The South African polycentric water resource governance-management nexus: Parlaying an institutional agent and structured social engagement.

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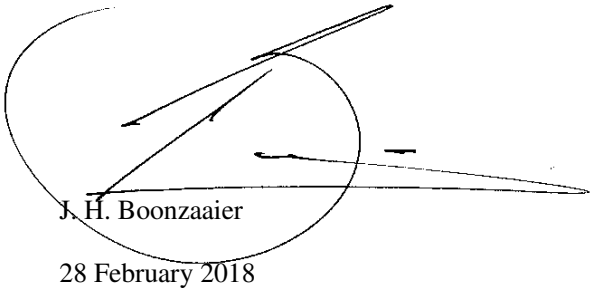
DECLARATION

I, Johann Hendrik Boonzaaier, herewith declare that this study is my own original work, executed by myself under the guidance by Prof. A. C. Brent. It has not been submitted at another university.



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ABSTRACT

Water resource concerns, coupled with subsequent intensive needs for energy and food production along with the greatest deterioration of ecosystems seen during the last 50 years were identified as a global crisis in the 20th century. The World Economic Forum rated the world water supply crisis as the fourth most worrying global risk in terms of risk likelihood and risk impact. Natural water resources are seriously threatened by the growing population, outstripping the capacity of the earth to produce subsistence for human beings. South Africa is restricted as a water scarce country. Despite its progressive water laws and policies, a review undertaken for Africa Water Vision 2025, revealed many critical shortcomings and failures. Evidence reveal that critical constraints in the governance-management process of implementing environmental policies and WRM care lie in a lack of efficient trans-disciplinary dialogue between policymakers, scientists, water managers and users and governance structures. To address the governance and institutional void, the fundamental research question sought to determine whether a local institutional agent could be parlayed to bridge the fragmentation between multiple users and governmental institutional structures and levels. Through longitudinal action research, the unique case of a mature self-steering local water management institution, the Impala Water Users Association in the Pongola River catchment in northern KZN of South Africa was evaluated. The study examined engagement with local stake holders to execute water resource governance and management in a polycentric multi-stakeholder scenario in South Africa. It aimed to restore and protect the resilience of the natural environment that is critical for fresh water resources to ensure sustainable long term water security of the Pongola River catchment. A number of vulnerabilities and weak points of society as well as spheres of governmental authorities were identified. While South Africa experiences an era of institutional and governance uncertainty, it was demonstrated and is submitted that the well positioned water users' associations in South Africa could fill the governance-management void left on a catchment scale. A polycentric approach to govern and manage water as a common pool resource was possible through the facilitation and structured engagement of a stable and suitable agent. While it is acknowledged that multi stakeholder engagement and water resource management is highly complex and taxing, it is argued that cooperative action among users can succeed in achieving many mutual water security goals and solving their immediate threats on the local scale. A polycentric institutional model is proposed by linking different role player clusters around a specific facilitating institutional agent.

Key terms: Institutional agent, polycentric governance, water governance, water resource management.

THESIS SUMMARY

In the modern era of the Anthropocene, humans created a paradoxical and concerning phenomenon. The natural water resources that sustain life on earth are seriously threatened by those who are totally dependent on it. As far back as 1798, Thomas Malthus realised that the power of a growing population was far superior to the capacity of the earth to produce subsistence for human beings. Water resource concerns escalated into a global crisis in the 20th century because of increased competition for water due to an exploding world population coupled with subsequent intensive needs for energy and food production. The Millennium Ecosystems Assessment of 2003 reported that ecosystems had deteriorated during the last 50 years more than at any other time in history. More recently, the World Economic Forum rated the world water supply crisis as the fourth most worrying global risk in terms of risk likelihood and risk impact. The seriousness of declining freshwater quality and short supply could replace the need for oil as the major crisis on earth.

South Africa is restricted as a water scarce country. Despite indications that South Africa has promulgated some of the best and most progressive water laws and policies, a review of key challenges and progress in water resource management (WRM) in South Africa, undertaken for Africa Water Vision 2025, revealed many critical shortcomings, failures and poor leadership. These are in accordance with the concerns of many South African researchers and practitioners that call for a more nuanced and practical approach to governance challenges in the water resource arena. Experience and evidence show that critical constraints in the governance-management process of implementing environmental policies and WRM care lie in a lack of efficient trans-disciplinary dialogue between policymakers, scientists, water managers and users and governance structures.

To address the governance and institutional void, the fundamental research question sought to determine whether a local institutional agent can be parlayed to engage and bridge the fragmentation between multiple users and governmental institutional structures and levels.

A qualitative theory building case study through longitudinal action research was conducted from 2014 to 2017. The research assessed whether a strategic positioned institutional agent can be parlayed to facilitate and execute water resource management on catchment level by engaging multiple stakeholders in a polycentric multi-stake holder setting. Through a critical realist approach a distinction was made between *ex ante* self-deterministic human behaviour in the realist realm, and *ex post* governance-management in the constructivist realm. A congruence analysis, including Toulmin's method of argumentation analysis, was utilised. Using the "Trialogue model of governance" as the theoretical basis, a polycentric institutional model is proposed by linking different role player clusters around a specific facilitating institutional agent.

This study attempted to answer the fundamental research question by evaluating the unique case of a mature self-steering local water management institution, the Impala Water Users Association in the Pongola River catchment in northern KZN of South Africa. The said Association exploited conducive circumstances to execute WRM on a catchment basis. It aimed to restore, support and protect the resilience of the natural environment that is critical for fresh water resources to ensure sustainable long term water security of the Pongola River catchment.

The study identified a number of vulnerabilities and weak points of society as well as spheres of governmental authorities. It demonstrated that a polycentric approach to govern and manage water as a common pool resource was possible through the facilitation of a stable and suitable agent. Structured engagement by continuous informing and educative consultation became a learning process both for the community of resource users and resource managers themselves.

While South Africa experiences an era of institutional and governance uncertainty, it is submitted that the well positioned water users' associations in South Africa could fill the governance-management void left on a catchment scale. While it is acknowledged that multi stakeholder engagement and water resource management is highly complex and taxing, it is argued that cooperative action among users can succeed in achieving many mutual water security goals and solving their immediate threats on the local scale.

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ACRONYMS and ABBREVIATIONS

CER	Centre for Environmental Rights
CMA	Catchment Management Agency
CME	Compliance, monitoring and enforcement
DDG	Deputy Director General
DG	Director General
DEA	Department of Environmental Affairs
DMR	Department of Mineral Resources
DoA	Department of Agriculture
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EO	Environmental officer
GWP	Global Water Partnership
IA	Institutional agent
IAP	Interested and affected parties
IWRM	Integrated Water Resource Management
MDG	Millennium Development Goals for 2015
MoU	Memorandum of Understanding
MSP	Multiple stakeholder platform
NGO	Non-governmental organisation
NWA	National Water Act, Act 36 of 1998
NWRS	National Water Resources Strategy
PAJA	Promotion of Administrative Justice Act, Act 3 of 2000
PDI	Previously disadvantaged individual
PMG	Parliamentary Monitoring Group

PROBA (Afrikaans acronym) The Pongola River Catchment Protection Association

RMDEC	The Regional Mining Development and Environmental Committee
SAAFWUA	South African Association for Water Users Associations
SADC	South African Developing Community
SDG	Sustainable Development Goals for 2030
SES	Socio-ecological system
WARMS	Water Authorisation Register Management System
WC/WDM	Water conservation / water demand management
WITS	The University of the Witwatersrand, Johannesburg
WMA	Water Management Area
WMI	Water Management Institution
WR	Water resources
WRM	Water resource management
WSA	Water Services Act, Act 108 of 1997
WSA	Water Services Authority
WSP	Water Services Provider
WTW	Water treatment works (treatment and provision of potable water to humans)
WUA	Water Users Association
WWF-SA	The World Wide Fund for Nature – South Africa
WWTW	Waste water treatment works
ZDM	Zululand District Municipality

1. INTRODUCTION AND UNDERLYING FOUNDATION

1.1 INTRODUCTION.

It is common knowledge that on a global scale environmental resources and, in particular, water supply is increasingly under pressure and is threatened as a result of the technologically advanced and developing industrial world (Ashton et al, 2006; Biswas, 2004; Falkenmark, 1989; Falkenmark, 2011; Funke et al. 2007; Muller, 2015; Scnellen and Schrevel, 2004; Tschakert and Dietrich, 2010). This phenomenon is referred to as the new epoch of the Anthropocene (Ferweda, 2012; Norström et al. 2014; Nykvist, 2014; Steffen et al. 2007; Tarolli et al. 2014).

According to the anthropogenic view, humankind is the most important centre of existence and is characterised by contrasting sentiments. Human beings exploit precious natural resources for their own benefit and/or livelihood in their quest for development. Business management systems are primarily concerned with financial performance and maximisation of shareholder wealth, but are less involved with the impacts on the environment (CDE[1], 2010; Labuschagne and Brent, 2005). In this way, the Anthropocene epoch has left a significant footprint on the planet by altering topography, affecting ecosystems and causing climate changes, which in turn has resulted in large planetary-scale changes in biological and ecological processes. The Millennium Ecosystems Assessment of 2003 reported that during the last 50 years, ecosystems deteriorated more than any other time in history (Haywood et al. 2010). Concerning environmental resilience and water resources, the World Economic Forum announced that the world water supply crisis presently ranks as the fourth most worrying global risk; firstly, in terms of risk likelihood and secondly, risk impact (Hedden and Cilliers, 2014; Howell, 2013). The situation is aggravated by the fact that water resource degradation is, to a large extent, the consequence of well-intended practices such as the use of fertilisers and pesticides in food production as well as coal mining for energy, which are carried out to support and enhance human livelihoods.

Without their realising it, the chronologically ordered writings of a number of scientists have noted a disturbing trend regarding natural water resources and their supporting environment. The concerns of a few prominent authors are thus highlighted.

As far back as 1779, Thomas Malthus wrote that the most dreadful resource of nature appeared to be famine (Elwell, 2009; Malthus, 1798:5). Even during his time, Malthus realised that the power of

[1] The Centre for Development and Enterprise (CDE) is one of South Africa's leading development think-tanks, focusing on vital national development issues and their relationship to economic growth. Through examining realities, CDE formulates practical policy proposals for addressing major social and economic challenges.

population was greater than the capacity of the earth to produce subsistence for humankind and that a premature death would befall the human race. In his "*An Essay on the Principle of Population*" written in 1798, Malthus posited that: "*A great law of necessity which prevents a population from increasing in any country beyond the food which they can either produce or acquire is a law so open to our view, that we cannot for a moment doubt it*" (Malthus, 1798: 11, 15, 32). He further stated that although the different modes that nature takes to prevent or repress a redundant population cannot be predicted, the prediction of "*the fact*" is certain. In essence, Malthus was concerned that population growth on earth would be restricted by available resources.

Water is one such resource: food production, as a prerequisite to preventing famine and sustaining life on earth, is totally dependent on water.

In 1968, Garrett Hardin explained his view of governance and greed in his "*Tragedy of the Commons*"; he declared, *"The population problem has no technical solution; it requires a fundamental extension in morality*" (1968). Referring to Malthus's logic, he posited that in a finite world, the share of the world's goods per capita must steadily decrease. Based on human nature, the reality is that whenever a new view or solution is proposed, it becomes the target of conflict and defeat when its opponents discover flaws in it.

After Malthus, 210 years later in 1989, Malin Falkenmark, after studying the massive water scarcity threatening Africa, asked why it had not been addressed (Falkenmark, 1989).

Falkenmark (2011), 22 years further on, referred to the problem as a global crisis. She contended that because of the increased competition for water resources as a consequence of the exploding world population coupled with subsequent intensive needs for energy and food production, the seriousness of declining freshwater quality and its short supply, would replace oil as the major crisis on earth.

In South Africa, the National Council for Scientific and Industrial Research (CSIR) at its 2008 conference, "*Science Real and Relevant*", prevented Turton (2008) from delivering his keynote address. Turton attributed the regression of resources and services in the water resource arena of South Africa to a critical shortage of leadership and skills; what he referred to as the "ingenuity gap", the concept developed by Homer-Dixon (cited by Turton, 2008).

Schreiner (2013), a former Chief Director in the Department of Water and Sanitation (DWS), raised concerns about poor performance and regression of resources and services and asked why the new South African National Water Act (NWA) has been so difficult to implement.

The theme that runs through the above chronology is concern about the risks that a water scarcity as a consequence of exploitation and neglect may hold for future generations. Many recent publications in the natural water resource arena sound an urgent reveille on a number of relevant topics; these include the maturing of aspiration as a paradigm to practice (Pahl-Wostl et al. 2011); reconfiguration of environmental expertise (Sörlin, 2013); a trans-disciplinary mode as a new mode of governing science (Maasen and

Lieven, 2006); pressing for reconfiguring actions towards polycentric thinking against the backdrop of progressing global warming (Muller, 2012b; Ostrom, 2012); mapping out the contours for a more resilient global future (Gerst, et al. 2014); and projecting and drawing up future possibilities for the future of South African water (Claassen et al. 2013; De Villiers and De Wit, 2010; Hedden and Cilliers, 2014).

To narrow down this very wide and complex arena and attempt to create a narrow focal point, an outline and dissection of different vital role players, drivers, and entry points is of vital importance.

1.2 Balancing the dynamics of the main interdependent role players around natural water resources

On a broad base, the main role players in any country competing for natural and water resources, as illustrated in **Figure 1**, are: industry, human livelihoods, and the environment itself; each is driven by its own needs and objectives. Through co-existence, in pursuit of providing for developing modern day needs, the role players endeavour to weigh and balance a sound and sustainable environment with industrial resources by exploiting development and human livelihoods. This phenomenon forms a very complex system of systems, referred to as a socio-ecological-system (SES) (Bohensky, 2006; Du Plessis, 2008; Ebbeson, 2010). It faces unique challenges, in co-existing dynamics, maintenance or building sustainability and resilience (Burns and Weaver, 2008 p.22).

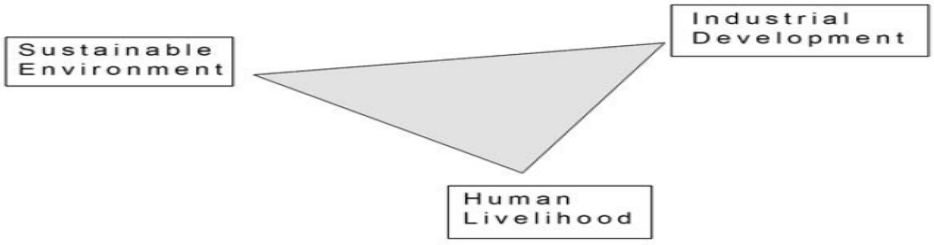


Figure 1: An illustration of the three main co-existing role players in competition that strive for a balance to maintain life on earth (Author).

The main role players within the socio-ecological-system are in constant moving dynamics to balance underlying forces. This involves different dynamics within each component (endogenous), but also between the components (exogenous). An example follows:

- Industrial and mining development: dynamics such as finance, shareholder wealth, and physical infrastructure established for livelihood.
- The environment: maintenance of resilience in delivery and execution of ecological services and provision of exploitable resources.
- Human livelihood: the development of people and communities with internal dynamics, utilising the other role players, subject to beliefs, culture, religion, perceptions and power plays.

1.3 Deterioration of natural water resource systems in South Africa

South Africa is a country blessed with huge reserves of many forms of natural resources, but is restricted as a water scarce country.

In terms of the South African Constitution and legislation, water, as a common pool resource, needs to be governed through the DWS as the governmental authority and the custodian of water resources of the country (Government of South Africa, 1996, 1998a). It is to be supported by lawful institutions that are vested with appropriate powers and responsibilities. Numerous publications have noted that South Africa, influenced by international best practices and standards, has a number of the best and most progressive water laws and policies in the world (Ashton, et al. 2006; Bohensky, 2008; Bourblanc, 2012; Schreiner, 2013; Smit, 2010; Uys, 2008).

Despite the provisions in the South African Constitution, regulations and law, with the associated principles and tools that hold promise for the coordinated development and management of resources, the practice of such systems has not yet found definition and application (Uys, 2008), and has had a poor record of successful implementation (Anderson et al 2009; Schreiner, 2013). The latter became very apparent with the reference to the following incidents in which the author was involved:

- The National Water Resource Strategy (NWRS) was only revised and updated in 2013 (DWAF, 2004; DWA, 2013a). Workshops and consultations in this regard were held during 2015. Such a NWRS2 implementation planning workshop of the 9 strategic actions set by the NWRS2 was held in March 2015 in Pretoria[2]. The acknowledgement and incorporation of the third tier in the institutional framework, the water user associations, were not done: they were largely omitted as a collaborator or as part of the implementation mechanism.
- During the two efforts in the process to establish a CMA in the Province of KZN, first during 2003 to 2005, the Usutu to Mhlatuze CMA and the second during 2013 to 2014, the Pongola to

[2] The author participated in the NWRS2 implementation plan workshop on 2 March 2015 in Pretoria.

Mzimkulu CMA, the role of organised agriculture and the crucial role that WUAs could play were omitted.[3]

- Great confusion and uncertainty were created with the *National Water Policy Review: Updated policy positions to overcome the water challenges of our developmental state to provide for improved access to water, equity and sustainability,* published by the Department of Water Affairs (DWA) in the Government Gazette on 30 August 2013 (Department of Water Affairs, 2013b). Accordingly, with this document, the Minister of DWA endeavoured to review and amalgamate the National Water Act, Act 36 of 1998 and the Water Services Act, Act 108 of 1997 based on claims of, amongst others, the lack of a mandate to develop a national strategy to address certain challenges and cover the entire water value chain.

Evidence reveals that South Africa is rife with the serious and perturbing phenomena of a number of deteriorating factors, such as a decrease in research funding and a loss of experienced and skilled human resources, which have resulted in an ingenuity gap (Turton, 2008); increased water pollution and deteriorating water quality (Ashton, 1999; De Villiers and De Wit, 2010; Driver et al. 2012; Funke et al. 2007; Institute for Future Research, 2009; Segal, 2009; Van Ginkel, 2011); disregard for environmental regulations and protocol, which has resulted in water resource degradation (CER, 2016a; 2017b-c); and a loss of water services and water infrastructure (CER, 2012; CDE, 2010; IRIN, 2009). As many as 60% of South African water ecosystems are threatened; of these 25% are critically endangered (Bohensky, 2008; Driver et al. 2012; Hedden and Cilliers, 2014; WWF-SA, 2017). Water demand forecasts of the National Development Plan for 2030 and the National Water Resources Strategy (NWRS 2) for 2035, have concluded that shortages in South Africa may emerge as the most significant constraint to development. This is in accordance with concerns expressed by De Villiers and De Wit (2010: 11, 22) who highlighted the significant negative effects of mining pollution and global warming on the projected availability of water by 2035.

The abundance of newspaper and televised news, and popular electronic media and programmes about environmental and state failure problems and challenges in South Africa, have created an increasing number of nascent epistemic communities, which has resulted in public outcries. General agreement and discontent among South African communities appears to have emerged concerning basic facts regarding the decreasing quantity and quality of water resources, the degrading and damaging impacts of human activities, especially in industry and mining, and poor service delivery as well as poor maintenance of urban infrastructure (CER, 2015c; 2016a; 2017b).

The latter has resulted in the development of a "social pathology" (Taljaardt, 1997:32) and phenomena of "self-organising networks" (Gooch, 2007 in Turton et al, 2007:124-125) and self-governance in society

[3] The author participated in the process to establish the Usustu to Mhlatuze CMA and the Pongola to Mzimkulu CMA, driven by the DWS regional office in Durban.

when certain thresholds of perseverance have been exceeded (De Villiers, 2012). In such circumstances, society has started to take over and execute numerous functions that would normally be associated with the state (Burns and Weaver, 2008; De Villiers, 2012). Currently, this has become an important consideration in South Africa; clear trends exist in which more and more governmental functions are being taken over by private entities at local levels to counter the inefficiencies of forms of government (AfriForum 2015; 2017(a-d); CER, 2014(f); 2015(b), (e); 2017(c)).

1.4 Rationale of the research

Empirical evidence and research papers that have been previously alluded to, suggested that South African institutional utilisation and leadership are failing to cope with the governance-management challenges posed by natural water resources. Evidence of degradation of ecological services, lack of care of natural water resources and the provision of efficient sustainable engineering services have become common knowledge in South Africa. This situation is aggravated by projections which suggest that future water availability in terms of quality and quantity in South Africa, which is critical to sustain an increasing population, is at risk because of the impacts of global warming, various forms of pollution, and an increase in use. Observation suggests that the water resource domain is dominated by socio-economic issues, such as poverty relief, development and education, and ideological political issues; this is discussed in the chapters that follow.

The natural water resource arena and its management is highly complex (Muller, 2012a). It follows logically that institutions or entities, and their leaders and managers employed to deal with the complexities of the common pool of water resources, should match the resource complexities in terms of skills and competence. The dynamics and competition in this mix regularly require revisiting the drivers of environmental degradation (Hardin, 1968), adjustments of mind-sets, and skills and behaviour for successful co-existence (Dent, 2012; Folke et al. 2002) and revision of management approaches (Muller, 2012a, b).

During the course of time, different models and approaches were developed and proposed to address water resource management (Ansell and Gash, 2007; Boyd et al. 2015; Edelenbos and Klijn, 2005; Lindley, 2014; Muller 2012a, b; Plummer et al. 2013; Pollard and Du Toit, 2008, Turton et al. 2007). The focal areas differed from theory to practical measures, each with its own levels of successes, failures and critiques; some were driven by the pure need to be published in scientific papers and others to resolve crucial practical needs.

Considering the vital role played by water in the food-energy nexus, growing populations, increasing agricultural and industrial water needs and climate change and poverty alleviation, Falkenmark (2014)

argued strongly that the ability to efficiently manage every available source of water is of primary and urgent importance before one can attempt to improve the socio-economic landscape.

