., & Biggs, H. C. (2011). Learning to bridge the gap between adaptive management and organisational culture. *Koedoe*, *53*(2), 1–6. http://doi.org/10.4102/koedoe.v53i2.1007

Sundays River Valley Municipality (SRVM). (2010). *Water Services Development Plan: January 2010 review*. Internal report prepared by Engineering Advice and Services, Port Elizabeth, for the SRVM. Kirkwood, South Africa.

Susskind, L. (2010). Policy & Practice: Responding to the Risks Posed by Climate Change: Cities Have No Choice but to Adapt. *The Town Planning Review*, *81*(3), 217–235.

The World Bank. (2011). Accountability in Public Services in South Africa. *Communications Development Incorporated*.

theoryofchange.org. (n.d.). What is Theory of Change? Theory of Change Community. Retrieved from http://www.theoryofchange.org/what-is-theory-of-change/

Thietart, R., & Forgues, B. (1995). Chaos Theory and Organization. *Organization Science*, *6*(1), 19–31. http://doi.org/10.1097/EDE.ObO13e31812e5535

Turok, I. (2014). The Resilience of South African Cities a Decade after Local Democracy. *Environment and Planning A* , *46*(4), 749–769. http://doi.org/10.1068/a4697

UNISDR, (The United Nations Office for Disaster Risk Reduction). (2012). Making Cities Resilient Report 2012. New York: United Nations Office for Disaster Risk Reduction. http://doi.org/10.2775/90060

Urry, J. (2005). The Complexity Turn. *Culture & SocietySAGE*, *22*(5), 1–14. http://doi.org/10.1177/0263276405057188

Wallace, D., & Wallace, R. (2008). Urban systems during disasters: Factors for resilience. *Ecology and Society*, *13*(1). http://doi.org/10.2307/2068365

Walters, C. (1997). Challenges in adptative management of riparian and coastal ecosystems. *Conservation Ecology*, *1*(2), art 1-art 1. http://doi.org/10.1111/j.1526-100X.2008.00478.x

Williams, B. K., & Brown, E. D. (2016). Technical challenges in the application of adaptive management. *Biological Conservation*, *195*, 255–263. http://doi.org/10.1016/j.biocon.2016.01.012

Wise, R. M., Fazey, I., Stafford Smith, M., Park, S. E., Eakin, H. C., Archer Van Garderen, E. R. M., & Campbell, B. (2014). Reconceptualising adaptation to climate change as part of pathways of change and response. *Global Environmental Change*, *28*, 325–336. http://doi.org/10.1016/j.gloenvcha.2013.12.002

Wong, T., & Brown, R. (2008). Transitioning to water sensitive cities: ensuring resilience through a new hydro-social contract. *Proceedings of the 11th International Conference …*, (April 2016), 1–10. Retrieved from http://web.sbe.hw.ac.uk/staffprofiles/bdgsa/11th_International_Conference_on_Urban_Drainage_CD/ICUD08/pdfs/638.pdf

Wong, T., & Eadie, M. (2000). Water Sensitive Urban Design - a Paradigm Shift in Urban Design. *10th World Water Congress*, (May), 8.

Wong, T. H. F. (2000). Improving urban stormwater quality – From theory to implementation. *Water - Journal of the Australian Water Association*, *27*(6), 28–31.

wsud.co.za. (n.d.). Water Sensitive Urban Design (WSUD) South Africa. Retrieved from http://wsud.co.za/wsud-for-south-africa/overview/

11. APPENDICES

20.1 Appendix 1: Adaptive initiatives considered in Deliverable 1

Table 6: Summary of adaptive initiatives considered in Deliverable 1, categorised with location of initiative and relevant reference tabulated

Category	Initiative name	Location	Reference
Risk assessment and management	3.1.1 Drought Emergency Measures in NMBM	Nelson Mandela Bay Municipality	(van Jaarsveld et al., 2011)
	3.1.2. Sustainable Urban Stormwater Management	Cape Town	(Haskins, 2012)
	3.1.3. Quantifying Water Vulnerability: a multi-dimensional approach	Various municipalities around the Orange River Basin	(Sullivan, 2011)
Supply-side initiatives	3.2.1. Diversification of water supply	South Africa, e.g. Kleinmond; rural areas in KwaZulu-Natal and Eastern Cape	(Mukheibir, 2008; Mwenge Kahinda et al., 2007; Allen, 2012; Dobrowksy et al., 2014)
	3.2.2. Implementation of pressure management in municipal water supply systems	Cape Town, Johannesburg and eThekwini Municipality	(Mckenzie & Wegelin, 2009; Scruton et al., 2011)
	3.2.3. Leak identification in a water distribution network using sparse flow measurements	Durban	(Mulholland et al., 2014)
	3.2.4. Handpumps in rural KwaZulu-Natal	KwaZulu-Natal	(Van Niekerk & Still, 2002)
	3.2.5. Control of invasive alien vegetation	South Africa	(Mukheibir, 2008; van Wilgen & Wannenburgh, 2016)
Demand-side initiatives	3.3.1. Progressive water tariffs	South Africa, e.g. Cape Town	(Mukheibir, 2008)

	3.3.2. Greater Hermanus Water Conservation Programme	Hermanus Municipality	(Gumbo, 2004; Tobergte & Curtis, 2013)
	3.3.3. George Local Municipality Drought Response Initiatives	George Municipality	(Baatjies & Hendrickse, 2015)
	3.3.4. Greenest Municipality Competition	Western Cape Province, e.g. Overstrand Municipality	(WCG, 2013)
Adaptive frameworks / planning tools / approaches	3.4.1. Durban's adaptive water governance system	eThekwini Municipality	(Hordijk et al., 2014; Sutherland et al., 2014)
	3.4.2. Handbook on Adaptive Management Strategies and Options for the Water Sector in South Africa under Climate Change	South Africa	(Schulze, 2011; Stuart-Hill et al., 2012)
	3.4.3. Sustainability Index for Integrated Urban Water Management (SIUWM)	South Africa	(Carden & Armitage, 2013)
Structured applications of AM	3.5.1. A Planning Framework to Position Rural Water Treatment in South Africa for the Future	South Africa, e.g. Ilembe Water Supply Scheme of Umgeni Water	(Techneau, 2006; Swartz, 2009)
	3.5.2. The Municipal Support Initiative: Capacity-Building Campaign to Support Catchment Resilience in Municipalities	Limpopo Province: Maruleng and Ba-Phalaborwa Local Municipalities	(AWARD, 2016)

20.2 Appendix 2: Detailed Generic Adaptive Planning Process