Experience and evidence indicate that critical constraints in the governance-management process of developing and implementing environmental policies lie in the nature and levels of dialogue between policymakers, scientists, water managers and users, and in the appropriateness of efficient governance structures. The way of practising science and its subsequent influence on informing policy and implementation needs adjustment (Burns and Weaver, 2008; Turton, 2008). This can be adequately dealt with only through strong and suitable governing institutional arrangements on suitable levels so as to interpret and create favourable conditions (Dietz et al. 2003; Ostrom, 2002 in Muller, 2012b) by employing trans-disciplinary collaborations as both a tool and an activity (Max-Neef, 2005).

Important factors should be considered in the set-up of an organisational system to address water resource management (WRM) as a common pool resource under challenging conditions, in order to ensure success (Balsiger and Debarbieux, 2011; Dietz et al. 2003, Muller, 2012b). Subsequently, relevant contextual questions may be posed.

Firstly, to what extent should there be fragmentation or coherence across the different governance levels that affect the natural water resources domain and support or restrict efficient governance? Secondly, what management instruments and low cost structures will enhance or hinder trans-disciplinary collaboration and service delivery in the domain of natural water resources? Thirdly, what institutional arrangement should match the complexity of WRM to cope with the intrinsic governing-management challenges required for WRM on local levels where the deteriorations are experienced? Furthermore, what level and scale will be relevant for such a suitable institutional setting relevant to WRM? Finally, does a "face-to-face communication and network" create a sense of collective belonging conducive to efficient WRM in a particular context such as a river basin?

Specific inspiration for guidance on answering the latter, particular questions for this research that led the main line of investigation and results, was obtained from three specific sources. The first and second were from South African authors, known for their involvement and expertise in the South African water and resource management domain, while the third was an international source. Firstly, Mr. Mike Muller, the former Director General of DWAF (Muller, 2012a, b, 2015). Secondly, Dr M. Dent from the University of KwaZulu Natal, South Africa who was enquiring into the new dispensation of the South African natural water resource management domain (Dent, 2012). The third source was the evaluation and governance assessment model of Van Rijswick et al. (2014). Guiding questions from Van Rijswick et al. and Dent, presented in **Figure 2,** are used to compile deductive propositions about the conceptual model.

Within the natural, political and institutional environment in which the natural water resource domain is situated, this study focused on the catchment level, alternatively in layman's language, known as the grassroots level where the resource's use, abuse and deterioration are taking place and being experienced.

In this study, there was an attempt to address this serious shortcoming in local natural WRM in South Africa by means of:

- Dissecting and synthesising the drivers affecting the concepts or constructs of the governance-management nexus in the natural water resource environment;
- Investigating the role and applicability of a facilitating institutional agent that has crucial leadership; and
- Investigating the functioning of a trans-disciplinary polycentric model through facilitating structured engagement.

It was postulated that subjective normative knowledge and values, and objective empirical knowledge and values in, and between organisational collaboration and relevant role players, could be bridged. Accordingly, this study would be applicable to, and contribute to limitations in, local natural WRM in South Africa.

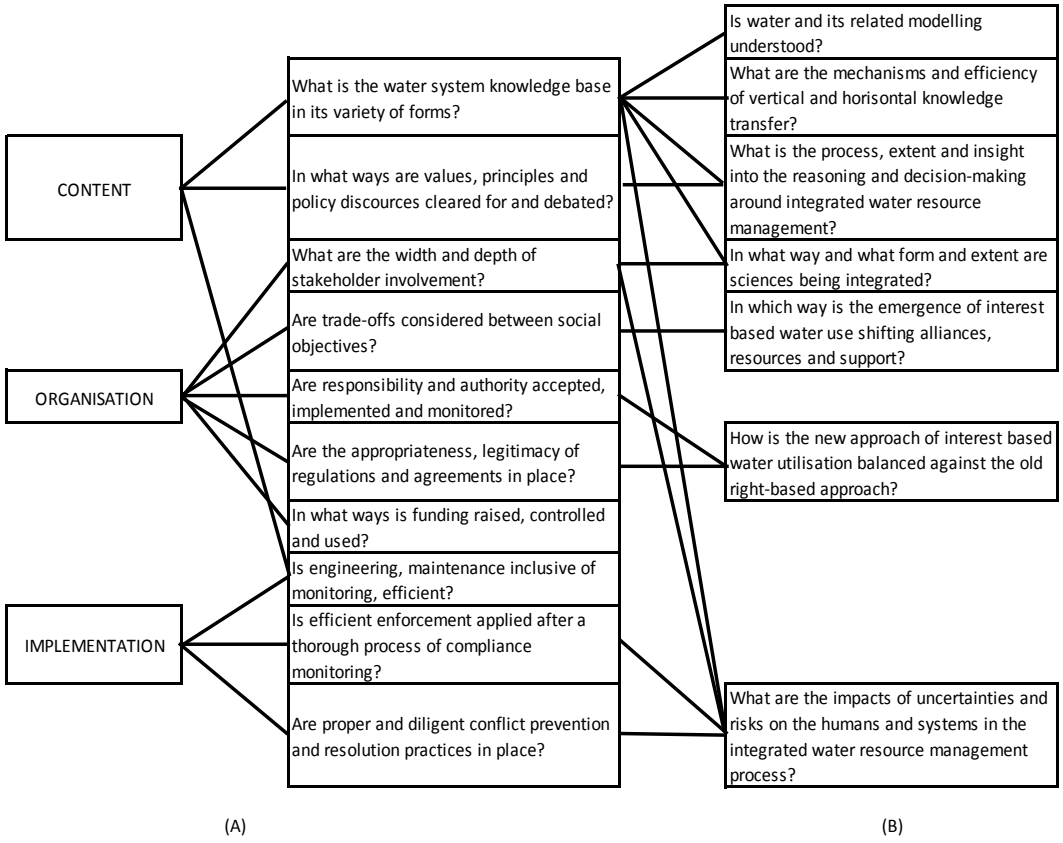


Figure 2: A list of critical guiding questions for this study, inspired from the studies of two researchers to evaluate and determine the role and efficiency of a local institutional agent in water resource management.

Sources: (A) Van Rijswick et al. 2014; (B) Dent (2012).

1.5 The research problem

The empirical evidence alluded to above reveals that in South Africa there may be the neglect of an existing institutional framework or setting, as well as the lack of a suitable model that describes an efficient setting to execute and facilitate local natural WRM.

Such a model should describe trans-disciplinary collaborations between multiple role players from various levels of power, knowledge and motives in the local, pluralistic, South African, natural water resources domain. Such domain challenges include different contextual issues, such as the technical and physical nature of the water resource, the organisational context and design and the socio-economic and political dynamics thereof.

The intended outcome of such a model is to constructively and closely bridge and facilitate the divergent needs of critical role players, from the grassroots levels of users and polluters to the authoritative levels of formal government.

A noteworthy, but imprecise utilisation of the terms governance and management by practitioners has been observed in the current environmental debate between and within crucial lower levels of role players interfacing in South Africa. This contributes to a number of disciplines being grouped in the WRM domain, which not only results in a poor comprehension of needs, motives and roles amongst them, but also in an evasion of care and responsibilities. A clear apportionment in the application of the intrinsic and subtle distinctions of a governance-management nexus in WRM may contribute to improved role-player interfacing and sustainable constructive and progressive resource care.

As described by the Trialogue model of governance developed by Turton et al. (2007), engagement involves a diverse range of parties with different core businesses, knowledge and prowess in dealing with the intrinsic nature of water resources governance and management. In practice, though, the engagement process and debate is experienced as fundamentally skewed.

A suitably positioned facilitator can initiate and manage constructive integrated and multi-disciplinary problem identification, analysis and solution synthesis through the ability to manage every available source of water efficiently, at least at grassroots level, while the extremely challenging and ever continuing social issues may still remain to be resolved.

1.5.1 The fundamental research question.

The fundamental research question sought to determine whether a local institutional agent could be

parlayed[4] (Cambridge Dictionary, 2015) to efficiently bridge a fragmentation in governmental institutional structures and levels, so as to engage with local stakeholders to execute cost effective water resource governance and management in a polycentric multi-stakeholder scenario in South Africa.

Three sub-questions supported the context of the fundamental research question.

1.5.2 Research sub-question One.

What different drivers play a role and exert influence on the complex natural water resources domain?

1.5.3 Research sub-question Two.

What role does governance and management play in maintaining sound and sustainable water resources in a multi-stakeholder setting?

1.5.4 Research sub-question Three.

In what way must a local institutional agent, in the current South African institutional framework, be parlayed to engage with polycentric multiple stakeholders to execute governance and management of natural water resources in a catchment?

1.6 Research strategy

1.6.1 The approach

Academic research, unique in its character, is an investigation into a phenomenon so as to yield a contribution to knowledge and, consequently, aims to contribute to new knowledge and understanding of matters in our world, no matter how small (Hart, 1998:24). To create and justify knowledge, humans adopt sets of beliefs and discourses about phenomena that form their paradigms about "what is real" and "what

[4] Parlay – derived from gambling. To turn or develop an initial stake, advantage or skill into a larger stake or something better.

exists". Two ways of justifying knowledge are by logic such as mathematical facts, and experience such as empirical phenomena and evidence (Bendassolli, 2013). It is, therefore, important that the philosophical concerns and approach of the researcher need to be clear before a strategy and method can be decided (Scott, 2005).

Empirical evidence plays an important role in the blending of findings and reasoning in the confirmation or rejection of an existing theory or development of a new theory (Bendassolli, 2013).

In search of knowledge, ontology is the view of the nature of reality. Ontology is a description concerning how the researcher sees and accepts what exists or what is real. Ontological beliefs determine the framework or epistemology of how the reality of what is about to be studied can be known. Such a framework describes how we can know or obtain knowledge about what there is to know. Major research ontologies, referred to differently by various researchers, are realism (or positivism), relativism and critical realism (Dieronitou, 2014; Tsoukas, 1994).

Realist or positivist ontology describes and accepts the existence of real facts and objects objectively, independent of the human mind. The realist is in essence reductionist and accepts that there is what there is. Relativist ontology focuses subjectively on reality as social constructions of human actions and consequences. Critical realist ontology pairs realist ontology with relativist epistemology and, therefore provides the opportunity that causality can be investigated and used to describe phenomena (Easton 2010; Scott, 2005). It can introduce notions of objectivity to a certain reality which is deterministic, but also allows for the emergence of what proposition is required to describe phenomena in open systems that are affected by deterministic reality (Scott, 2005). From a philosophical point of view, Kant (1795: viii) distinguished between "nature" as a mechanical phenomenon and providence, which transcends sense-experience. He argued that knowledge or a priori or deductive principles of reason can only be developed in the sense-experience realm (Kant, 1795: ix). The theoretical justification of knowledge is established through practical reasoning in a dogmatic form of imperatives affecting the will, which Kant described as the recognition of the precepts of duty. The view of the reciprocation between the mechanical (the positivist component) and sense-experience (the relativist component) conforms to the critical realist approach of the realist and constructivist realms.

In qualitative studies, ontology of relativism is normally employed as the approach. As the anathema of positivism, relativism is a search for meaning rather than truth. It implies that there are multiple interpretations of reality that can neither be false nor true (Dieronitou, 2014). Relativism believes that multiple truths exist that are dynamic and contextual, which may be conflicting and change over time, but may still be true. It also argues that multiple constructs are created about reality, which are influenced by the experiences and interactions of the researcher and or between human beings.

Derived from Greek, epistemology refers to the relationship of the researcher to what is known. The epistemic approach determines how the reality ought to be studied and what kind of meaning can be

ascribed to it, in order to regard the reality as proper knowledge (Dieronitou, 2014; Tennis, 2008). Constructivism, as an epistemological approach, relies on inductive logic by arguing from the particular to the general. Constructivism believes that meaning and a multiple of realities that can be considered to be correct are interactively and transactionally constructed and are based on interactions with the social environment. Therefore, it is influenced by the social, political, cultural, ethnic and economic values of society.

Qualitative studies are useful to provide an in-depth investigation that relates to a social context involving governance and management phenomena and to convince one that such knowledge is applicable and can be generalised (Bendassolli, 2013; Blumberg et al. 2008, pp 192-193; Flyvberg, 2006; Johnson and Onwuegbuzie, 2004; Scholz et al. 2006; Welman et al. 2010, p. 188).

In such cases, the quantification of information is not always possible or desirable in order to obtain and interpret the meaning and context accurately.

Qualitative researchers obtain logic by means of induction from a posteriori[5] empirical experience while quantitative researchers do so from a priori deductive phenomena. A difficulty with inductive reasoning with respect to empirical observations when in the process of developing scientific theory, is purported to be a "leap" from the empirical visible to the invisible theory and the belief about cause based, for example, on recurring events. Notwithstanding, Popper (1959) argued (in Bendassolli, 2013) that observation and perception themselves, being driven by expectations and experiences, cannot exist without theory. Theory must, therefore, be rejected or confirmed by experience or observations; this is the intrinsic way the dynamics in the world work. In essence, according to the authors cited in Bendassolli (2013), theory may have nothing to do with truth or the approximation to facts, but provides the capacity to assist in a presentation of paradigms and solving challenges of practical interest.

Strong theory, a set of propositions or systematically interrelated concepts to explain or predict phenomena, is characterised by a growing set of observed data (Bendassolli, 2013; Schermerhorn, 2008:24-25), and the possibility of seeing and sensing the conditions in which the major proposition or hypothesis is most or least likely to hold (Sutton and Staw, 1995; Tennis, 2008).

Although the traditional reductionist methods based on a realist ontological approach do not provide an adequate framework for understanding a qualitative study such as water resource management (WRM) within the framework of a social ecological system (Burns and Weaver, 2008), Tsoukas provided an excellent presentation of a realist ontology of management (Tsoukas, 1994) supported by a critical realist approach in case study research in marketing (Easton 2010) and education (Scott, 2005).

[5] An "a posteriori" statement is made on the basis of experience or evidence. An "a priori" statement is independent of experience or before evidence is obtained.

Inspired by the work of Mintzberg and Tsoukas (Kumar, 2015; Mintzberg, 1971; Tsoukas, 1994) and founded Sutton's and Staw's (1995) notion of promoting the extension of reasoning and development of new conceptual arguments other than those which empirical data might justify, the author proposed a critical realist approach in conducting this study.

He began with a realist argument that the nature of being and individual self-determining behaviour is triggered and driven by internal psychological forces (a reality). This deterministic human behaviour needs to be tamed and steered, especially when groups of humans (organisations) and their activities start to become important, so as to act in an orderly way for the mutual benefit of all through avenues constructed by humans (governance and management).

Causality questions what makes things happen and what leads to certain events. In the current situation, one could ask what leads to poor governance or what the causes of water resource degradation are. The latter are visible empirical outcomes.

One may question whether the research problem lies in the "relativist or constructivist" domain: the institution and the rules or, with the behaviour of the person, in other words, the realist reality. From the perspective of the realist reality, it can be argued that "a reality", that is, the individual behaviour of a person, which is also influenced by social behaviour, causes events to happen through its power and/or ability (Easton, 2010; Scott, 2005). Human beings are learning agents who have powers and the capacity for self-determination to learn from their actions and change their behaviour to adapt and persist. Furthermore, it can be argued that there are two entities involved in the phenomenon: parts of the same structure and the internal behaviour of a part in one encompassing structure, such as a person in an organisation or two separate entities who have an external relation to each other; for example, a person and an organisation. Consequently, the reasoning may be extended to how it manifests itself to deal with the complex challenges of the natural water resource environment in South Africa by a facilitating agent through multiple stakeholder platforms (MSP) and a polycentric setting. These human constructs should be studied from a constructivist epistemological perspective because the empirical context suggests that emergent and changing properties such as social learning and adaption within and between the entities, the person and the organisation exist. The causal relationships between the entities are both necessary and contingent as each cannot exist or function without the other. The critical realist approach is supported by the arguments of Bellah (1991) and Drucker (1995) in Turton et al (2007:97, 201), that the management of organisations and agencies involved in eco systems, is embedded in the beliefs, values, morals and ethical concepts of the role players involved. These are, amongst others, determinants for the mission statements and core competencies of organisations.

According to Bhaskar (in Tsoukas, 1994; in Easton, 2010), an empirical event which is experienced, occurs and is caused because of a mechanism that is active and deterministic in the real domain, illustrated in **Table 1.** In terms of this study, it is argumented to be the intrinsic self-deterministic nature of human

behaviour. Human behaviour in terms of social co-existence is being ordered through human constructs such as governance policies, management and institutions.

Table 1: An illustration of the principle of Bhaskar that empirical events are caused by mechanisms in the real domain.

	Real domain	Actual domain	Empirical domain
Mechanisms	X		
Events	X	X	
Experiences	X	X	X

Source: Tsoukas, 1994.

Toulmin's method of argumentation analysis is another systematic approach to the rejection or acceptance of observations or arguments as proof of foundations of knowledge (Toulmin, 1958 in Hart, 1998, p. 87-89; Kim and Benbasat, 2006; Verlinden, 1998). Illustrated in **Figure 3**, it entails a process of evaluating claims on the basis of evidence; the data that presents the claim. Suitable warrants that form the rational links between the data and claim, backed by the context that supports the validity of the warrant and evidence, need to be offered. Warrants may either be field-invariant, in other words, a pattern of analogy or rule of thumb that the reasonable person would use, or field dependent: a specific domain such as science or law. Finally, a qualifier should be expressed as how true the arguer purports the logic or plausibility of the claim to be.

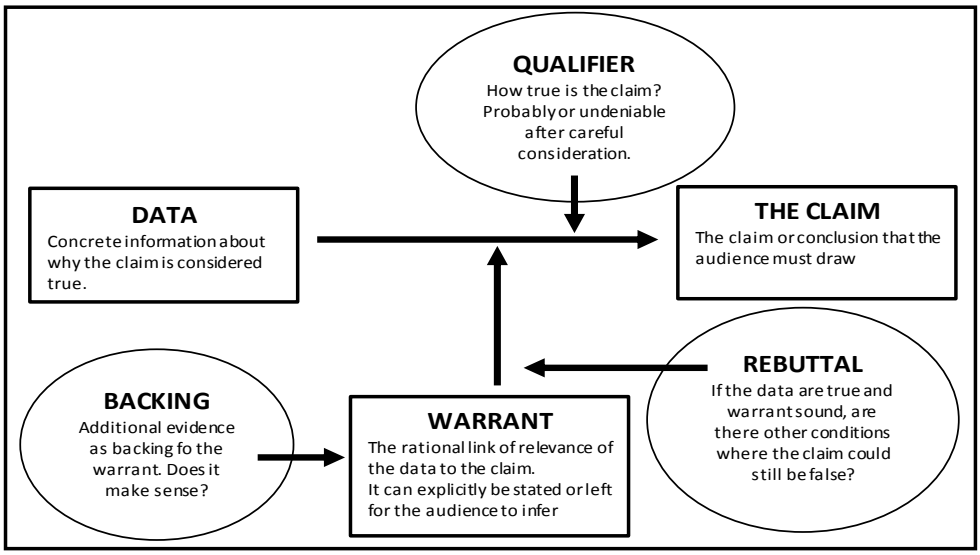


Figure 3: An illustration of Toulmin's systematic model of argument analysis.

Data analysis was conducted according to the model of congruence analysis. This offers the opportunities to draw causal inferences in case studies which are smaller in extent. It validates whether empirical evidence is in congruence with a theoretical model. It is executed through a two-step process. First, specific propositions need to be deduced about the theory under investigation. The deduced propositions then need to be compared with empirical observations. A second step evaluates not only whether the theory and/or its propositions correspond to the empirical observations but also if it displays better empirical congruence than other rival theories. Alternatively, it should predict crucial aspects of the empirical process more accurately than other theories (Blatter and Blume, 2008; Blatter, 2012). The deductive propositions will be guided by the governance assessment model of Van Rijswick et al. (2014), supported by the questions by Dent (2012) presented in **Figure 2** above.

Delineating units of analysis or measurement in the context of the natural water resources environment, the focus of this study, contains the concept of scale, which are widely and diversely described (Balsiger and Debarbieux, 2011).

Scale, that is, the unit of measurement of a case (Yin, 2009:27) or the unit of management and participation, is important when interactions in the water resource arena are considered. It needs to be defined within the context of its use or application (Balsiger and Debarbieux, 2011). When one is focusing on the operational and observational aspects of scale, it is not simply a unit or combination of spatial containers. These would be water basins of the natural environment, which can be considered as the combined natural aquatic, air, topographical terrestrial components and biodiversity landscapes or alternatively, from a reductionist perspective, refer to a specific component; in particular, water. However, intrinsically scale also contains social and political power networks, which determine other boundaries of challenges, with socially constructed material processes and outcomes (Lebel et al. 2005; Rangan and Kull, 2008).

In this study, the delineated unit of analysis or scale of measurement was the water basin or water catchment, which contained both the natural water body and the co-existing socio-economic component, with specific reference to the Pongola River catchment in northern KZN, South Africa.

Knowledge is created and built by means of participating in a living process (McNiff and Whitehead, 2002:18). As the author was deeply embedded in the research content and case, action research was employed. Holwell (in Reason and Bradbury, 2008:153) and Marti and Villasante (2009) regard it as a legitimate research method, through the concepts of recoverability, purposeful articulation of themes and iteration where meaningful assertions should be open to ongoing inquiry. The latter implies that knowledge and experience are inextricably linked (Kandlbinder, 2004 in Marti and Villasante, 2009). Action research allows for personal reflection about views and values developed through dialogue and interaction with a situation and role players (McNiff and Whitehead, 2002:15-17; Whitehead and McNiff, 2006:19, 24-25). This reflection contributes to new insights (Bradbury et al., in Reason and Bradbury, 2008:83, 85), such as in this case, which the author wishes to address. Creating validity is, just as in other research practices,

very important. Validity in action research can be ensured by pursuing a worthwhile purpose, prevention of bias in the participation of the researcher, the ability of the researcher to know and transform reality, allowing a democratic process to allow participation (Marti and Villasante, 2009). By investigating longitudinal practices and applied concepts and approaches through a new interpretation, the author aimed to bring new trans-disciplinary evidence to the fore. This supported the construction of a new concept or models, which would contribute to more effective basin-based integrative WRM down to ground level.

It is submitted that this study and this case has much relevance, according to indicators proposed by Yin (2009:32, 36, 47-50, 185-187):

- This case is the playing out of real life phenomena in South Africa that impact on human beings and nature
- As it revolves around water, on which life on earth depends, it will be of momentous public interest and national importance
- It is a unique case since it has attracted little exposure and investigation, it deals with current developments and is expanding an existing theory
- The study is complete as it considers rival theories and rival entities
- The case is a typical one in a typical catchment setting and is therefore highly applicable (generalizable) to the other 278 ones in South Africa
- The author is deeply involved in the case and uses intrinsic prior knowledge and experience of current thinking and discourse about the topic.

The flow of the research approach and validation is illustrated in **Figure 4**. This illustration follows the argument of Bhaskar (Easton, 2010) and illustrates the development from the realist ontology through to the constructivist epistemology and data validation.

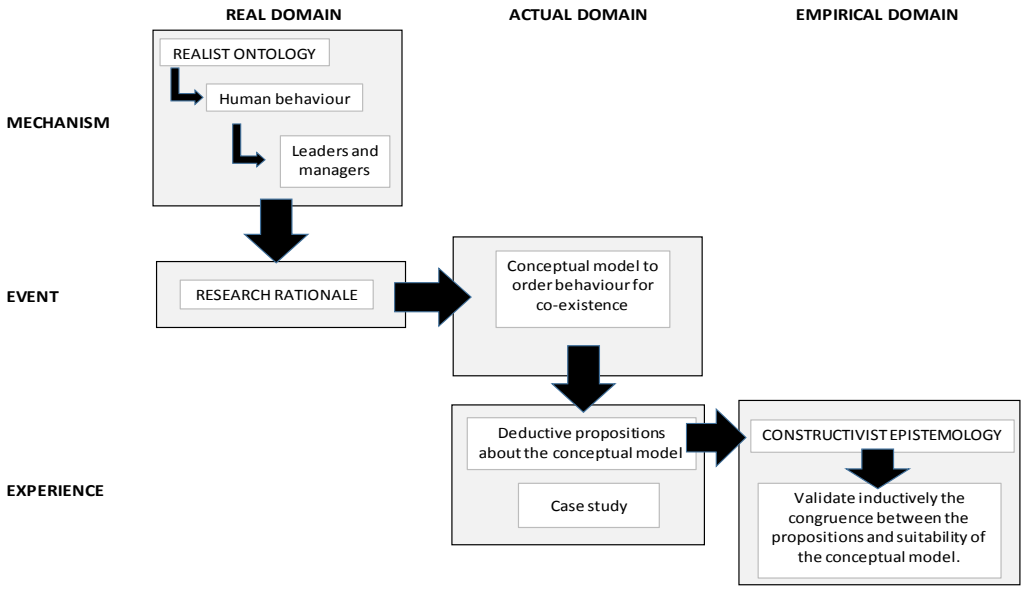


Figure 4: An illustration of the research strategy flow showing the relationship between the realist ontology and constructivist epistemology according to the description of Bhaskar (Tsoukas, 1994).

1.6.2 Sources of evidence

The following sources of evidence were used to conduct the study:

- Primary and secondary literature
- Semi-structured individual interviews
- Semi-structured focused group workshops and
- Case study evaluation of existing real life activities.

With respect to the latter, the following South African case was analysed in depth:

- The Impala Water Users Association in the Pongola river catchment. The author is the CEO of this association and is personally involved in the execution of all numerous local WRM functions.

1.6.3 Summary

The summarised research strategy is presented in **Table 2**.

Table 2: A summary of the research approach followed in this study.

Ontology	Critical realism.
Epistemology	Constructivism and inductive reasoning.
Methodology	Qualitative case study research and use of empirical and case study evidence. Evidence validation by triangulation, reasoning validated by Toulmin's method of argument analysis. Data and conceptual model validation through congruence analysis.
Relevance	Practical and societal values in South African water catchments.
Linkage to theory	Theory building.
Study type	Longitudinal action research.
Participant sampling	Non-parametric purposive quota sampling in the appropriate target domain.
Target domain	The natural water catchments in South Africa in which mature water user associations or irrigation boards are functioning.

Unit of analysis	The Pongola River Catchment in northern KZN, South Africa.

2. LITERATURE REVIEW – Towards a conceptual model to address the water governance-management nexus in South Africa

"Only wholeness leads to clarity

And truth lies in the abyss"

Friedrich von Schiller

2.1 INTRODUCTION

The literature review needs to yield sufficient and in depth arguments containing knowledge-based and argumentation-based elements to justify the execution and content of the study (Hart, 1998:174).

Knowledge-based elements refer to previous work done and lead concepts, definitions and theories provided. The researcher further presents ways in which these elements were developed and operationalised as solutions to the problems under study.

Argumentation-based elements indicate what was incorrect and contradictory in previous work. Alternative concepts that might solve the problem under investigation in the study should be proposed.

Water and water resources in the context of social and ecological services are extremely complex. Water, as a common societal good, is a connector of many sectors in South Africa. Water has no substitute (Dent, 2012; Falkenmark, 1989). Water interconnects many fragmented disciplines and sectors such as agriculture, industry, social development, human livelihoods and ecology. Priscoli (2012, in Muller, 2015) emphasised that the WRM is at the nexus of economics, public policies, nature, ethics, values, beliefs and rational thinking. Accordingly, water is approached, used and treated diversely by the multiple stakeholders who are distributed over different geographical scales, locations and conflicting functional jurisdictions and disciplines (Bakker and Morinville, 2013; Dent, 2012; Merrey, 2008; Molle, 2008; De Villiers and Mkwelo, 2009).

Natural scientists and hydrologists examine watersheds whereas politicians and sociologists investigate "problem sheds" that extend across a watershed boundary. Natural scientists have little understanding and knowledge of social sciences and in turn, social scientists are not very concerned and knowledgeable about environmental sciences (Burns and Weaver, 2008). Because of differences in the contexts of scientific disciplines, it appears that those most concerned about the environment are not able to solve real, practical problems and those that result in degradation that are caused by the needs of society. The consequence of this complexity and challenging nature is that managers and entities working in and with water resources require a specific capacity that matches this complexity to efficiently, sustainably and legitimately resolve the challenges and conflicts of the water sector.

To examine this complex natural water resource and the human, political and institutional environment that surrounds it, the author choose to follow a logical exposition of a number of themes that are considered to form fundamental drivers that exert influence on and affect activities in the natural water resources domain. The topics and interaction of the different drivers are illustrated in **Figure 5.**

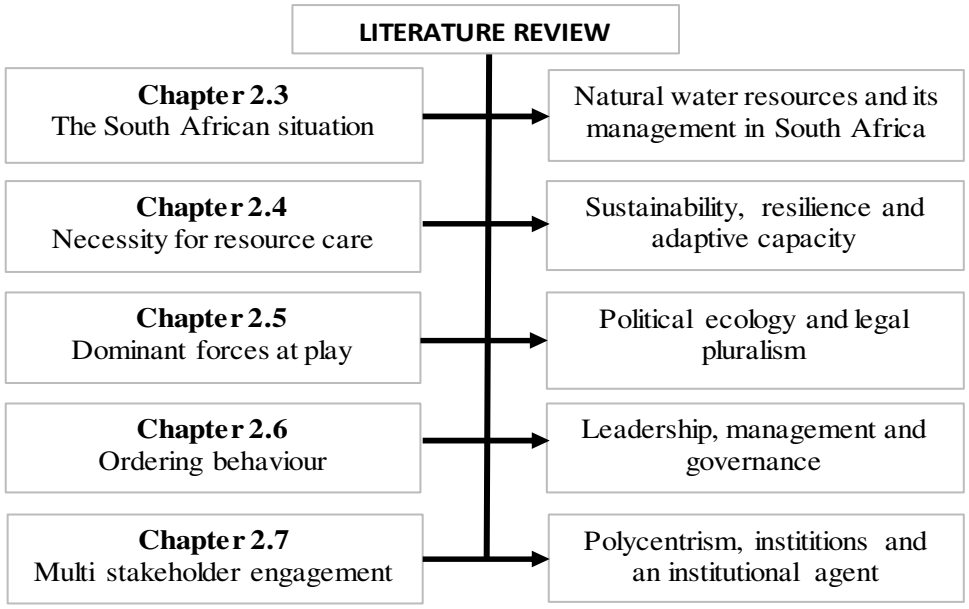


Figure 5: An illustration of the driver themes elaborated on in the literature review that exert influence on water resource management

In the following sections of this literature review, each such driver theme is addressed and examined. All the themes subsequently coalesce into a particular form, which this study employed to answer the research questions.

2.2 LITERATURE REVIEW STRATEGY

Being a systematic process, the objective of the literature review is to obtain a comprehensive and progressive contextualisation of the themes in the water arena in South Africa. Utilising theories and work that have been conducted and developed in the field of study, such a review then reveals and allows an interpretation of what variables are relevant to the subject and further, provides information on what relationships and gaps exist between the existing theories and practices (Blumberg et al 2008, p106; Onwuegbuzie et al. 2012; Welman et al. 2005, p 38).

In a literature review, multiple sources of evidence from different disciplines that are considered closely related to the field of study are obtained and assessed. Such an approach is warranted for three reasons. First, it assists the researcher in understanding the intellectual thinking and traditions that have shaped the ways paradigms and knowledge have developed. Second, the study field addresses a very complex continuum, which involves multiple role players and disciplines that need to co-exist and interact. Studying the different themes in different disciplines creates an intellectual collaborative mind-set to gain insight into the ways in which each interact with, depend on, and enhance or constrain one another. Third, the natural water resource governance and management arena in South Africa is characterised by a dynamic socio-cultural context of role players that are challenged or driven by a particular political ecological view and legal pluralistic norms in which use, rights, interests and behaviours are embedded.

The specific methodology followed to obtain primary and secondary sources of literature relevant to this study for evaluation is presented in **Table 3**, which is a compilation from Blumberg et al. (2008, p 107-133), Hart, (1998, p31, 56, 89, 131), Ongwuegbuzie et al. (2012) and Welman et al. (2005, p42-44).

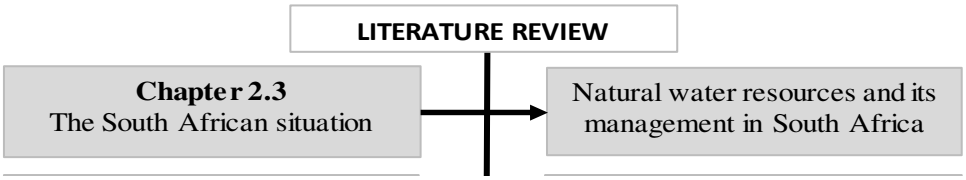
In the assessment of the literature, the following elements, obtained from Blumberg et al. (2008, p 107-133), Hart, (1998, p27), Ongwuegbuzie et al. (2012) and Welman et al. (2005, 42-44), were considered:

- The scope and contextual arguments that were similar to, different from and supported the research question and research context;
- An evaluation of supporting and contradicting arguments; and
- The methods and methodological omissions.

Table 3: An outline of the steps and methodology followed to obtain and evaluate multiple primary and secondary literature sources applicable to and suitable for this study.

Step	**Activity**
Definition of the research question	A consideration of the theme, refined the research question and identified essential arguments
Key terms, topics and authors	Listed key search terms, relevant topics and selected key authors prominent in the field of study
Literature search	Used different academic data bases from the Merensky Library Services of the University of Pretoria for peer reviewed publications Used the internet as well as consulting various relevant organisations for primary reports, press releases and documents Noted documentary TV news debates and topical newspaper articles that are relevant to the field
Identified core publications and formed a foundation	From the essentials of the study, a short list of core publications was selected based on both the topic and well-known authors to guide a more in-depth main narrative and view of work done and relevant theories to form a foundation of knowledge
Filtered for relevance	From the foundation of knowledge, multiple sources of literature were scrutinised for specific relevant topics, representation and legitimacy Representivity refers to the extraction of adequate meaning and the combination thereof from the sources. It was obtained through between-source triangulation, between-source complementarity, between-source development and between-source expansion Legitimation refers to the confirmability and credibility of the assessment. It was obtained through the process of between-source triangulation and between-source initiation. Efforts were made to source a great variety of South African literature in this field
Qualitative literature review	A review was conducted on the filtered sources by applying the following methodologies: Componential analysis, theme analysis, qualitative comparative analysis and narrative analysis
Synthesis of the information	The relevant and supporting meaningful blocks of information abstracted from the assessed body of literature formed the building blocks for the synthesis of a new body of knowledge, which culminated in the new proposed theory in order to answer the research questions

2.3 NATURAL WATER RESOURCES AND WATER RESOURCE MANAGEMENT IN SOUTH AFRICA



"I am ashamed to think how easily we capitulate to badges and names, to large societies and dead institutions."

Ralph Waldo Emerson, Self-Reliance

2.3.1 National water resource management.

Concepts of integrated water resource management (IWRM) in river basins were already being formally applied as far back as 1926 in Spain (Rahaman and Varis, 2005). Over the years, along with the advances in knowledge and science, the concept of IWRM) as we understand it currently, was further developed and refined through a number of international conferences and international collaborations and reports on water and sustainable development.

The United Nations (UN) Conference on Water and the Environment on Water in Mar Del Plata in March 1977, has been viewed as a significant breakthrough; it resulted in IWRM resorting to political and management agendas (Muller, 2015; Snellen and Schrevel, 2004; Rahaman and Varis, 2005; Hipel et al. 2008). This was followed by the Brundtland Commission Report of 1987 entitled *Our Common Future*, which specifically addressed the concept of sustainable development.

The 1992 UN Conference in Dublin, in preparation for the planned UN Conference in Rio de Janeiro in 1992, brought further momentum to the four well-known Dublin principles and led to the establishment of the Global Water Partnership (GWP) in 1996. The GWP defined and developed implementation mechanisms for IWRM (Jonch-Clausen, 2004; Hipel et al. 2008; Medema et al. 2008; Muller, 2015). The second World Water Forum in The Hague, Netherlands in 2000 and the World Summit on Sustainable Development in Johannesburg in 2002 focused specifically on the concept and the further refinement, development and implementation of IWRM, sustainable development and a "green economy". After the Rio+20 summit in June 2012, it appeared however that besides the various summits as platforms, supports insight into resource sustainability issues, no breakthrough in constructive commitment was achieved (Ee Ong et al. 2012).

The IWRM approach is a process that can be implemented at an international, national or regional level. Its methodology and execution cascades from the highest levels down to lower levels of relevance. It is, however, of crucial importance that specific enabling factors are present to enable implementation.

The South African National Water Act, Act 36 of 1998, describes the ultimate aim of water resource management as being "to achieve sustainable use of water for the benefit of all users and [adds] that the protection of the quality of water resources is necessary to ensure sustainability of the nation's water resources in the interests of all water users" (Muller, 2012b). This description very clearly emphasises the resource as the focal point. Ashton (1999) and Funke et al. (2007) described the primary goal and process of IWRM as optimising the relationships between the capacity of the available resource to provide a sustainable service and the use of the resource. The process involves the understanding of complex relationships and the necessity for users and responsible institutions to maintain and care for the water resource in a sustainable way by managing the interrelations between the water resource, land use and the ecosystem. The approach is at a basic level a decentralised catchment approach that links water to the hydrological cycle, the ecosystem and sound land use practices (Falkenmark, et al. 2014). It requires multi-dimensional and trans-disciplinary participation of relevant stakeholders and practices of human activities (Ashton, 1999; Bourblanc, 2012; Falkenmark et al. 2014; Hipel et al. 2008). It is characterised by the need for multiple stakeholder platforms (MSP) to resolve issues pertaining to WRM.

Water resources, their development and management are in essence very closely associated with extreme problematic challenges such as the political, cultural, economic and geographical context of a country or region. It follows logically that approaches will differ from situation to situation (Jonch-Claussen, 2004; Molle, 2008; Snellen and Schrevel, 2004).

Swatuk (2005) cited a number of authors who listed problem challenges which were purported to represent their WRM challenges in the South African Development Community (SADC) countries; South Africa,

Namibia, Malawi, Mozambique, Swaziland, Tanzania, Zimbabwe and Zambia; these are presented in **Table 4.**

A prominent problem in the SADC countries is the significant increase in human populations and distribution and settlement of humans in water scarce areas, which places a strain on available resources and management to provide and maintain the existing infrastructure.

More disciplines and challenges in the WRM arena have been made evident by the literature. This involves the fields of social and political sciences becoming more prominent than those of environmental and engineering sciences (Muller, 2012b, 2015). A number of challenges and topics that have been addressed and are topical in the WRM domain are presented in **Table 5.**

Table 4: A list of water resource management problem challenges that the SADC countries experience.

Inequality of access	Limited financial resources	Declining infrastructure
Poor service delivery	Declining water quality	Institutional fragmentation
Conflicting policies	Stakeholder conflicts	

(**Source:** Cited by various authors in Swatuk, 2005)

Table 5: A list of different challenges and topics that are being incorporated into the domain of WRM

Socio-political	**Natural scientific**	**Managerial/Engineering**	**Policy-regulation**
Political transformation	Natural water resource protection	Water abstraction and use	Planning demand and supply
Social development	Measuring and data collection	Water distribution	Policy and regulation
Human land settlement	Water pollution	Trend analysis and future planning	Water allocations
Unemployment	Resource rehabilitation	Trade-offs	Trans-boundary negotiations
Poverty eradication		Infrastructure development	
Social education and awareness		Green economies	
Protection of minorities		Compliance, monitoring, enforcement	
Access to water		Conflict resolution	

(**Sources:** Dent, 2012; Hedden and Cilliers, 2014; Herhold, 2010; Hoogesteger, 2016; Kemerink et al. 2011, 2013; Merrey 2008; Mollinga et al. 2007; Reay 2013; Turton et al. 2007, 2008).

From the background described above regarding the nature of WRM and its relation to political, cultural, economic and geographical contexts, an understanding of the rationale of GWP in its founding three conditions that must be established for implementation is evident. They are described as the three pillars of IWRM illustrated in **Figure 6**, which are needed to balance the natural water resources in terms of water as a resource and water for livelihoods.

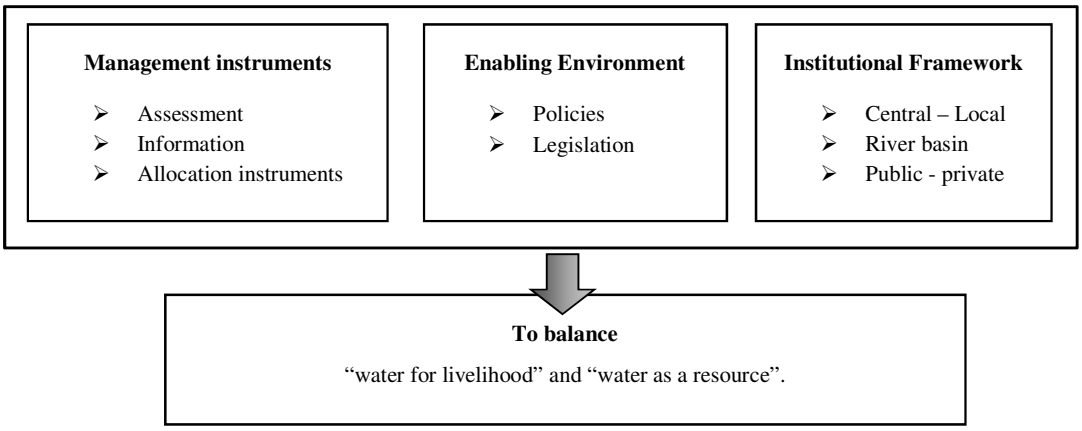


Figure 6: An illustration of the three pillars of IWRM

(**Source**: Jonch-Clausen, 2004)

The enabling environment reflects the policies, strategies and appropriate legislation needed to support the interrelated management process in such a complex environment in which many role players deal with water resources. Management instruments are the skills, manpower, experience and approaches required by the different institutions and role players to execute their particular duties. The third pillar illustrates the institutional framework that needs to be created through which the factors in the enabling environment can be implemented.

The foundational "three pillars" of the IWRM model are supported by two additional views. The first was provided by Mitchell in his defence of the IWRM after critiques by Biswas. The second can be found in the 1993 World Bank's Policy Paper on Improving Water Resource Management (Snellen and Schrevel, 2004).

Mitchell stated that three distinctive concepts of IWRM are crucial for the understanding and application of IWRM as a process, namely:

- Normative management concepts are described as "*what ought to be"*. In the context of the GWP model, they entail aspects such as *inter alia* institutional arrangements and frameworks, and the creation of communication and awareness.
- Strategic management concepts are described as "*what can be"*. They include *inter alia* aspects such as analysis, review, planning and reform.
- Operational management concepts are described as "*what will be"*. They involve *inter alia* aspects such as action plans, compliance, monitoring and evaluation.

The 1993 World Bank Policy Paper on Improving Water Resource Management (Snellen and Schrevel, 2004) is considered to be consistent with the Dublin principles and the global consensus reached at the Rio Earth Summit in 1992 and provides three fundamental principles, namely:

- The ecological principle argues that much greater attention should be paid to the environment and the river basin, which should be the unit of analysis in interdependent water management;
- The institutional principle promotes inclusive stakeholder participation and the principle of subsidiarity in water resource management; and
- The instrument principle focuses on management of water as a scarce resource, and incorporates the use of economic and incentive principles in improving allocation and quality.

Supported by the two views, it is important to note the correlation which suggests that the IWRM approach can only be successful if effective legislative regulations, an enabling institutional governance system and efficient managerial instruments are put in place together with political will and commitment (Gallego-Ayala, 2013).

Furthermore, in terms of land topography, river catchment areas or groundwater aquifers, water follows its own boundaries. It was, therefore, accepted that the management of water resources could, in terms of the IWRM approach, only make sense if addressed in a water basin or catchment. It has long been acknowledged that the river basin or catchment or watershed is the most suitable scale or unit for water resource management through applying an integrated approach (Ashton, 1999; Ashton et al. 2006; Waalewijn et al. 2005). Integrated Catchment Management (ICM) is described differently, but in essence is the same. This approach recognises a river basin or catchment as a living ecosystem that consists of an interlinked web of land, water, vegetation and people as well as many biochemical processes (Ashton, 1999; Malzbender et al. 2005; CDE, 2010; CER, 2012).

However, developing industrialisation stimulated increased competition for water use and related social challenges. Social and political challenges however, cross water boundaries and catchment basins. The new liberal bottom-up approach of participation therefore argued against the watershed. This view argues in favour of a 'problem shed" concept (Mollinga et al. 2007; Muller, 2015; Warner et al. 2008) focusing on the region affected and characterised by political and social problems.

Different arguments and viewpoints are presented by the two camps to promote or argue against the choice of the watershed as a suitable unit of management; this is illustrated in **Table 6.**

The opposite argument emphasises that the river or catchment basin as the unit of measurement and management places the water resource as the central focal domain (Turton, 2003; Warner et al. 2014). It follows that such participation takes place in the context and on the scale that the participants legitimise as meaningful for their perceived challenges (Kurtz, 2003; Lebel et al. 2005; Medema et al. 2008, Muller, 2015).

Table 6: Various arguments presented for and against a watershed as a suitable scale or unit of water resource management.

Arguments in favour of a watershed	**Arguments against a watershed**
Achievement of collective goals	Competition
Shared exposure to risks and responsibility	Human conflict and power distribution
Sense of trust and belonging	Vague watershed boundaries
Proximity to the stakeholders and challenges	Cross-cutting distribution of biodiversity
Flood and risk control	Inter-basin transfers
Smaller manageable units	
Demographically induced water demand	

It consequently becomes evident that a "problem shed", puts political and social challenges first and above the intrinsic importance of the water resource, its protection and sustainability. The focus of the "problem shed" logically then neglects the ultimate objective of water resource management, stated in the preamble of the NWA; to protect the quality of water resource to ensure sustainability (Government of South Africa, 1998a).

South Africa and many other countries adopted IWRM as the preferred approach to water resource management (Funke et al. 2007; Rahaman and Varis, 2005; Anderson et al. 2009; Falkenmark et al. 2014). With the new dispensation in South Africa, the basis of water management and the promotion of IWRM as the methodology of approach to water resources management can be found in the Constitution of South Africa, the National Water Act, Act 36 of 1998, the White Paper on a national water policy for SA of 1997 (DWAF, 1997) and the National Water Resources Strategy (NWRS) (DWAF, 2004; DWA, 2013a).

Despite claims that IWRM is widely accepted as the ideal holistic solution for the management of water resources and a general understanding of its fundamental principles, it has also attracted much critique, which has focused on several aspects of the model and approach (Anderson et al. 2009; Biswas, 2004;

Biswas, 2008; Funke et al. 2007; Schenk et al. 2009). IWRM has not performed well and has not yielded the intended results (Biswas, 2004; 2008; Falkenmark et al. 2014; Muller, 2015). Amongst other problems, it has been realised that there is a difference in the interpretation and application of IWRM in developed and developing countries.

After studying trends in IWRM literature, Gallego-Ayala (2013) found that there are no longer many studies and publications either because the concept is in a mature phase or it is becoming "old-fashioned". Falkenmark et al. (2014) argued that the difficulties may be found in the confrontation between its application and governmental institutional divides, as well as bureaucratic domains of the state. It is, thus, a question of how to cross this divide and achieve a process of joint collaboration to govern land and water resources.

A number of researchers and managerial reports have claimed that people are not actually performing constructive and real IWRM, but purport to do so. They subsequently claim legitimacy for their activities by attaching the IWRM tag to them (Biswas 2004, 2008, Falkenmark et al. 2014).

2.3.2 The South African natural water resource governance-management approach.

In South Africa, two different pieces legislations regulate two different forms of water resources and related services through different types of water management institutions (WMI) through the Department of Water and Sanitation (DWS) (Pegram and Mazibuko, 2003). This hierarchical layout is presented in **Figure 7**.

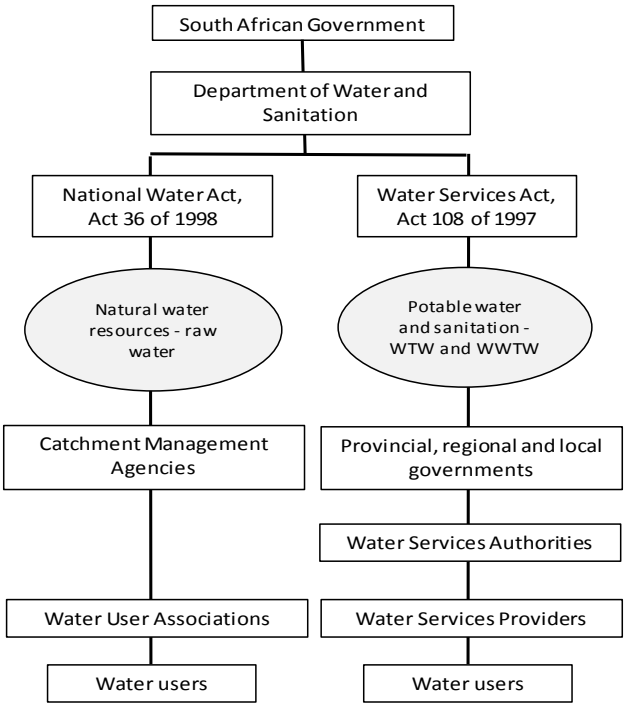


Figure 7: The hierarchical outlay of the Department of Water and Sanitation (DWS) under the two forms of water legislation in South Africa.

(**Sources:** Redrawn from Pegram and Mazibuko, 2003 and Rodina and Harris, 2016).

- The Water Services Act, Act 108 of 1997 (WSA) regulates water services by ensuring potable water provision, sanitation and related infrastructure, through Water Services Authorities (WSA) and Water Services Providers (WSP).
- The National Water Act, Act 36 of 1998, (NWA) regulates natural water resources and prescribes the requirements for natural water resource management through the DWS and two Water Management Institutions, namely, the catchment management agency (CMA) as a second tier in the institutional framework and water user associations (WUA) as the third tier.

With respect to the objectives of the NWA and NWRS, Muller (2012b) summarises the water resource management (WRM) functions as presented in **Table 7**.

Table 7: A summary of water resource management (WRM) functions described by Muller.

Monitoring and information
Monitoring of and collection of data about the resource
Monitoring of and collection of data about water use and user sectors
Research and sector knowledge management
Planning and strategy
Systems analysis and planning
Options analysis
Strategy development
Coordination, consultation, communication
Public awareness and information
Administration and enforcement
Resource allocation
Conflict resolution and arbitration
Monitoring of water quality and pollution control
Regulation, monitoring and enforcement
Institutional development
Infrastructure exclusively for WRM purposes
Measuring weirs
Flood retention basins
Multi-purpose Infrastructure for WRM and service provision purposes, e.g.:
Dam for hydropower generation with capacity for flood control
Dams and water transmission to augment general supplies to a region
Operation of infrastructure to meet system needs
Operation and maintenance of infrastructure

(**Source:** Muller, 2012b).

In order to achieve the WRM objectives through the NWA, the 1997 National water Policy as well as the National Water Resource Strategy (NWRS) 1 and 2, this three tier institutional hierarchy for water resource management has been established to devolve power to promote progressive decentralised participatory and more transparent processes so as to protect, conserve and manage South African water resources. According to the Water Management Institutional Overview[6] written by the then Director General of the DWS, Mr Mike Muller, the frame work provides for progressive decentralisation of water resource management to the appropriate levels. The NWA provides for the establishment of 19 water management areas (WMAs) across South Africa (Muller, 2012b). The so-called CMAs are the entities that govern and manage the 19 WMAs. WUAs, which are also classified as water management institutions are meant to execute water management by co-operative user role players on a restricted and local level. In this process, the current DWS regional offices could decrease in size, and transfer and delegate a significant number of their powers and functions to the CMAs and WUAs (Dent, 2012; Kapfudzaruwa and Sowman, 2009; Meissner et al. 2013; 2016; Pegram and Mazibuko, 2003; Rodina and Harris, 2016).

It was hoped this approach would prove to be better and more efficient in many aspects than the state (Rogers et al. 2000; Dent, 2012; Pegram and Mazibuko, 2003; Redelinghuys and Pelser, 2013). The hierarchical layout of the two forms of legislation through the different institutions is illustrated in **Figure 7**. The 3 tier hierarchy for natural water resources (raw water) exist between the DWS or its regional offices, the CMAs and the WUAs.

Since the promulgation of the NWA in 1998 through which 19 WMAs were established, only two governing CMAs have been established and are functional. On 19 March 2012, the then minister of Water and Environmental Affairs gave approval to decrease the number of WMAs and subsequently, CMAs to nine (Government Gazette, 2012). Much effort was expended during the period 2013 to 2015 to have the remaining six CMAs established, excluding the already functioning Nkomati-Usutu and Breede Gouritz CMAs, and setting up the different governing boards. This process, however, was not fully executed. Against all odds, a notice was issued by DWS on 11 September 2017 which indicated that the Department had reconsidered the institutional model. It indicated that after diligent considerations, DWS had concluded it would establish only one CMA to execute WRM for the whole of South Africa.

Other governmental and provincial government departments that are regulated by other forms of legislation, but have direct links to and affect natural water resources include the Department of Agriculture (DoA), Department of Environmental Affairs (DEA), Department of Mineral Resources (DMR) and Department of Rural Development.

[6] The Water Management Institutions Overview guide by the Department of Water and Forestry, written for public clarity, explains what the different water management institutions are, how they should be established and their overall functions.

Quinn (2012) reviewed the progress of the DWS (then the Department of Water Affairs) that was responsible for WRM in respect of key challenges for Africa Water Vision 2025. The findings of Quinn revealed many critical shortcomings and failures of the DWS, which are summarised in **Table 8.**

Quinn's (2012) findings are in accordance with many concerns of and challenges identified by researchers (Anderson et al. 2009; De Villiers and De Wit, 2010; De Villiers and Mkwelo, 2009; Driver et al. 2012; Hedden and Cilliers, 2014; Herhold, 2010; Turton, 2008; Meissner, 2016; Reay, 2013; Redelinhuys and Pelser, 2013; Schreiner, 2013) and non-governmental organisations (NGOs) in South Africa (CER, 2014 a-f, 2017 a-c). A number of authors such as Colvin et al. (2011), Dent (2012), Turton (2008) and Sharmer (2009), (in Dent, 2012), have concurred that in South Africa the current generation of leaders is very poorly prepared to deal with current and future environmental challenges and does not harness multi-stakeholder innovations efficiently.

Table 8: A summary of some findings regarding the performance progress of the DWS to achieve key challenges set by the Africa Water Vision 2025

Challenge objective	**Findings**
Strengthening of water resource governance	Poor and neglected. For example, since the promulgation of the NWA in 1998, only 2 of the 19 CMAs had been established by 2012 and there were plans to decrease the number of CMAs to 9
Ensuring sufficient and adequate water for the environment and life supporting ecosystems	Despite 60% of the national coverage of water systems reserve determinations having been done in 2010, none had been fully implemented
Ensuring water security for food production, delivery of services, climate change and reverse of water resource degradation	Very poor and alarming. The NWRS of 2004 was only reviewed in 2014. Licensing of water use is far behind and clouded with confusion. CME on abstraction and pollution prevention is very poor. Although Working for Water had cleared approximately 1,6 mill hectares of alien invasive plants, the follow-up was very poor. Very little happened in terms of strategies and preparation for climate change
Capacity development, maintenance and improvement of skills and knowledge base	Regardless of excellent initiatives such as Blue Drop and Green Drop programmes, the National River Health Programme and the National Aquatic and Environmental Health Monitoring Programme, the dangerous toxicity levels and degradation of natural water resources increased significantly. Regardless of the Water and Forestry Learning Academy and MoUs with a number of high education institutions, a critical shortage of skilled engineers, technicians and climate specialists exist

(**Source:** Quinn, 2012).

Ryers et al. (2008, in Burns and Weaver, 2008), argued that the inability of government and conservation science to counter environmental and water resource degradation in the face of complex challenges, can be attributed to a number of important factors:

- poorly developed governance systems and mechanisms
- poor quality institutions and institutional neglect
- the absence of effective governance institutions at appropriate scales and levels
- insufficient resources and capacity, and the inability to supply ingenuity and innovate
- the disciplinary gap that exists between natural sciences and human behaviour
- an implementation gap that exists between policy- and decision-makers and sciences
- lack of political will and stakeholder support and
- barriers and conflict of interest.

They are supported in argument by Daily et al. (2009), Pahl-Wostl et al. (2011) and Turton (2008: 167). Barbier and Homer-Dixon (1996 in Turton, 2003: 167) calls it the failure of a developing state.

The core of these weak performances in South African can be attributed, to a large extent, to a decline in the capacity and capability of many spheres of government and a lack of leadership, unsatisfactory management performance, and poor governmental and institutional performance (Ashton et al. 2006; Boonzaaier, 2013; CDE, 2010; CER, 2012; 2015c; 2016a; 2017b; Dent, 2012; Malzbender et al. 2005; Pollard and Du Toit, 2010; Reay, 2013; Schreiner, 2013).

Inefficient leadership can, for example, be deduced from the swift effort made by the Minister of the Department of Water Affairs on 30 August 2013 to revise water policies and implement a number of irrational changes to the National Water Act, Act 36 of 1998 (DWA, 2013b) before any proper and in-depth investigations, consultations and considerations[7] were executed.

Even though the process and visions of the establishment CMAs failed, critical aspects of WRM functions and processes must continue to function. These illustrates how important it is for critical role players groups with common challenges, to work together.

Muller (2012b) summarised the desired water management functions as presented in Table 7.

While the CMAs were examined thoroughly and put into the main focus, the author is of opinion that WUAs, in particular their potential to add value in terms of their strategic positioning, are neglected and unexplored.

[7] The proposed "National Water Policy Review" was gazetted by the Minister of DWA, in Government Gazette No 36798 on 30 August 2013 and solicited public comments over an unreasonable short period before 30 September 2013. Author was involved in a forum representing WUAs in South Africa,that opposed this matter from September 2013 to November 2016.

2.3.3 Concerning trends in the Department of Water and Sanitation, custodian of South African water resources

Mounting critiques, and internal problems, caused the DWS to revise its CMA policy; as mentioned, it resolved to decrease the number of WMAs and CMAs from 19 to only 9 (Government Gazette, 2012). Thereafter much effort was expended by DWS to continue with the establishment of the seven remaining CMA's as governing bodies for the seven remaining WMAs, through appointed external consultants. Two processes ran simultaneously from 2013. The first was the so called Kingfisher Project[8], driven by institutions from the Netherlands to provide specific training for the acting CEOs of the about-to-be established CMAs. The second was the process that ran in each WMA, through the consultants, to have business cases drawn up and to obtain consent through public consultation processes for approval by the minister of DWS. Subsequent to the latter, 12 to 15 role players from each remaining WMA needed to be nominated on an advisory council, which was needed for support and to inform the first members of the first Board of the proto CMAs.[9] [10]

A notice was published in the Government Gazette (DWA, 2013b), Notice 888, notifying South Africa that the Minister of the DWS intended to review the National Water Act, Act 36 of 1998, based on what is called the "2013 Proposed national policy review". What was peculiar about this notice that drew wide attention, was that, as noted, it was published on 30 August 2013 yet the public review and consultation comments were to be submitted by 30 September 2013. However, invitations for public consultation from DWS as well as for these meetings were only received and took place from October 2013, well after the expiry date stipulated in the Government Notice 888 of 30 September 2013.

Notwithstanding, numerous comments were sent from a wide range of stakeholders to the minister of DWS of which the author had access to 20, listed in **Appendix A.**

This action of the Minister of DWS to revise the NWA, constitutes an administrative action[11] It should accordingly comply to the relevant regulations in terms of sections 33(1) and (3) of the Constitution of South Africa (Government of South Africa, 1996), as well as section 3 of the Promotion of Administrative Justice, Act 3 of 2000 (PAJA) (Government of South Africa, 2000). If it does not, the action is subject to review in terms of section 6 of PAJA.

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[8] Personal discussions with members from the Netherlands team on the WWF CMA Water Stewardship workshop, from 21 to 22 September 2016 in Sandton, Johannesburg.

[9] The author participated closely and actively in the public consultation process of the business case for the Pongola to Umzimkulu CMA for KwaZulu Natal.

[10] The author was nominated by the sub-region, comprising of approximately 144 000 ha of irrigation and agricultural water use, as its representative on the advisory council.

[11] Administrative action involves any action or decision by an organ of state when exercising a power in terms of the Constitution of South Africa, which may affect the rights of other persons (PAJA, section 1).

The notice did not comply in terms of procedural fairness, as mentioned above.

According to comments from various commentators received (listed in **Appendix A**) it appears that significant substantive and contentious flaws emerged in the policy document. The main problems were related to the knowledge of the DWS about intrinsic facts on the ground and interpretation of law, the Constitution of SA, the NWA and the NWRS.

Some critical policies subject to revision and factors submitted by the minister that justified the intended revisions included in the policy review document (DWA, 2013b) and that have relevance to this study, are as follows:

- The minister contends that there are "after years of implementation" gaps in water policies (Policy review paragraph 1.1).
  Commentators argue that these "gaps" are instead failures to implement and enforce existing policies. This poor implementation and the failure to deal constructively with challenges are well known in the public domain.
- The minister contends that it is defensible to consolidate the NWA and the WSA into one seamless and practical act, in order to deal with the "whole water value chain, from resource to consumptive use". Services provided in terms of WRM and potable water and sanitation, are too inconsistent. The NWA and WSA legislation do not provide sufficient mandate and power to the Minister to regulate challenges in the water value chain (Policy paragraphs 1.3 and 1.4).
  Commentators (appendix A) argue that no evidence exists to support the claim that the current two acts cannot achieve water value chain goals. The reasons submitted by the minister are incorrect in terms of law and in conflict with the Constitution of South Africa, the WSA and the NWA. Of importance is the provision in section 40 in the Constitution, namely, that three interdependent and distinctive spheres of government were established on national, provincial and regional levels. Schedule 4 of the Constitution provides clear outlines of their functions and objectives. The intrinsic functions, knowledge areas, type of infrastructure and services between the focal areas of the NWA and the WSA are considered to be too specialised and diverse to consolidate these Acts into one.
- In terms of water use, a principle of "use-it-or-lose-it" will apply in which the minister will mandate time frames whereby all existing lawful water use will cease to be recognised. There will furthermore be no form of temporary or permanent trading allowed between authorised water users. (Policy review paragraphs 2.1 and 2.2).
  Commentators argue that this view does not recognise the reality that water is a fluid of which the availability, certainty of supply and locality depend on landscape, climatic area and season. The policy position is in conflict with existing, sound, provisions in the NWA as well as with recognition of regulations, productive use of water and food production objectives in terms of the National Development Plan.

- Economic regulation will be applied throughout the water value chain that will set rules for tariff and charge determination, control, monitoring and enforcement (Policy review paragraphs 3.1).
  Commentators indicate that current problems in terms of water tariffs and/or compliance monitoring and enforcement relate directly to failures of implementation of systems in DWS and failures to resolve issues in this regard. It is common knowledge in the water arena that the WARMS administrative and financial system of DWS cannot cope with the related administration of the approximately 65 000 registered water users in South Africa.
- A regional water utility needs to be established to plan, build, operate and maintain regional bulk infra-structure (Policy review paragraph 3.2).
  Commentators claim that these functions are already covered by Water Services Providers, and Water Boards. Current infra-structure problems and subsequent poor services encountered are to a large extent due to inefficient management, cumbersome procurement procedures and corruption.
- The minister reaffirms the support and functioning of CMAs and the carrying out of WRM functions where CMAs are not yet established. However, the Minister will disestablish WUAs and amalgamate them and their functions with Regional Water Utilities (Policy paragraph 3.3).
  Commentators argue that the Minister failed to recognise and understand the crucial role of WUAs in the local scene. It was further argued that in stark contrast to significant failures of local government and municipalities in water services and infra-structure maintenance, WUAs, prove to be highly cost efficient in numerous objectives required by the NWA. These include accountability in water use, water use charges and tariff collection, water supply and infrastructure maintenance.

On 11 September 2017, a notice distributed by DWS indicated that the Department had reconsidered the institutional model (DWS, 2017). After diligent considerations, it decided to establish only one CMA to execute WRM for the whole of South Africa[12]. This situation renders the globally lauded approach to decentralised WRM of the South African water resources and intended linkages between the tiers inefficient and void. The hierarchical illustration in terms of the NWA, from **Figure 7**, is redrawn in **Figure 8** below to illustrate the void created by the break in the hierarchical tiers. Besides the DWS, the Departments of Agriculture, Environmental Affairs, Rural development and Mineral Resources all have influence on the natural water resources. Owing to the revision of the establishments of CMAs in each WMA as well as the uncertainty that exists concerning the role and future of WUAs, a critical void is being created. This void may have detrimental effects on the WRM in the future.

[12] Notice 24/2/1P from the Acting DG of DWS to Deputy Directors, Chief Financial Officers, Provincial Heads, Chief Directors and Directors.

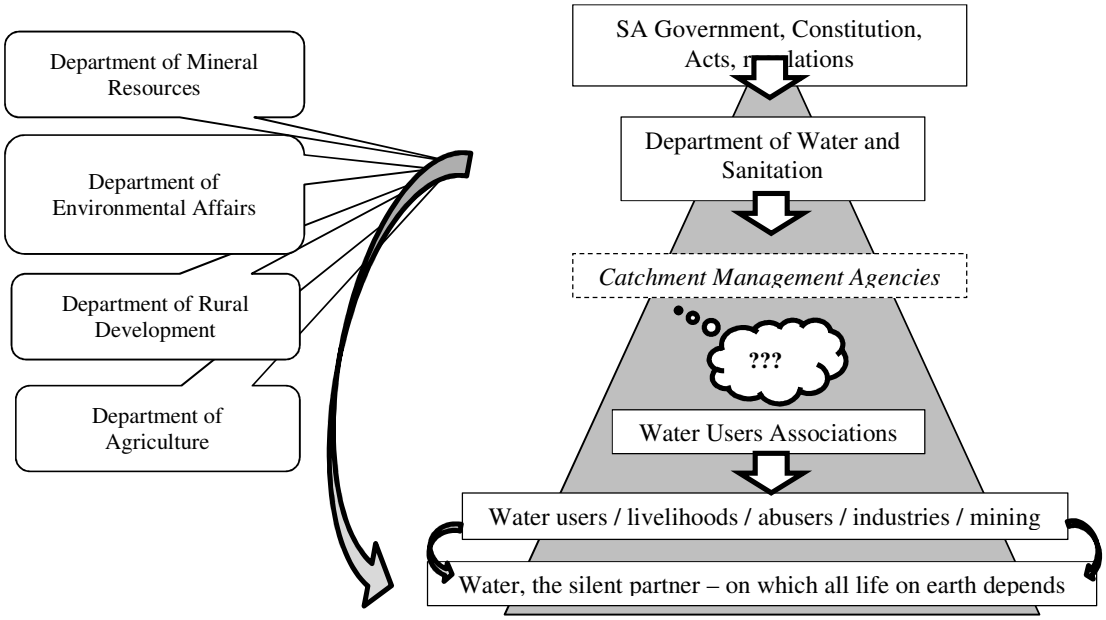


Figure 8: An illustration that show the void created by the break in the links between the three tier hierarchical relationship of the DWS, the CMA and WUAs in water resource management as well as the involvement of four other governmental departments on the water resource.

Subsequent to the publication of the intended National Water Policy Review, the Minister of DWS launched an investigation into the role, functions and efficiencies of WUAs across South Africa. A first investigation targeted 15 WMIs, during 2015, and a further 8 WMIs during July to September 2017.[13] Called "due diligence investigations", consultants for the DWS visited each of these targeted WMIs. These visiting teams executed their assessments by merely scrutinising the administrative processes and financial management, while emphasising at length the extent of demographic and gender transformation of the Governing Board, membership profile and personnel structure. It was noteworthy that very little attention was accorded to WRM functions, the motivation amongst others, for revision of the NWA and amalgamation with the WSA.

A further concern regarding stability, guidance and good leadership from DWS is mounting as deduced from the very high turnover of senior personnel in the Department, presented in **Table 9**, and the ratios

Table 10**.**

[13] The author participated in both these investigations. The Impala WUA, the case study, was part of the targeted WMIs investigated.

Table 9: A list indicating the turn-over of Directors General and Ministers in the Department of Water and Sanitation since 1996/97

Years	Directors General			Ministers
1994/95	Mr M. Muller	DG		Prof K. Asmal
1995/96	Mr M. Muller	DG		
1996/97	Mr M. Muller	DG		
1997/98	Mr M. Muller	DG		
1998/99	Mr M. Muller	DG		
1999/00	Mr M. Muller	DG		Mr R. Kasrils
2000/01	Mr M. Muller	DG		
2001/02	Mr M. Muller	DG		
2002/03	Mr M. Muller	DG		
2003/04	Mr M. Muller	DG		
2004/05	Mr M. Muller	DG		Ms B. Sonjica
2005/06	Mr J. Sindane	DG	Replaced	
2006/07	Mr M. Rampedie	Act DG	Interim	Mrs L. Hendricks
2007/08	Ms P. Yako	DG	Dismissed	
2008/09	Me N. Ngele	Act DG	Suspended	
2009/10	Mr T. Balzer	Act DG	Interim	Ms B. Sonjica
2010/11	Mr T. Balzer	Act DG	Interim	Ms E. Molewa
2011/12	Mr M. Sirenya	DG	Replaced	
2012/13	Mr T. Balzer	Act DG	Interim	
2013/14	Mr T. Balzer	Act DG	Interim	
2014/15	Ms M-A Diedricks	DG		Ms N. Makonyana
2015/16	Ms M-A Diedricks	DG	Sudden resignation	
2016/17	Mr S. Mkhize	Act DG	Suspended	
2017/18	Mr D. Mashitisho Mr S. Mkhize	DG Act DG	Suspended Interim	

(**Source:** Annual reports of the DWS)

Table 10: A summary of the ratios of Directors General and Ministers of the Department of Water and Sanitation over different periods

	Period	Years	Appointments	Ratio
DG's	1994 - 2005	11	1 x DG	11 years per DG
	2005 - 2017	8	5 x DG's 8 x Act DGs	0.61 year per DG/Act DG
Ministers	1994 - 2004	10	2 x Ministers	5 years per minister
	2004 - 2017	13	5 x Ministers	2.6 year per minister

Media comments regarding controversy continue to be made on the performance and financial governance of DWS. These also convey concern; the following documents are presented in support.

The Parliamentary Monitoring Group (PMG) meeting with DWS, minuted on 3 August 2010 (Sotyu, 2010) that the following was reported to the PMG committee by Ms N. Ngele, the ADG of DWS:

- The good performance of DWS
- The imperatives for delivery and execution of effective governance
- The promotion of accountability
- That DWS is still going through a learning curve regarding the costing of *inter alia*, business plans, strategic focus and alignment of the DWS budget.

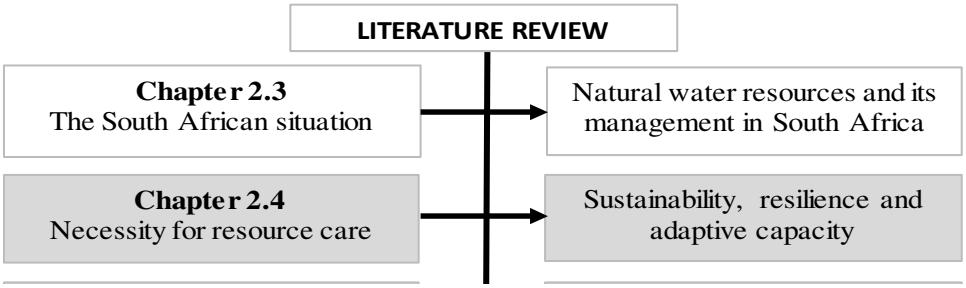
The same report further minuted that Mr O. Ayaya, the Chief Financial Officer of DWS, confirmed that goods and services were being delivered by DWS.

Both Ms Ngele and Mr Ayaya were suspended on charges of tender fraud.

Media reports, quoting highly respected scientists, claim that the ongoing water crisis facing Gauteng can be attributed to the delay in phase two of the Lesotho Highlands Water project. It did not start on time in 2015 due to the escalating inefficiency of the DWS (PMG, 2016; Watson, 2017).

During April 2017 to October 2017, the Parliamentary Portfolio Committee on Water and Sanitation debated serious concerns with Minister N. Makonyana regarding persistent media reports of poor delivery performance and financial control. It was alleged that the Water Trading Entity (WTE) had an overdraft of around R3.5 billion and was unable to account for about R654 million on its books and was considered technically bankrupt (ANA Reporter, 2017; Herman, 2017, Watson, 2017). These concerns were amid the further controversy after the appointment of Mr. D. Mashitisho early in 2017 as the DG and his suspension during July 2017.

2.4 SOCIAL ECOLOGICAL SYSTEM SUSTAINABILITY, RESILIENCE AND ADAPTIVE CAPACITY



"Greater complexity …… and a higher chance of nonlinearities tend to boost the number of unknown unknowns in the natural, social and technology systems around us.

Homer Dixon, 2000

2.4.1 Socio ecological system.

As emphasised previously, human life and all forms of bio-diversity are absolutely dependent on water. Therefore, natural environmental sources need to continue indefinitely so as to provide water sustainably as a life-supporting commodity. However, water as a natural resource of water has been exposed and subjected to different forms of controversies. From the anthropogenic viewpoint, natural water is replenished from the sky and belongs to no one; thus, representing a "common pool resource". Examples of the latter include fishing grounds, pastures, forests, water and the atmosphere. However, in reality, natural water resources may be owned by national, regional or local governments as public goods, by communal groups as common property resources or by private individuals or corporations as private goods. When they are owned by no one, they are considered and used as open access resources. In terms of the South African Constitution and National Water Act, water in South Africa is considered a common pool resource that belongs to all South Africans under the custodianship of the Government (DWA 2013(a), Government of SA, 1998(a)).

The basic units of the natural water resource environment are river basins or catchments, created in terms of the way the topography of the earth has been shaped by water. River basins or catchment areas are the

spaces where human activities take place to create livelihoods by using natural water resources (Cumming, 2011; Plummer and Armitage, 2007). In creating such a livelihood for future generations, subsequent interaction, competition and exploitation across a number of scales and levels by role players, functioning as a "human system", result in positive and negative socio-economic impacts on natural water resources in particular. Natural water resources, as part of ecological systems, are vulnerable and subject to problems of congestion, overuse, pollution and destruction unless the use thereof is controlled and limited in various ways (Bohensky, 2006; Folke et al. 2002; Harding, 1967; Ostrom, 2010). These interactions within and between the systems are essentially interdependent, ever changing and very difficult to predict in advance. This combination of these systems is referred to as the "socio-ecological system" or SES (Bohensky, 2008; Folke et al. 2010; McGinnis and Ostrom, 2014; Mistry et al. 2010).

The "socio-ecological system" (SES), illustrated in **Figure 9,** is in essence characterised by:

- high level of uncertainty (Cumming, 2011)
- constant evolvement (Fischer et al. 2009)
- alternating configurations (Bohensky, 2008) and
- accellerated human activities (Folke et al. 2010).

Through these interactions, each system responds and has the potential to evolve and maintain itself if it possesses a capacity to learn (human systems) and adapt (human and ecological systems). It therefore possesses resilience, but also simultaneously has the ability to destroy the system (itself) or the sub-systems.

Considering the competing dynamics in a SES, the concerns of numerous scientists who have expressed apprehension about resource exploitation and deterioration are becoming important pointers for the scientific discourse in the contemporary era of the Anthropocene. Consequently, it is important to take trans-disciplinary links into consideration with respect to the intrinsic characteristics of humans as a role player who exert an influence on matters related to natural water resources.

Many theorists have attempted to understand human behaviour and in particular, the consequences of the interactions of humans for the natural environment. In this respect, five very interesting and noteworthy theories, which have developed over time concur in crucial aspects about human-environment interaction and interdependence. This is illustrated in **Figure 9**

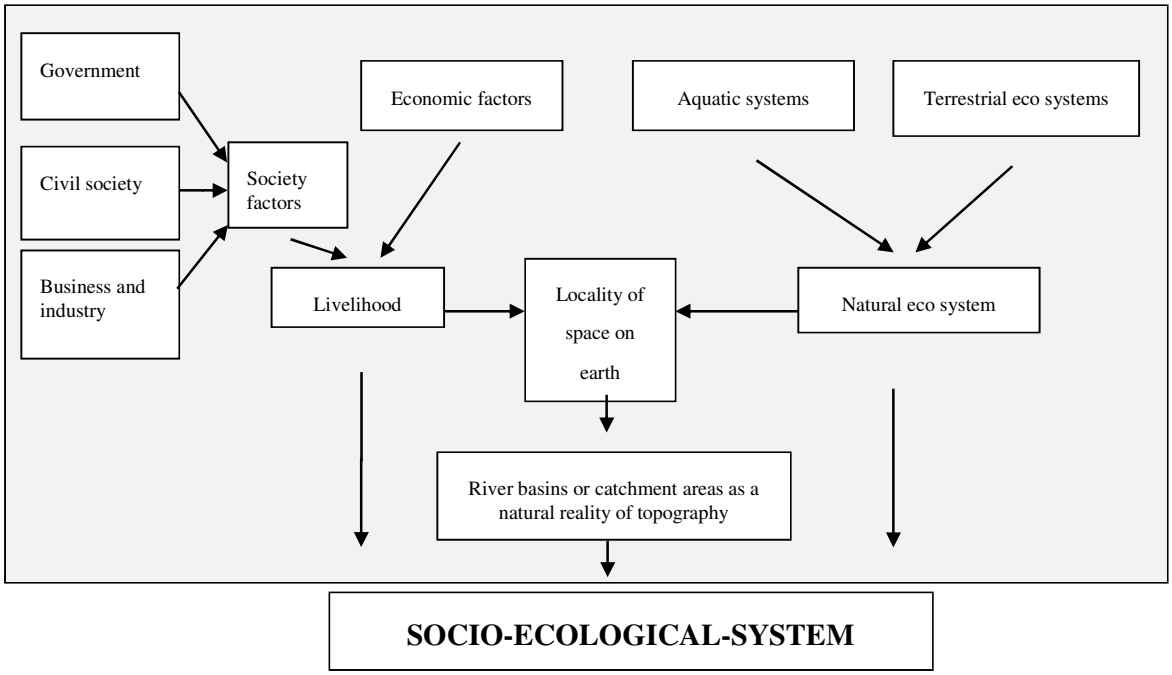


Figure 9: A simple illustration of the interacting components of the socio-ecological-system.

(**Source:** The author)

2.4.2 Sustainability.

To reiterate, in 1789, Thomas Malthus warned about the threat of famine on future human populations (Elwell, 2009; Malthus, 1798:5). The classical theory of Lewis Henry Morgan in 1877, the neo-evolutionism theory of Leslie White in 1943, the ecological-evolutionary theory of Gerard Lenski in 1966, and the life-expectancy of the industrialised civilisation in the Olduvai theory of Richard Duncan in 1989 (Duncan, 2009; 2013) are in agreement: they describe the dependence of humans in their socio-cultural evolution on environmental/biological influences and their reliance on the capacity of the earth for sustainable provision of their growing needs. An important determinant of evolvement and advancement of human cultures on earth is the ability of societies to capture, harness and control energy. The latter emphasises development as a fundamental driver to exploit earth's resources through forms of qualitative and quantitative human induced scarcities, such as environmental and water resources degradation and various forms of pollution. This naturally leads to inequalities and inequitable ranking within and amongst nations on earth (Elwell, 2009) and, accordingly, explains the dominance of politics in the water resources domain; this is discussed in a subsequent section.

The quest to make more water economically available to provide for population growth and increased development is illustrated in **Figure 10**. In the figure, the author combined the three models, devised by Ohlsson and Turton (1999), Molden et al. (2001) and Ashton and Haasbroek (2002) as described in Turton (2003, 142, 144, 151). It portrays a summary of the paragraphs above by illustrating the chronological depletion of available water, what Muller (2012b) also refers to a "intensity of water use", in that:

- Engineering infrastructure was created to put more available water to the economic use of increasing population growth and concomitantly burgeoning industries
- The water use traversed through different levels of water availability thresholds, through stages of water abundance, scarcity and deficit, coined here as "anthropogenic threshold events",
- As water availability changed over time, humans needed to implement different phases of adaptation and coping throughout the different stages of water availability so as to sustain themselves.

The arguments and examples raised above, indicate that the deficit and adaptation phase illustrated in **Figure 10** exists. That is the position that humankind is currently being exposed to.

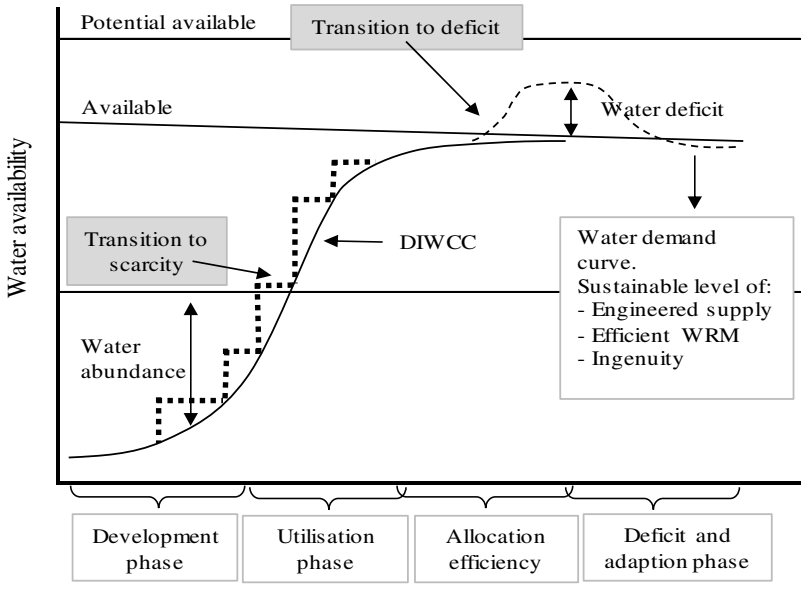


Figure 10: A combination of the three models by Ashton and Haasbroek (2002), Molden et al (2001) and Ohlsson and Turton (1999), depicting anthropogenic threshold events that have led to the current drive towards rethinking water resource management to cope with water deficit circumstances (Source: Turton, 2003: 142, 144, 152)

Social, economic and cultural dynamics need to improve to develop the capacity to meet future needs for developing and growing populations; this brings the concept of sustainability into context. An interesting

and indeed critical paradox for survival of the species on earth stems from the competing goals of sustainability in biodiversity conservation and sustainability in economic development; both require challenging deliberations and decisions (Dietz et al. 2003; Folke et al. 2002).

The concept of sustainability was formalised in 1987. It is defined in the Brundtland report of the World Commission on Environment and Development (WCED) as: "*development that meets the needs of the present generation without compromising the ability of future generations to meet their needs*" (DEAT, 2004; Snellen and Schrevel, 2004; Haywood et al. 2010; Cumming, 2011).

Endorsed by South Africa, sustainable development is defined by the South African National Environmental Act, Act 107 of 1998 (NEMA) as follows (Government of South Africa, 1998b):

> Section 1(1); Sustainable development means the integration of social, economic and environmental factors into planning, implementation and decision-making, so as to ensure the development serves present and future generations.

In this context, sustainability is driven primarily by the realisation in a society that it (the society) must execute constructive and viable practices to offer future value to an organisation or the community. Sustainability is also a scientific discipline that endeavours to study and understand complex interactions between humans in their quest for development and the capacity of the environment to continue to provide ecological services.

Accordingly, many activities and novel policies were developed to address the challenges of sustainable development such as the Millennium Development Goals (MDGs) of the United Nations, which, it was agreed, would be successfully achieved in 2015 (Burns and Weaver, 2008, p 5). Eight over-arching goals with 32 target indicators were established. The MDGs endeavoured to address sustainability challenges such as the alleviation of poverty, strengthening of democracy, elimination of conflict, creation of security in food, water and energy supply, broadening health services and provision, and improvement of health and education. Only one goal of the seven dealt specifically with water resources. It strove for the conservation of water resources by acknowledging the balancing of water supply with demand, inclusive of the maintenance of water quality, biological diversity and resilience of the resource (Easterly, 2009; United Nations, 2015(a):52). To a large extent, the global endeavour of the membership states to attain the MDGs by 2015 has failed. Although the sustainability principles were widely accepted in South Africa, this did not lead to sufficient implementation, practice and realisation. Only 59 % of the applicable targets set for South Africa by the MDGs were achieved in 2015 (Statistics SA, 2015).

To continue the endeavour towards sustainability, 17 new "Sustainable Development Goals" (SDGs) replaced MDG 2015 and were proposed for 2030 (SDG 2030). These were agreed to by member states on

25 – 27 September 2015. Greater priority was placed on global and national environmental security (United Nations, 2015b).

However, humans and nations differ intrinsically in their culture, political, economic and demographic characteristics (Adejumobi, 2000; Bakker and Morinville, 2013; Burns and Weaver, 2008; Skinner, 1998) and therefore, their knowledge and viewpoints on interpretations, willingness and capacity to attain sustainability differ too (Taljaardt, 1997; Turton 2003:146). In order to improve the capacity of society to use its resources wisely, the sustainability concept requires learning interactions, which lead to learning among humans.

It is appears that the challenges of sustainable development can be approached efficiently, but more efficiently through the integration of knowledge beyond mono-disciplines, through collaborative concepts such as inter- or transdisciplinarity (Esler et al. 2016). Therefore, delicate balancing is required when planning economic growth and development, because business and society are deeply embedded in their relationship with the environment in which they operate (Haywood et al. 2010; Falkenmark, 2011).

Science and education as centres of knowledge contribute to the improvement of knowledge and capacity of growing societies in the use and protection of resources in such a manner as to secure their future needs.

2.4.3 Resilience

The saying "survival of the fittest" is as true for the natural environment and natural water resources as it is for humans. Both have critical thresholds for "survival".

Resilience, a concept developed by Holling (1973 in Cundill and Fabricius, 2008) is the ability of ecosystems to maintain a certain state of equilibrium and retain the same functions, structure and feedbacks when exposed to external disturbances (Clarvis et al., 2014; Cundill and Fabricius, 2008; Folke et al., 2010). Such a system or a society thereby mitigates or eliminates its vulnerability to a pending risk exerted on it (Muller, 2012a); a reaction similar to the survival response mentioned previously.

Haywood et al. (2010) elaborated on the following important and very relevant extensions to resilience:

- Ecosystem resilience is a situation where the natural ecological system can withstand a certain number of shocks before it rebuilds or changes itself when necessary
- Resilience in social systems has the same definition, but includes the added capacity of humans to anticipate and plan for the future
- Business resilience is the capacity of a business to adapt, survive and grow in the face of unsuspected and dynamic changes.

The resilience of a natural system follows a spiral process or reciprocal dynamics between a first order resource or scarcity (renewable and/or non-renewable resources) that triggers a response from a second order resource or scarcity (human resources) (Ohlsson and Turton, 2000; Turton, 2003:149-151). Ohlsson (1999, in Turton, 2003:148-150) proposed that reciprocating events follow a typical reciprocal/oscillating spiral pattern; Ohlsson described the latter as first and second order scarcities or events. The Ohlsson model holds that a problem or event such as a degrading water resource that holds a certain risk for society will be described as a first order scarcity, problem or event. The response of authorities to address this degrading resource, the governance or managing effort, triggered by the first order event, is described as the second order response. This is a social response that emanates from the utilisation of social capital. The latter response may create new first order events or scarcities, which solicit new second order social responses to address the recent first order event, oscillating back and forth as time and activities continue (Ohlsson and Turton, 2000; Turton, 2003:158).

The concept is illustrated by the sigmoidal curve in **Figure 11**. It indicates that pressure on natural resources caused by exploitation, a first order event or scarcity, triggers a second order resource response that mitigate the scarcity back to within the limits of the carrying capacity of the resource. Such second order responses may again create a renewed first order scarcity, which will again trigger a subsequent second order response to cope with the new condition and so forth. Seen in the context of utilising water as a common pool resource and asymmetries in society, such first and second order behaviour is of critical importance. It contributes to understanding the fundamental design principles and institutional architecture for adaptive management and governance processes of a SES. Subsequent management and governance can build or destroy resilience.

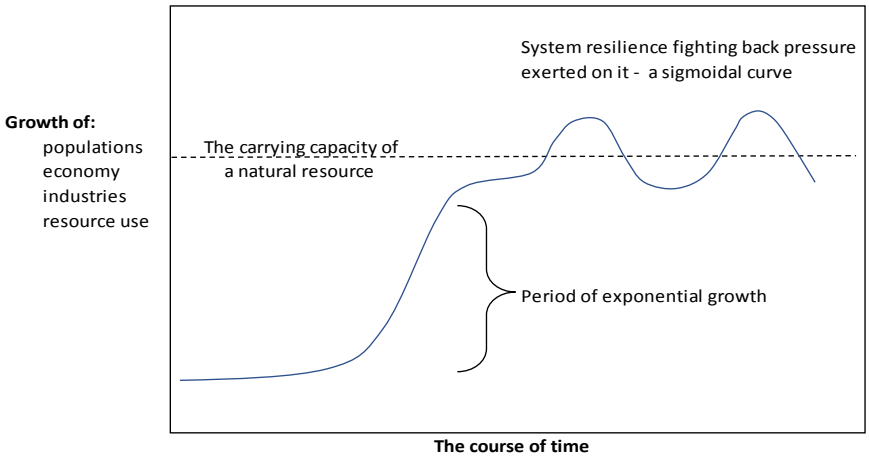


Figure 11: A simple illustration of the effect of the resilient dynamics of a system maintaining itself subsequent to exponential growth of the system in excess of the carrying capacity of a resource in the absence of or, of poor management

(**Source:** Adapted from Miller, 2006:121)

In relation to a human being or human systems, it is assumed that a crisis or shortages will inform and shape the emergence of exigent social resilience to deal with the current and future challenges through a process of adaptation (Burns and Weaver, 2008). This leads to the concept of transformability. In the context of resilience in a SES, it refers, for example, to the capacity of the human system to execute actions to create a fundamentally new system when economic, political and/or ecological conditions become untenable.

What these concepts have in common is reference to the adaption of a system to maintain a current equilibrium or transformation to another state when disturbances exceed a certain threshold in order to withstand the disturbances. Turton (2003:145), Walker et al. (2004, in Cundill and Fabricius, 2008) and Fabricius and Cundill (2014) declared that the adaptability of a SES to persist requires the actors in the system to be able to learn so as to influence resilience.

Another important factor for maintaining resilience is the extent of the variety of viewpoints and interpretations that challenge the limits of reasoning and encourage innovation. The latter emphasises the importance and intrinsic role of leadership and management resources (Turton, 2003:145-146).

In contrast, the natural water resources system cannot learn as humans do, but is able to maintain a certain degree of resilience because of the inherent characteristics of the natural environment.

2.4.4 Adaptive capacity

Ecosystems and the adaptive capacity to maintain sustainability depend on the collaboration between several stakeholders. Different terminologies and concepts describe this process; they are consequently explained.

Adaptive governance (Dietz et al. 2003) refers to the process of dealing with complexity and change under uncertain conditions that are difficult to control. It involves diverse interest groups and the reconciling of conflict among groups of people who differ in values, interests, perspectives, power and the kind of information they bring to the situation. Empirical work on the emergence of adaptive governance of a SES has illustrated the interdependence of four features of governance: actors, networks, organisations and institutions as well as how learning interaction evolves and they combine to shape and influence governance processes and SES change (Osterblom and Folke, 2013; Plummer et al. 2013; Plummer et al, 2014; Regeer and Bunders, 2009).

A similar concept, adaptive management, became an approach very sought after for addressing difficult problems (Fabricius and Cundill, 2014). These authors' review of literature revealed that two major objectives of adaptive management through public participation include adaption and responsiveness in relation to improved biological conservation and adaptation in relation to improved governance. They

concluded that learning through public participation was very poor, but took place mostly among researchers and managers.

Adaptive co-management is defined as "a situation in which two or more social actors negotiate, define and guarantee amongst themselves a fair sharing of the management functions, entitlements and responsibilities for a given territory, area or set of natural resources" (Cundill and Fabricius, 2008, Plummer et al. 2013). It refers to a flexible and context-specific community-based system of learning-by-doing and action of natural resource management, which works with and is supported by collaborating role players at multiple levels (Cundill and Fabricius, 2008; Grecksch, 2015; Medema et al. 2008; Plummer and Armitage, 2007, Plummer et al. 2013; 2014; Schultz et al. 2011). It employs adaptive learning and linkages between these actors and therefore, relies on efficient network structures. It was, however, found that the high cost and time consumed by too much public participation far outweighed the benefits derived from it (Muriti and Murphy-Ives (2007) in Fabricius and Cundill, 2014; Plummer et al. 2013).

The term "institution" refers to rules that are employed to regulate people's interactions. Cundill and Fabricius (2008), quoting a number of authors, posited that efficiently functioning institutions, which link organisations and role players are crucial ingredients for common pool resource management. Accordingly, it is assumed that role players have equal power and capacity to guide and influence the process.

Cundill and Fabricius (2008) compiled a number of social conditions for effective adaptive co-management from various authors; these are presented in **Table 11**.

Table 11: The necessary social conditions for effective adaptive co-management.

	Social capital	**Adaptive capacity**	**Self-organisation**	**Adaptive governance**
Intrinsic conditions	Trust. Common rules and norms Groups of common interests.	Willingness to: Learn from mistakes. Engage in collaborative decision-making. Accept a diversity of institutions.	Ability to monitor and respond. Information flow and social networks. Arenas for collaborative learning.	Conflict resolution. Compliance with rules and regulations. Being prepared for change.
Extrinsic conditions	Support from higher levels. Legal entitlement to the resources in question.	Enabling legislation.	Funding. Access to accurate and relevant knowledge.	Adequate infrastructure.

(**Source:** Cundill and Fabricius 2008:540)

Strategies required for an efficient adaptive process are comprehensive cross-scale and trans-disciplinary knowledge networks, analytical dialogue, proper institutional arrangements and creative innovation that

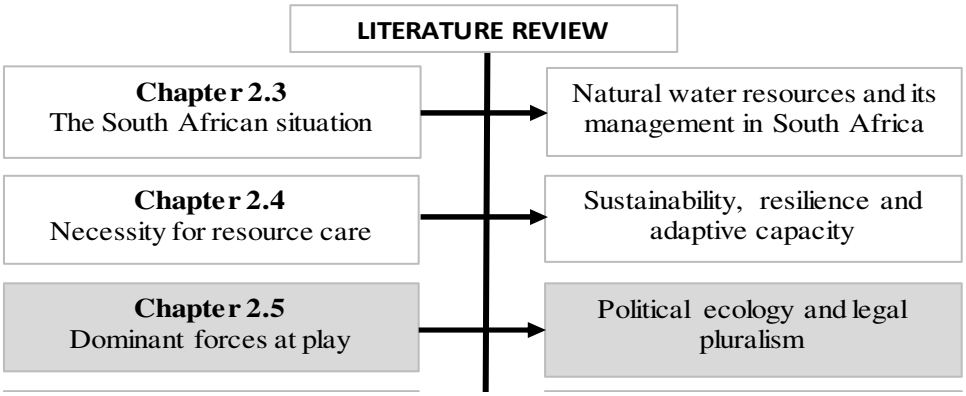
must be able to address various layers of knowledge and authority (Cundill and Fabricius, 2008:540; Dietz et al. 2003; Grecksch, 2015; Rogers et al., 2000). As an alternative to cross-scale knowledge networks, the notion of structured engagement may also be applicable (Muller, 2012a). This concept will be further elaborated on in section 2.7 below.

According to Dent (2012), a great deal of attention has been given to engagement and adaptive management on higher institutional levels in this regard. In South Africa, social learning and adaptive management are becoming more important on grassroots level; the level where users and abusers operate and interact. Furthermore, they have become important in instances where the challenges in complexity and sensitivities are much more prevalent (Dent, 2012).

The South African local context, or grassroots levels in water catchments, contains common pool resources, which comprise the playground of reality and which are exposed to anthropogenic pressures and exploitation. The local arena is characterised by great differences in capacity and abilities of the different communities and role players. They differ from "powerless spectator communities" with no knowledge and adaptive capacity to communities with a high capacity and ability to adapt (Cundill and Fabricius, 2008; Malzbender et al. 2005). These conflicting interests and differences in knowledge and capacity restrict the adaptive capacity for sustainable biodiversity conservation, slow down decision-making and constructive progress, and limit the impact of appropriate scientific knowledge (Schultz et al. 2011).

Bakker and Morinville (2013), Ostrom (2012a and 2012b) and Pahl-Wostl (2007) demonstrated that adaptive capacity and the ability to attract a diversity of actors in response to challenges is strongly related to polycentric governance. It facilitates the formation of coalitions and networks, enhances distribution of power, creates effective co-ordinating structures that guide learning and transformation, and balances bottom-up and top-down influences.

2.5 POLITICAL ECOLOGY AND LEGAL PLURALISM



> *"A society's management and use of natural resources, both the means used to extract resources like water from the natural environment to the ends towards which its exploitation is directed, is structured under a set of legal statutes, social norms, cultural practices and political institutions. Given the ability of modern technology to control nature, these rules, values, habits, laws, regulations, public policies, authorities and bureaucratic agencies, now largely determine our relationship with the natural resource. A water management regime, then, includes the knowledge, organisations and human choices which determine who gets water and when, from where and for what purpose and price, and how it can and should be used".*
>
> ***Waller (1994) in Warner et al. 2008.***

The natural water resource dynamics in a SES are not only closely linked to the scientific disciplines of the natural environment, but also inextricably linked to social cultural developments, political power and political processes and aspects such as governance of scale (Balsiger and Debardieux, 2011, Bourblanc, 2012; Bryant, 1998; Lade et al. 2013; Malzbender et al. 2005; Meisner, 2014; Norman et al. 2012; Skinner, 1998). Co-existence requires consensus building, which in diverse communities, results in political conflicts. It follows that water resources, to sustain existence, attract conflicting and contrasting viewpoints between the multiple stakeholders that govern, manage and use the natural resource; at times, to pursue competing objectives that serve their own political agendas (Farah et al. 2011; Merrey, 2008; Swatuk, 2005). Therefore, the political contexts of water resources cannot be ignored, but need to be revealed as

an important influencing factor that exerts significant power which, in turn, affects decision-making and outcomes stemming from co-existence.

Two political processes inform policy and law, but at the same time also elicit conflicts (Warner et al. 2008). The politicisation of issues emanates from discord that evolves from differences in views and questioning of the status quo. Depoliticising issues could release tension and build compatible co-operation and progressive resolution.

The functioning of the capitalist state affects the environment through continuous development and political decision-making, which are contradictory to protective environmental sentiments (Ioris, 2014). To sustain long-term health and order in a country, society relies on the regulatory mandate of the authoritative legal and legislative functions and institutional mechanisms of a government, to balance political and industrial powers on the one hand and environmental sentiments on the other (Clarvis et al. 2014). Sound legal regulations are also needed to prevent or control destructive processes of over-exploitation and non-complying harvesters (Burns and Weaver, 2008; Lade et al. 2013).

In South Africa, evidence however suggests that legal regulations have often failed to regulate people and systems and thereby protect water resources and environmental degradation (CER, 2014 (a), (b), (d), (f), 2015 (a), (e); De Villiers and Mkwelo, 2009; Swatuk, 2005). It is submitted that this may be ascribed to the concepts of legal pluralism and political ecology (Kemerink et al. 2013; Malzbender et al. 2005), which are of great importance in South African society.

Legal pluralism refers to a paradox in law in South Africa because of the co-existence and interactions of various and sometimes contrasting normative orders at play. Besides the combination of different cultures, each with their own views and ways of living, legal pluralism includes the everyday political ideologies of the state, and the economic, religious, spiritual and cultural doctrines that govern people's lives (Bourblanc, 2012; Kapfudzaruwa and Sowman, 2009; Kemerink et al. 2013; Malzbender et al. 2005). The simultaneous existence of these different normative orders in a pluralistic society results in the realisation and/or extortion of different rights in the social context.

Political ecology may be described as an interdisciplinary approach that combines the concerns of the natural ecological environment and broader social and economic political circumstances in a region, country or the world. It aims to understand the interlinking processes of land degradation, access to and control of ecological resources and social processes (Blaikie, 2008; Bryant, 1998). Finally, it contributes to the policy debate through knowledge and insight produced in the discourses of complex intertwined economic, ethical, socio-cultural, power dynamics and political agendas in balancing development and sustainable ecological practices (Blaikie, 2008; Bryant, 1998; Rocheleau, 2007; Swyngedouw, 2009). A number of authors have shown how power dynamics in water struggles in various countries are shaped by race, gender, class and social-cultural relations (Adejumobi, 2000; Farah et al. 2011; Rocheleau, 2007; Swyngedouw, 2009).

The demographics of South African society are characterised by pluralism in a number of ways, but most importantly, by ideological powers and socio-cultural diversity (Dent, 2012; Kapfudzaruwa and Sowman, 2009; Kemerink et al., 2011; 2013; Meisner, 2014; Meisner et al., 2013). Issues that are less obvious, but are also present, include the conflict between the strongly developed western capitalist customs and economy, and intrinsic, traditional, indigenous, ancestral and spiritual customs and socialist views about the economic principles of Africa (Adejumobi, 2000; Farah et al. 2011; Kapfudzaruwa and Sowman; Malzbender et al. 2005; Skinner, 1998). Intrinsically, western culture and leadership are viewed as very individualistic characteristics. Elsewhere, in less individualistic cultures, such as Africa and Asia, intrinsically more collaborative practices and the communal nature of leadership are evident (Gerzon, 2003). Regardless of the slow process of "modernisation", democratic renewal and development of new political societies in African countries as well as strong primordial bonds of kingship, ethnicity, traditions and ancestral customs still dominate rural communities while urbanised communities struggle to balance and adapt to conflicting macro and micro social realities of post-colonial awakening (Irobi, 2005; Sharara, 2015; Skinner, 1998).

An important aspect that South Africa, as part of Africa, needs to take into consideration is the recurring problem of poor governance apparent across Africa (Adejumobi, 2000; Farah et al. 2011). According to Huntington and Davidson (in Adejumobi, 2000), it appears that African governments simply do not govern and lack the capacity to promote social welfare and economic change. The dominant doctrine is one of dictatorships struggling for accumulation of power and wealth, which leads to increasing material poverty and environmental degradation.

An indicator of the extent of divergence in preferences and values in the population in South Africa, for example, was noticeable in the ideologies and themes of the 206 different political parties that registered to participate in the 2016 local municipal elections; these are depicted in **Table 12**. The intricacies and complex nature of the social system of the South African society, which is also manifested in socio-ecological contexts related to natural water resources is evident in Table 12.

Some black communities in South Africa still govern their affairs and water through traditional leaders, namely, nKosi's and Chiefs, traditional healers, namely, iZangomas and traditional indigenous cultural practices and beliefs. WRM is, in contrast, a western developed concept that is driven by state policy and regulations based on statutory legal systems. Three examples that illustrate this difference in approach are as follows:

- In terms of state policy, water is regarded as an example of economic goods while customary law treats water as a free "god-given" common pool resource (Kapfudzaruwa and Sowman, 2009).
- During 2015, the local stewardship officers of the WWF-SA developed a natural water resource for domestic use by the Ndlemetzhe community in the Pongola river headwaters. However, this resource was never utilised and was abandoned as the community believed that the specific area

Table 12: An indication of the variation in thinking, feeling, values and sentiments derived from the categories of the 206 political parties, registered for participation in the 2016 local municipal elections

	Categories of parties	**Number registered (%)**
1	Revolution / freedom / liberation	12 (13%)
2	Religious	8 (9%)
3	Socialistic/communistic/ideology	3 (3%)
4	Activity and change orientated	8 (9%)
5	Independence	11 (12%)
6	Employment/workers orientated	3 (3%)
7	Democratic	11 (12%)
8	Specific specified groups or groupings	17 (18%)
9	Academic	1 (1%)
10	Advising/educating	1 (1%)
11	Community orientated	19 (20%)

(Source: Electoral Commission of South Africa, 2016)

(Accessed 14 Sep 2016)

was plagued by ancient spirits (Personal experience of the author and the WWF-SA stewardship officer, Ayanda Cele, 2015).

- In the Mhlangase area of northern Kwa-Zulu Natal, between Pongola and Nongoma, farm land was bought by the Department of Rural Development from commercial farmers to be distributed to previously disadvantaged individuals (PDIs) from the area. However, some portions of the land had existing leases. In terms of South African Law, the principle that a lease is protected when a property is being sold, protects the tenant up to the expiry of the lease. However, the principle was rejected vehemently and threatened violently by those who held traditional views, which led to protests in order to evict the tenant (Weich, Attorneys 2017. Personal communication with the transferring attorney).

The new modernistic and humanistic approaches that study and describe nations and people wrestle with intrinsic and deep-rooted differences between groups of people that are hard to understand and resolve. These include the quest for power and ethnic differences, which inherently lead to many forms of inequality (Adejumobi, 2000; Irobi, 2005; Skinner, 1998).

It is the responsibility of a government to set sustainable national goals to ensure water security in terms of sufficient water supply and balancing of needs by means of, amongst others, a sufficient water

supply vision, balancing of needs, access, food production and control of losses. On a local and national scale, these measures require appropriate institutionalisation with the appropriate authority, application of legislative regulations and high accountability (Adejumobi, 2000; Irobi, 2005; Hedden and Cilliers, 2014). The latter are all crucial determinants of the degree of legitimacy of an institutional setting.

In order to examine the complexity of governing people and their conduct, Administrative Law, as well as the following pieces of legislation: the Constitution of South Africa, the Bill of Rights and the National Water Act (NWA) and the Promotion of Administrative Justice Act, Act 3 of 2000 are now discussed.

Administrative law is one body of legal rules, which regulates the exercise of public functions and public power or the legal authorisation to execute a particular function of society, business and organisations in South Africa. It reflects the theory of the state in which it operates, but also deals with concerns of democratic legitimacy and party politics. General and particular administrative law are concerned with the rational and reasonable balancing of rights, interests and obligations in the exercise of authorisation and regulation of the nature of public power and performance of public functions between public authorities and private individuals or institutions (Quinot, 2015, p3, 57, 61). Administrative law is supported by the promulgation of the Promotion of Administrative Justice Act, Act 3 of 2000 (PAJA), emanating from section 33(1) of the Constitution of South Africa. Accordingly any administrative action involving a decision taken by an organ of state in its exercising of a power that may affect the rights of citizens of South Africa must according to section 33(1) and (3) of PAJA, be procedurally and substantively fair.

It is, therefore, important to consider the structure and functions of the state such as provision of services like sanitation and water in terms of administrative law. Effective administrative law is fundamental to any rule of law and constitutional democracy, which is demanded by the Constitution and the culture of justice in South Africa.

The supremacy of **the Constitution of South Africa** and the conduct and obligations of legal rules are established in section 2, as is the fulfilment of the Bill of Rights in section 7 of the Constitution (Government of South Africa, 1996). In the execution of governmental functions, section 238 of the Constitution of South Africa makes provision for the principal of the delegation of authority to lower levels in the administrative hierarchy of government (Government of South Africa, 1996; Quinot, 2015:11). The separation of powers as a triadic categorisation of functions and institutions is described[14] by Principle VI of the Constitution. It is, as a means to an end, aimed at ensuring accountability and transparency, and securing common interest and responsiveness in the conduct and institutional structure of governance (Quinot, 2015, p38-39). A distinction is made between institutions and personnel, and the functions thereof. The capacity and recent trend of political leaders in South Africa to influence, control and even capture the administration of South Africa, thus resembling despotic power (Meisner, 2014), is also

[14] The Legislature, the Executive and the Judiciary (respectively sections 43, 85 and 165 of the Constitution of SA).

realised in the phenomena of eliminating accountability and excessive incidents of corruption, amongst others, with leaders in Parliament[15] (Eloff, 2017; February, 2017; Madonsela, 2016:14-26, 29-33).

The South African Bill of Rights (section 27) and the Constitution (sections 44 and schedule 5) promulgate the mandates and authorisations to national and provincial authorities to regulate South Africa's water supply and distribution. They further provide the mandates to interfere with provincial and local authorities to act in the public interest in relation to water resources and water services (Quinot, 2015, p 45).

The DWS is the custodian and authority of South Africa's water resources and water services. It is responsible for the formulation and implementation of policy and regulations to govern the sector and execute efficient water resource management to ensure sustainable economic and social development (Government of South Africa, 1998(a); DWA, 2013(a):1; 2015(a)).

The design of the National Water Act, Act 36 of 1998 (NWA) was driven by a socialist oriented political ideology in order to redress inequality, create equal opportunities for all citizens (Kemerink et al. 2011) and utilise the concept of decentralised institutions as vehicles for transformation (Kemerink et al. 2013).

In terms of the NWA, sections 28, 31 and 49, water right holders are not guaranteed that their envisaged water licences will yield the water that they are entitled to, but can expect that their allocated right will be reviewed to balance future human and environmental needs (Clarvis, et al. 2014). This, including the uncertainty of the land reform process is not, however, compatible with the western capitalist principles on which the South African economy is based (Kemerink et al. 2011). Such a reform in water management and water use will imply a change in water law and policy, which will subsequently result in change, adaption and/or discomfort in social, political and economic relationships between people. The playing fields of water law, water management and water use are, therefore, expressions of social, political and economic power relationships between people.

In relation to governing and managing South African water resources, the NWA provided for the establishment of 19 WMAs and the creation of 19 so-called CMAs. In terms of the decentralising principle, the CMAs would take over specific functions and delegations from the DWS to govern and manage water resources in water management areas. In this process, the current DWS regional offices would decrease in size and transfer a significant number of their powers and functions to the relevant CMA. As indicated, the number of to-be-established WMAs and CMAs decreased from 19 to 9 in 2016 (DWA, 2016). Only two of the nine CMAs are functional. Bourblanc (2012) expressed the view that because of the role of the

[15] The Nkandla development, the removal of Mr Nene as Minister of Finance, the alleged state capture and influencing of appointment of ministers by the Gupta family, SABC Board controversies, the recent appointment of Brian Molefe to Parliament, the emergency summoning by President Zuma of Finance Minister Gordhan while on a European commercial visit soliciting economic interest in SA, the Cabinet reshuffle in April 2017 and the replacement of Minister Gordhan with the inexperienced Malusi Gigaba as Minister of Finance, offer some examples.

envisaged CMAs in terms of regulation, authorisation and coordination of water users, it can be expected that political interference will be inherent in the composition of the governing boards of the CMAs.

Critical voids resulted from the lack or delay of important projects being executed such as the Lesotho Highlands Water Project Phase 2, for Gauteng's water supply from Lesotho (City Press, 2016; Meisner, 2014; Ntsukunyane, 2015; Timse and Ntaote, 2016) and the incomplete deliberations and resolutions of important projects to resolve the acid mine drainage[16] (AMD) in Gauteng (Bobbins, 2015; Greenpeace, 2011; Taylor, 2014).

Political strategies related to entities, governmental departments and contractors appointed to execute important functions revolve around political party interest groups and political clientele that are close supporters of specific political parties. In South Africa, it is common knowledge, conveyed in frequent TV news bulletins and newspaper reports, that there are allegations and debates over various role players and institutions regarding alleged state capture (Madonsela, 2016). Furthermore, incidents of cadre deployment by and in the current South African government of inexperienced and unqualified people (Erasmus, 2014; Van Onselen, 2012) have been driven by political and personal agendas that have resulted in corruption (CER, 2016(b); Newham, 2014), rather than rational deliberations to deal effectively with real environmental challenges so as to provide future sustainable water security.

A questioning of rationality was emphasised when the DEA and DMR created and accepted the "One Environmental System" in terms of which it is alleged that the DMR acts as judge, jury and executioner when considering the impact of mining applications on the environment (CER, 2014 (a), Webber Wentzel, 2014).

The pattern of community settlements is a social-engineering concern evident in many areas (Muller, 2012b). Community and homestead settlement is driven by the traditional customs governing how Chiefs and nKosi's provide plots for homesteads and the concourse of people in and around townships. The very disordered rushed settlement of people has resulted in no water availability and/or non-existence of infrastructure such as sewerage systems; this makes post settlement planning and implementation of important services extremely difficult if not impossible (Landman, 2016. Personal communication; Maree, 2016. Personal communication).

The continual abundance of news, electronic media reports and programmes about environmental and state failure problems and challenges in South Africa results in more nascent epistemic communities, which causes more public outcry that may culminate in dissatisfaction ranging from intense collaborations to extreme forms of violent rioting. Subsequently, it appears that a general agreement among South African communities has emerged about some basic facts regarding the decreasing quantity and quality of water

[16] Acid mine drainage refers here to the contaminated subsurface water filling up in mine voids, approaching the surface and decanting into the environment.

resources, and degrading and damaging impacts of human activites, especially urban infrastructure, mining near water resources, poor service delivery and inferior maintenance of infrastructure (CER, 2014 (a), (c), (d), 2017; Dabrowski and De Klerk, 2013; Hedden and Cilliers, 2014; Herhold, 2010; Reay, 2013, Swatuk, 2005). The South African context has demonstrated a decreasing capacity and competence to balance real-life realities such as a resource degradation, water scarcity and the necessity of food production versus the so-called "struggle promises" (Bourblanc, 2012) referring to populist political promises of abundance that were made to the ordinary people during the political freedom struggles.

Asymmetries in knowledge, resources, power, interests, needs, and characteristics of the political ecology landscape and political pluralism landscape are significant determinants in what constitutes a natural environmental problem and what the most appropriate solution to it should be (Balsiger and Debardieux, 2011).

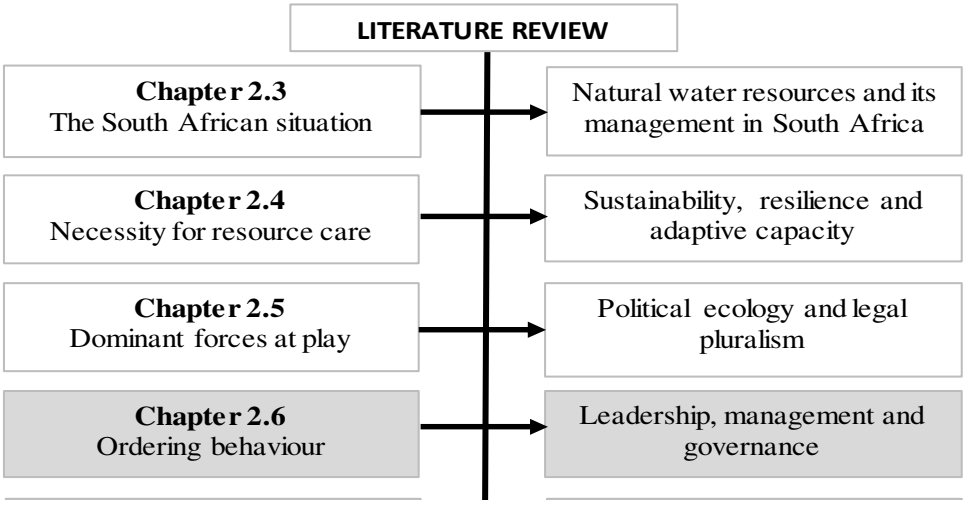
Thus, evidence has strongly suggested that the role and impact of irrational decisions and poor political leadership in South Africa has had dire impacts on environmental and water resources.

It is clear that WRM is more complex than merely sound environmental scientific management and care. There are challenging contrasts in dealing with the technical science aspects of water resource management as well as the social needs, which have been evident in the political agendas and failures of the government of the day (Balsiger and Debarbieux, 2011; Bourblanc, 2012). Social power, emanating from poor management, poor decisions, neglect, greed, competition between political, social, and/or economic interests, has very negative manifestations in institutional dimensions of water resource security (Bakker and Morinville, 2013). Managing the latter appears to be very difficult in reality because of different values and norms among humans (Dent, 2012; Dietz et al. 2003).

It is concluded that to create powerful networks of relationships so as to share a common vision is the ideal. The perceived homogenously democratic force of society in which all stakeholders thus search for resources and act in support of community interest flowing from a premise of rationality is, in fact, not a true reflection of reality (Hardin, 1968; Hoogesteger, 2016; Turton, 2003:134).

Therefore, the two different components of water resources, as provided for by the NWA and the WSA: natural raw water resources, and potable water supply and sanitation services should be kept separate so that each can receive its own particular institutional, governing and managerial attention.

2.6 THE GOVERNANCE-MANAGEMENT NEXUS



> *"It's not the institution which makes its students famous but the students who achieve great heights make their institutions famous."*
>
> ***Amit Abraham***

2.6.1 Leadership.

The concepts of governance and management, both ambiguous forms of steering (from the Greek as discussed below), cannot inherently take place within themselves alone, but involve the behaviour of humans (Scott, 2005; Tsoukas, 1994). Controlling and ordering human systems such as a group or nation require a human action which, in the normal course of life, may be viewed as execution of leadership. Leaders might be an individual, a government or an organisation.

Bourblanc (2012) and Rogers et al. (2000) suggested that, in terms of cognitive meaning, and the execution and sustainability of systems that are subject to leaders, a finer distinction of, and between, governance and management on various levels is needed. In terms of a realist premise, intrinsic behaviour determines human action, while human action effected through leaders eventuates in management and governance. Therefore, a finer distinction and relationship synthesis is now outlined.

Leadership, or a leader, refers to any person or organisation who exerts a significant influence by means of authority on the activities of other people; leadership may also be defined as promoting adaptive or useful changes (Gerzon, 2003; Schermerhorn et al. 2008:242-243). Inherently, leaders may act with integrity and high morals – or exactly the opposite. They might motivate and steer people to higher causes and prosperity or could break down perceived order, create retrogression, exacerbate violence and exert negative dominance over others. Regardless of whether one is a "positive moral" leader or a "negative immoral" leader, both types emerge from within the intrinsic psychological make-up of a human being which shapes behaviour, evolution and development.

Human behaviour refers to all emotions and physical actions that are associated with individuals. Individual motivation and behaviour stem from an intrinsic psychological dimension that urges action; this is most evident in the behaviour of small children (Deci and Ryan, 1985:11). Motivation is an example of a behaviour, be it the result of self-determination or psychological egoism that is critical in leadership (Ryan and Deci, 2000 a, b). Freud's theory of instinct in 1914, Allport's 1937 description of functional autonomy, Hull's empirical drive theory of 1943, organismic theories and the theory of self-determination propose that humans as organisms are active beings: therefore they intrinsically initiate behaviours such as reacting to their environment, and self-regulating or managing aspects of their drives, emotions and needs (Deci and Ryan, 1985:3-4, 11-12). Evolutionary psychology, behavioural genetics and self-determination theories posit that the inherent psychological development and needs of humans form the basis for competence, autonomy and personality integration, which is essential for optimal functioning and constructive social development; this eventually determines a person's standing in life (Leary, 2012:14, 20, 22; Ryan and Deci, 2000 a, b; Tsoukas, 1994). Motivation, an individual force that drives the level, persistence and direction of a person's behaviour or work is eventually actualised in the manifestation of leadership and performance by means of governance and management (Schermerhorn et al. 2008:111-125).

Hence, the existence and shape of human behaviour can only be described from a realist ontological perspective in that it is there because it is there. The many studies and theories that have endeavoured to describe what is observed and understood about human behaviour are secondary outcomes or constructs. However, primarily, human behaviour originates from within and is ontologically real (in terms of positivism) without the intervention of man with human constructs (in terms or relativism).

The word "governance" originates from ancient Greek, which means "to steer", while the word "management" is derived from Italian and French and means "to handle" or "to keep house". Both terms are ubiquitous, but also ambiguous (Bourblanc, 2012; Tsoukas, 1994). The two concepts have been defined and employed by authors in various ways. There has been a tendency among authors, and especially practitioners, to use the terms freely; thus, governance has been equated with management and/or both terms have been used interchangeably as a "catch all" phrase for different concepts (Bourblanc, 2012).

In various research publications, various descriptive names or terminologies in the domain of water and water resources have been linked to the same phenomenon The various descriptions, recorded from a number of publications, are shown in **Table 13.**

Table 13: The variation and similarities in descriptive names given to management and governance, abstracted from various scientific publications.

Water management	**Water governance**
	Corporate governance
Integrated catchment management	
Integrated water management	Integrated water governance
Natural resource management	Water resource governance
Adaptive water management	Adaptive water governance
Watershed management	Watershed governance
	Environmental governance
Water basin management	
Water flood management	

Sources: Quoted from: Bakker and Morinville (2013); Bourblanc (2012); De Stefano et al. (2014); Kemerink et al. (2011); Teisman et al. (2013); Pahl-Wostl et al. (2011); Pahl-Wostl et al. (2013); Van Buuren (2013); Van Koppen and Schreiner (2014); Van Rijswick et al. (2014)

The use of activities that comprise steering in both governance and management are exercised on different levels and to various degrees, depending on the level of authority and context. Effective water resource steering (governance or management) requires the involvement of many sectors of society to co-operate collectively within certain frameworks. It should reflect the same values, principles, aspirations and imperatives, and accommodates differences so as to achieve common objectives for the future (Muller, 2012b). The realities of degradation and challenges faced in WRM have to do with the anthropogenic actions and the ways it is being led, governed and/or managed. Humans tend to find ways to evade governing rules; this subsequently puts strain on both the government and management process of the natural water resource (Dietz, et al. 2003).

Confronting sensitive realities in such situations or the debate in and about WRM, has resulted in various forms of leaders, leaderships, organisations and describing terminologies. It has softened up in euphemistic terms such as “entrepreneurial”, “collaborative”, “neo-liberal”, “cross-boundary”, “bridging”, “democratic” and “reinventing” (Gerzon, 2003). In order to portray an image of a leader as one that seeks responsibility and sustainability, James MacGregor Burns (in Gerzon, 2003) provided a definition of good

leadership. It is stated as a situation where engagement amongst people takes place in such a way that the good leader helps others to rise to higher levels of morality and motivation. Such leaders are presumed to exercise good forms of governance and management.

The negative aspects of steering involve concerns about increasing failures. The latter are very evident in the manifestation of the growing incapacity and inefficiency of institutions and in particular, in various spheres of South African national, regional and local government, described previously. Such inefficiencies result in an impetus towards, and emergence of societal self-organisations through cross-disciplinary hybrid networks (De Villiers, 2012; Max-Neef, 2005; Teisman et al. 2013; Van Breda et al. 2016). These networks form beyond traditional institutional arrangements and in cross-boundary spheres to reflect hybrids of society, government and industry. There is a global and increasing trend towards self-governing, "less state" and a more "bottom-up" voice of society that expresses dissatisfaction with state failures, poor service delivery, degradation of resources and the protection of the interests of minorities against inefficient or oppressive majorities (CER, 2015 (e), 2017; De Villiers, 2012; Hoogesteger, 2015).

Where, how and when does one distinguish between governance and management and what is the relationship between the two terms? A study conducted by Ohlsson (1999, in Turton, 2003:148-150) revealed that reciprocating events follow a typical reciprocal/oscillating spiral pattern, which Ohlsson referred to as first and second order scarcities or events. In the Ohlsson model, a problem or event such as a degrading water resource that holds a certain risk for society is described as a first order scarcity, problem or event. The response of the authorities in addressing this degrading resource, known as the governance or managing effort, which is triggered by the first order event is described as the second order response. This response is a social response that emanates from the utilisation of social capital. The latter response may create new first order events or scarcities, which solicit new second order social responses to address the recent first order event. Oscillation may occur as time and activities continue (Ohlsson and Turton, 2000; Turton, 2003:158).

In the following sections, the researcher attempts to provide a better insight into the role, meaning and relationship of, and between, governance and management.

2.6.2 Management

Management in itself, and specifically, the management of environmental and water resources is a very complex task (Dietz et al., 2003; Teisman et al., 2013; Tsoukas, 1994; Kumar, 2015).

Management functions have been described differently by various schools of thought (Tsoukas, 1994). The classical school of thought defined management in terms of the fundamental functions of planning, organising, leading and controlling. The systems approach views management as a development of experience founded on objective organisational requirements for securing identity and sustainable

effectiveness. The historical school defined management in relation to the evolution of market economies and emphasised building of capital and development of products and markets through controlling people and processes. Subsequently, management has been defined by researchers similarly and or in the context of their study domain. Parker (2002, in Bourblanc, 2012) described management as the process of ordering and controlling people; the aim thereof is task performance. Griffin (1990:6) and Schermerhorn et al. (2008:14) defined management as a set of activities, including planning and decision-making, organising, leading and controlling, directed at an organisation's human, financial, physical and informational resources; the aim being to achieve organisational goals in an efficient and effective manner.

Borrini-Feyerabend (2007, in Cundill and Fabricius, 2008) and Nicholas and Steyn (2008:3) viewed management as an executive activity in which people plan, organise and integrate resources and tasks to achieve project goals

Various fields of management have been developed. Operations management is defined as the management of the direct resources required to produce the goods and services provided by an organisation (Chase and Aquilano, 1989:7). These direct resources are described as the five Ps: people, plant, parts, processes and planning. Nicholas and Steyn extended this definition to project management, in order to include the managing of systems of tasks by a single project manager. In contrast to traditional managers who are specialised in managing one discipline or department of an organisation, the project manager takes responsibility for a number of different disciplines to meet project goals (Nicholas and Steyn, 2008:6-7).

The management of water resources is much more comprehensive and involves an encompassing complexity (Bakker and Morinville, 2013). The Global Water Partnership (GWP) defined integrated water resource management as a process, which promotes the co-ordinated development and management of water, land and related resources in order to maximise the resultant economic and social welfare in an equitable manner but without compromising the sustainability of vital eco-systems (Jonch-Clausen, 2004; Snellen and Schrevel, 2004). In this context, management is an approach that links water to the hydrological cycle, the ecosystem and risks in activities undertaken for positive future humane outcomes for all relevant human and non-human role players (Ashton, 1999; Bakker and Morinville, 2013; Hipel et al. 2008).

The manager, also described as the team leader, is the person that normally executes those functions and faces unique challenges. Managers on different levels and in various disciplines are expected to lead people and processes to achieve organisational goals (Griffin, 1990:10, 14, Kumar, 2015; Schermerhorn et al. 2008:13-16). Mintzberg stated that the manager applies specific skills and competencies such as technical skills, human skills, emotional intelligence and conceptual skills to execute divergent functions and assist in immediate decision-making; accordingly, the manager eventually determines whether the institution performs well (Kumar, 2015). These skill capabilities of the individual, are thus primarily inherent behaviour (Kumar, 2015; Tsoukas, 1994).

In this vein, Tsoukas (1994) in accordance with Mintzberg (cited in Kumar, 2015) argued that the ability and skills of managers to manage the diverse activities and challenges of an organisation efficiently or inefficiently are primarily inherent behaviours. A relativist view implies that management can only be described in an empiricist domain and therefore, cannot be described in terms of causal capabilities.

Management is normally associated with an organisation or similar form of structure. Tsoukas (1994) described it as sets of constraining and enabling rules in a combination of constituent parts, providing the form through and in which the management functions are executed to achieve its objectives. The structure is based primarily on its functions and shaped by its strategy (Kumar, 2015). Strategy as the starting point of a business evolves deliberately and/or informally at any level in an organisation and most importantly, is the starting point of planning and eventual execution.

Finally, in terms of the realist paradigm, Bhaskar explained that the real world exists in three separate domains of consequential order: the real, the actual and the empirical (Tsoukas, 1994). The manifestation of each is triggered under specific conditions by the causal powers of the former. The concept is illustrated in **Table 14.**

Table 14: The relation and interaction of different causal powers as triggers for the realisation of events that manifest in three different reality domains.

	Real domain	**Actual domain**	**Empirical domain**
Mechanisms	X		
Events	X	X	
Experiences	X	X	X

(**Source**: Bhaskar, 1978 as in Tsoukas, 1994)

The synchronisation of the triggers depends on human activity in its execution of causal powers and manifests in the specific pattern shown above. Causal power mechanisms reside in the real domain. Once the mechanisms are activated, they trigger the realisation of an event that manifests in the actual domain. Once manifested in the actual domain, it is observed in the form of experiences in the empirical domain.

Therefore, management eventuates from intrinsic human behaviour, of which the latter, is both deterministic and adaptive. It determines what happens in the course of an individual's life, and to the social community and the organisation. In relation to this study, it also determines the eventual well-being of environmental resources. This intrinsic behaviour (inner mental and cognitive behaviour that eventual would drive activity) is therefore not primarily "constructed" by human action, but rather its consequence of exposure. According to Bhaskar, the external resultant action of human behaviour, such as fraudulent

and plundering leadership, is experienced as the empirical constructs of the human being (refer to Table 11).

This can be linked to the philosophy and challenges of natural water resource management. Understanding that the success or failure of the concept of IWRM is vulnerable to social, political and cultural factors in a particular setting is logical.

2.6.3 Governance

Achieving cooperation and acceptance of a shared responsibility in fragmented water systems with a divergence of role players is a very challenging task. These facts and drivers led to the development of many different approaches in order to overcome this challenge; these included sustainable development, adaptive management and integrated water resource management. A number of researchers have expressed the opinion that many of these aspects need to be addressed through good governance (Anderson et al. 2009; Ashton et al 2006; Biswas, 2004; Biswas, 2008; Duit et al. 2010; Edelenbos & Teisman, 2013; Funke et al. 2007; Malzbender et al. 2005; Turton et al. 2006). Teisman et al. (2013) considered these approaches as "forerunners" to water governance.

One may ask why, if there are good and efficient managers and management systems, is governance a prominent requirement? Furthermore, as both management and governance appear to be concerned with the same activities and actors, one may question the relation between the two.

Empirical work on the emergence of adaptive governance in a SES has illustrated the interdependence of four fundamental features of governance, namely; actors, networks, organisations and institutions. These four features combine to shape and influence governance processes in sustainable SES change (Osterblom and Folke, 2013).

Many definitions and descriptions of governance have been developed over time.

Folke et al. (2005) described governance as the structures and processes by which people in societies make decisions, share power and create conditions or institutions for ordered rule, collective action or social coordination. The concept was explained by Adejumobi (2000) and Balsiger and Debardieux (2011) as formal arrangements adopted by organisations when dealing with public issues so as to create and sustain welfare in society. Ashton et al. (2006), Araral and Hartley (2013:17) and Van Rijswick et al. (2014) viewed it as an exercise of acquired authority. Cundill and Fabricius (2008) explained governance in the context of a social-centred approach where emphasis is placed on partnerships between stakeholders and the relationships of power in the process of decision-making. Goran Hyden (1992, in Adejumobi, 2000) emphasised the authority, trust, accountability and reciprocity exchange in the relationship between the governors and the governed to reinforce democratic norms and practices. Jessop (2003) in Teisman et al.

(2013) referred to governance as "reflexive self-organisation of independent actors involved in complex relations of reciprocal interdependence". Borrini-Feyerabend (2007, in Cundill and Fabricius, 2008) explained governance as consisting of who decides what can be done and how decisions are taken. Bressers and Kuks (2013) posited that water governance takes place through five dimensions: multi-level, multi-actor, multi-perspective, multi-instrument and multi-resource dimensions. These dimensions adjust to each other according to three path dependency mechanisms: sets of values, cognitive frames of reference and power configurations. This is in accordance with the views of Balsiger and Debardieux (2011), Dent (2012) Edelenbos and Teisman (2013) and Hoogesteger (2015) that natural water resources governance is linked to values, norms and regulatory mechanisms when dealing with the challenges of use and subsequent impacts.

In the King IV report, King (2016:23-26) placed a strong emphasis on the interlinking of governance with sustainable development and ethics as primary imperatives. As governance does not stand on its own, it fully depends on good leadership and the underpinning of 17 principles to achieve "governance outcomes". King (2016:40) viewed governance as a process and function of "leadership" to steer and set strategic direction, approve policy and planning, oversee and monitor activities, and to ensure accountability. The desired eventual governance outcomes, the result of the integrated process, will create an ethical culture, obtain good performance of the group or organisation, maintain effective control and operate within the boundaries of legitimacy and the law (King, 2016:35-36, 40).

The King IV report further stated that governance cannot be approached and executed in "mindless compliance" with sets of rules, but is rather, the "applying of mind" for the best set of practices to achieve desired results in the context of the issue at hand (King, 2016:35). It concurs with similar arguments by Mintzberg that the manager in management should not be restricted by overemphasing *a priori* theoretical and rule basis, but ought to be allowed to utilise competence creatively in interpreting and making decisions that are based on the immediate in situ context (Tsoukas, 1994).

In dealing with risks and uncertainties, associated with the reasons for governance, Klijn and Koppenjan (2012) proposed a governance network theory that not only proposes an efficient approach to deal with the complexities, interdependencies and dynamics of public problem-solving and service delivery issues, but also provides the capacity to support learning. The development of this theory originates from research into policy networks, inter-organisational service delivery and policy implementation.

Governance network theory is characterised by the following core concepts and assumptions:

- Inter-dependent actors with their own perceptions of frames of problems and solutions
- Complex interaction and negotiating problem-solving, policy implementation and the implementation of service deliver.
- Institutionalisation of the relationships between actors evolving from interaction, power relations, and setting and regulating behaviour and rules

- The complexity of interaction and processes within networks requires guidance and management. These are aimed at facilitating interactions, exploring innovation and driving implementation.

Teisman et al. (2013) approached water governance in terms of an interactive compilation of an empirical concept and a normative concept.

As an empirical phenomenon, water governance portrays and describes what actually happens on the ground and shows a growing interdependence between the various actors in order to address issues through collective action. This enhances greater insight into and better effectiveness in solving challenges (Teisman et al., 2013; Van Rijswick et al., 2014). Teisman et al. (2013) referred to the co-existence and independent decision-making of a self-organised water board in the Netherlands, alongside a central water department as an example.

As a normative phenomenon, governance deals with organising decision-making and collective action. Teisman et al. (2013) described this as an organising network of interdependent actors in order to bring together the necessary resources to implement consented collective action. The normative perspective assumes the high probability that competing actors will co-operate to achieve a harmonious outcome. Mehta et al. (in Teisman et al. 2013) viewed this as a "tapestry of conflicting and competing authority claims" in the efforts to balance harmony and subsidiarity, as Bakker and Morinville (2013) phrased it.

Once the governance process, in the context of its multiple and complex dynamics, is understood, informed prescriptions about policies can be made. In broad generic terms, policies are described as instruments of governance and are, therefore, purported to be rational, non-theoretical and mutually beneficial goal-seeking tools to obtain desired results. Policy created by governments are, however, mostly informed by current ideological paradigms.

As governments seldom have all the necessary resources available in their execution of governance, they make use of external actors. In practice, this creates a space which diminishes the role and capacity that a single governance level may have in the formulation and implementation of policies (Bakker and Morinville, 2013; Teisman et al., 2013). It is here that the participation of suitable role players such as society and business is entrenched as stakeholders in the governance process.

All of the above definitions of governance may be combined into a process of informed decision-making that involves collective, interactive and joint actions which enable trade-offs to be made between competing users of a given resource so as to mitigate conflict, enhance equity, ensure sustainability and hold officials accountable.

It appears that governance is ultimately concerned with power and structures by which societies make guiding decisions. Accordingly, there should be an institutional architecture of suitable "fit and scale", which acts as a mediator to ensure constructive and efficient collaboration towards a mutually beneficial goal.

Governance then, comprise the constructs of people who make, implement and control it (Warner et al. 2008), requires entities to work together at multiple levels and disciplines through integrative thinking and stakeholder inclusivity (King, 2016:23). It follows then that the governing body just plays the role of overseeing the functioning of the management and performs no role in management itself. Governance relates to providing the right direction and leadership to manage the operations of an organisation sustainably. To achieve these goals in complex arenas and multiple role players, governance relies on networks of individuals, organisations and institutions at multiple levels. This description portrays a polycentric institutional and decision-making arrangement (Bakker and Morinville, 2013).

However, being a process in which people steer people and people activities, the efficiency of governance is strongly influenced by culture, social structures, preferences, historical background, educational levels, literacy and linguistic abilities, power relations and political economic relationships (Ashton et al., 2006; Muller, 2015).

2.6.4 Governance as a Trialogue.

In an attempt to examine core elements of water governance and interfacing linkages between three key role players, Turton et al. (2007) published *Governance as a Trialogue: Government-Society-Science in transition*. The key role players are referred to as the "governance cluster", the "society cluster" and the "science cluster". A consideration of the previous discussions from the perspective of the Trialogue model, reveals that it is clear that the science cluster responded well and produced new knowledge and insight. It was, however, not possible to create leverage to advance sustainable practices in South Africa (Burns and Weaver, 2008). Furthermore, the government and its political and governance processes did not achieve constructive practices. It appears that the society cluster, which presumably includes the business, industry and mining sectors continued normally despite the growing societal dissatisfaction with poor services and state corruption. It is submitted that the government-science-society combination did not appear to make the much-needed breakthrough on good governance and various levels in the clusters and grassroots levels, so as to reshape the health and water resources of the ecosystem.

The "Trialogue model of governance" was developed (Ashton et al. 2006; Turton et al. 2007) in an attempt to link the three main participating stakeholders in a partnership to promote close collaboration and interaction between each of these sectors, which are represented by the stakeholders. These are referred to as clusters and illustrated in **Figure 12**.

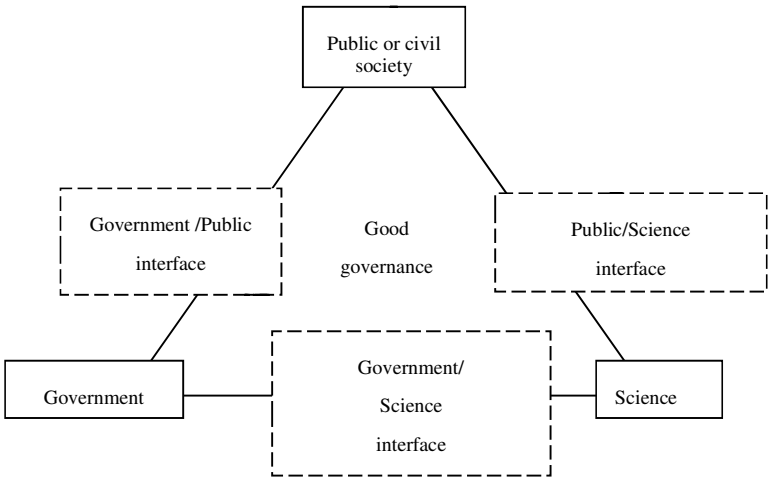


Figure 12: A conceptual diagram illustrating the linkages and interfaces between government, science and the lay civil society in their collective partnerships and contributions to "good governance"

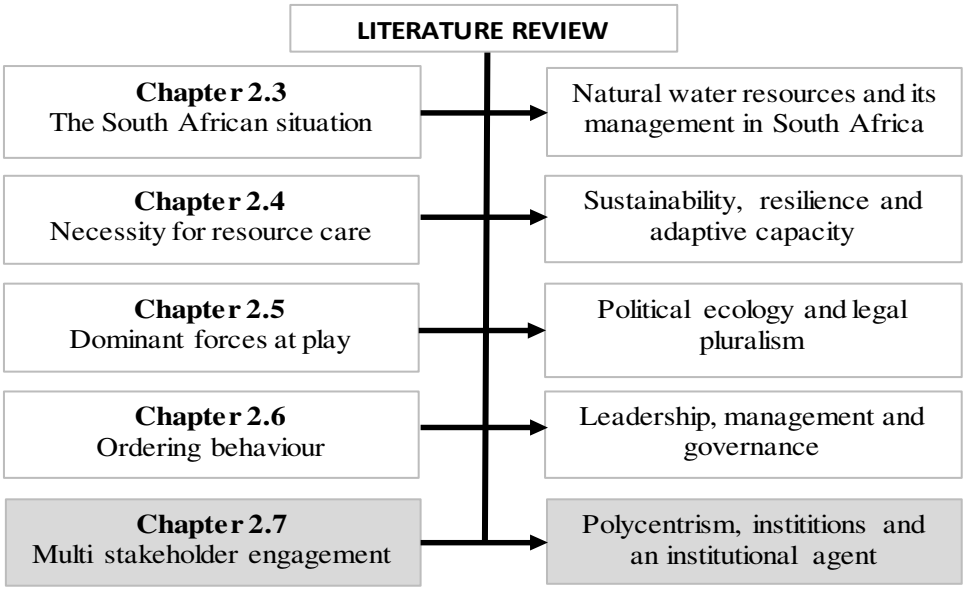
(**Source:** Ashton 1999)

The model attempts to emphasise the necessity of harmonious and productive relationships between the three clusters and to promote understanding, responsible decision-making and collective responsibility for efficient water resource management; hence, the name, which is a combination of the terms "triangle" and "dialogue".

In a similar fashion, Ioris (2014) conceptualised that the natural environment, civil society and government are all in a "trialectical" relationship of environmental statehood balancing interests and contradictions.

The three clusters of the trialogue model represent not only the obligations and responsibilities of their particular functions, but also specific responsibilities and actions in which they are involved in on behalf of society. Accordingly, these clusters should be interdependent (in the context of relying on each other, for example, survival) and mutually supportive, and their interactions should be guided by agreed principles and shared values to achieve their objectives (Haywood et al. 2010).

2.7 MULTI STAKEHOLDER ENGAGEMENT



"Contraria sunt complementa."

Opposites are complementary

Niels Bohr

2.7.1 The main role player interactions.

In order to balance underlying forces, the main role players within the SES, with special reference to natural water resources, find themselves in a situation of constantly moving dynamics (Reed et al. 2009). Within each component there are endogenous dynamics, while exogenous dynamics exist between the components. Examples include:

- Human communities and livelihood: The development of people and communities with internal dynamics, utilising the other role players, subject to beliefs, culture, religion, perceptions and power plays.

- Industrial and mining development: Creates wealth through dynamics such as finances, shareholder wealth. Also creates and develops tangible things needed for development and livelihood.
- Science and knowledge: Science represents the creation of knowledge, training and education by various forms of institutions to inform and drive the development of humanity, industries and governments.
- The Government: In South Africa, the South African government is the custodian of natural water and water resources through its DWS.
- The environment: The creation outside of humankind on and around earth that provides exploitable resources and a habitat for the living through ecological services.

The component – human communities and livelihood development

In relation to existence, human development possibly plays the most important role. Humans and human needs are the drivers in industrial and mining development, but also the exploiters of the environment to fulfil these needs.

Furthermore, as intimated, humans are the most difficult to manage. People and leaders have willpower and interpretations of their own, which are driven by numerous factors. They determine and create different entities and numerous policies through different perspectives, with both positive and negative outcomes, in their quest to develop communities and create livelihoods. This phenomenon is coined, for the purposes of this study, as the "human factor".

Taljaard (1997:114) defined community development as a process through which a community "*develops the will power to develop*", so as to obtain the skills with the objectives of influencing its own destiny and quality of life, and controlling and managing its own resources. The only factor that can, therefore, effectively comprehend the complex dynamics within a community as well as change the dynamics from one behaviour to another, is the community itself. Korten, Chamber and Taylor concluded (Taljaard 1997: 116) that in a development process striving to achieve desired improvements, the approach should be "people-centred" and not "people-orientated". Consequently, success can be achieved solely if a process is motivated, driven and controlled by a community itself (Taljaard, 1997:116). Such a process entails knowledge and learning, which are determined by the ingenuity of the community and intrinsic characteristics of the institutional forms that evolve from such a development need and process (Turton, 2003:147-170)

Working with complex systems, such as livelihood development and resource management, both developmental ethics and environmental science promote the solution of problems through cross-sectoral integrative and logical collective approaches, particularly between science and development practice

(Anderson et al. 2009; Reed, et al. 2009; Regeer and Bunders, 2009; Taljaard, 1997:26, 78, 112; Turton, 2003: 133-134).

Somjee (1991:1, in Taljaard, 1997:23, 32) showed that in the scientific and practice interface of community development or livelihood development, compartmentalised approaches occur, consequently resulting in isolated specialisation within different focus areas, where practitioners are fearful of losing the scientific and rigorous character of their own disciplines. This phenomenon is commonly known as the inefficient "silo" effect when working with complex systems; a characteristic of other science disciplines as well.

Accordingly, from a community development ethics viewpoint, Taljaard (1997:28) quoted Manfred Max-Neef (1991): "*....only a trans-disciplinary approach allows us to understand, for example, how politics, economics and health have converged*". Max-Neef argued, using an example, that if poor health is the outcome of unsound politics and the result of economic policies which are poorly designed by economists, and which affect whole communities, then economists can no longer claim that they are solely concerned with the economic field, that is, situated in their "own silo" of economics.

Taljaard (1997:32) elaborated on his interpretation of the argument that if communities are fixated on a continuous struggle for sustainable livelihood, which is perpetuated and enforced by poor management of related needed services, a pathology develops, which subsequently results in a collective pathology in communities.

This "collective pathology" characterised by violent public protesting is a common contemporary phenomenon in water quality and water services issues, which have dominated the South African televised and printed news media recently.

Research has indicated that the deterioration of environmental and fresh water resources and services in South Africa can largely be attributed to institutional and management challenges, poor accountability performance, poor application of sound principles, various forms of legislation, economic pressures, and forces and political power plays in this complex arena (Anderson et al. 2009; Boonzaaier, 2013; CDE, 2010; CER, 2012; Herhold, 2010; Malzbender et al. 2005; Schreiner, 2013;Turton, 2008).

With reference to the notions of participation in adaptive co-management in a complex SES, studies emphasised the importance of bridging institutional structures to coordinate and facilitate collaborative interfacing networks across different levels of knowledge and power systems (Hoogesteger, 2015; Hoogesteger 2016; Schultz, 2011). Experience as well as the evidence of Maganga et al. (2004) and Sokile and Van Koppen (2004) in Swatuk (2005) suggested that new institutions and mechanisms very soon create new second order conflicts and confusion. The localisation of existing institutions is considered easier and more practical to adapt than the establishment of new institutions (Swatuk, 2005). Gumbo et al. (2003) in Swatuk (2005) pointed out that efficient institutional practices can only take place when supported and guided by sound legislative powers.

Westley et al. (2013) stated that literature contradicts the notion that SES cannot be governed by a top-down command and control form of management. SES research has also discovered strong evidence of the role of individual agency in achieving transformations, from less adaptive to more adaptive management and governance systems (Olsson 2006). This apparent paradox suggests a need for a new framework of executing SES governance.

The component - Industry and mining

Attention must be given to the importance of industrial and mining development in livelihood development in certain contexts.

In South Africa, the mining sector, in particular, contributes, to a large extent, to deteriorating environmental and fresh water resources. Turton (2013) stated that for many years, South Africa was characterised by a self-interested culture in the mining industry; the role players developed their own style of arrogance and disregard for policies that were related to regulation and environmental protection and rehabilitation (CER, 2014a; CER, 2015 (a), (b), (d); 2016).

As will be alluded to later in the case study, the author's personal involvement with a new "coal mining tsunami" in search of unexploited reserves in the headwaters of the Pongola river catchment in northern KwaZulu-Natal confirms that dealing with this enormous wealthy industry is very difficult and costly. In contemporary South Africa, the difficulty of dealing with such an industry, is exacerbated against a backdrop of defunct support from appropriate governmental organisations and poor comprehension of the sensitivity of certain aquatic and terrestrial resources.

Environmental management and protective agents, in general, compete against colossal giants which enjoy powerful financial, administrative and legal support. The crucial drivers of industrial and mining development, besides their contributory role in providing needs, are finances and shareholder wealth that do not tolerate laziness and resistance (Haywood et al. 2010; Labuschagne and Brent, 2005). Such primary self-interest is not conducive to the furtherance of common interests (Turton, 2003:134), such as water resource care.

It further appears that current revisions in various forms of legislation in South Africa, with the purported objective of improving environmental protection and management, in practice actually benefit unscrupulous organisations in practice (CER, 2014a, 2016).

The component - Science and knowledge:

Science represents the creation of knowledge, training and education by various forms of institutions to inform and drive the development of humanity, industries and governments.

The component - Government:

In South Africa, the South African government is the custodian of natural water and water resources through its DWS. It acts through mandates received from the Constitution of South Africa, the National Water Act, act 36 of 1998, the Water Services Act, Act 108 of 1997 and the National Water Resources Strategy. Although the DWS is the custodian of water resources, the activities and influence of several other governmental departments that directly involve water resources, are; the Department of Environmental Affairs (DEA), Department of Agriculture (DoA), the Department or Rural Development and the Department of Mineral Resources (DMR).

The component – the environment:

The inter-relationships and interdependencies of natural resources and the services thereof are described as "natural capital" (Miller, 2006:7), which is the sum of "functions of" and "functions for" natural resources (Plummer and Armitage, 2007). Similar to, and through the hydrological cycle, water as a freshwater system supplies ecological and economic services to the environment and humans. (Miller, 2006:104), and supports all biological life on earth (Labuschagne and Brent, 2005; Miller, 2006:54; Pollard and Du Toit, 2008). The services offered by the freshwater system are presented in **Table 15**. Humans and human activities, the population explosions, and poverty and industrial developments involve complex nonlinear interactions with the environment, which exert great pressure on natural capital (Ashton, 1999; Cumming, 2011; Falkenmark, 2011; Hipel et al. 2008).

Table 15: The ecological and economic services offered by the freshwater system.

ECOLOGICAL SERVICES	ECONOMIC SERVICES
Climate moderation	Food
Nutrient cycling	Drinking water
Waste treatment and dilution	Irrigation water
Flood control	Hydro electrical power
Ground water recharge	Transport corridors
Habitat support for aquatic and terrestrial species	Recreation
Genetic resources and biodiversity	Employment

(Source: Miller, 2006:104)

The natural environment and freshwater resources are maintained through their own intrinsic resilient capacity. Concerned public role players and scientists in the field are desperately trying to develop new ways of thinking and methodologies, to protect the environment and freshwater resources against the relentless anthropogenic pushing against environmental resilience. Besides those outcries and voices, the environment does not have a voice to raise its concerns. It is silently losing resilience and the ability to deliver ecological services and soundlessly transforming into an undesired state, which human beings may not be able to reverse.

2.7.2 Integration, transdisciplinarity and structured engagement.

Kant (1795:vi) in his essay, *Perpetual Peace: A Philosophical Essay,* wrote that co-existence cannot be realised if a dedicated effort and duty ("indispensable conditions") amongst all role players are not exercised. Referring to nations, Kant argued that collaborative treaties amongst nations are only binding for as long as it is not in the interest of the role players to denounce them. Securing peace between individuals is only possible through the establishment of an institution.

Socrates debated that the many needs of a human lead to the creation of a state, which creates systems and methods to control it (Kant, 1795:5-6). Kant, Grotius and Rousseau posited that a state cannot function without people (pp 25-26), just as these groups (nations) cannot live side by side without recognition of each group's position, regulatory law and the state to protect themselves.

Hobbes (cited in Kant, 1795:42) and Kant (1795: 46) argued that because of the imperfect, malicious nature and untrustworthiness of human beings, coercive power and punitive arrangements are necessary to guarantee harmonious relationships in a community. Kant debated less pessimistically, but in the same vein as modern views of adaptive capacity and adaptive management, that "their capacities are destined to unfold over the course of time in accordance with the end to which they are adapting" (p 48). Kant was referring to his cosmopolitan view that humanity will eventually develop to a high state of civilisation. Kant further argued that the life of a human is filled with unattainable desires. Human life therefore purports to be full of development through endeavours, but however not of attainment, due to continuing unattainable desires.

In relation to the knowledge and views developed by Kant and the scientists of 1795, water, as a common pool resource and its related services provisions, is related to close linkages between the role players comprising the human factor. Constructs such as institutional development, governance, the creation and maintenance of infrastructure, and the control, monitoring and enforcement of policies and regulations appear to be a continuous endeavour in the quest for sustainable solutions. This interaction involves the use of top-down versus bottom-up interactive, communication and decision-making processes between the different role players' needs, funding and execution to achieve efficiency.

In every combined human activity, of whatever purpose, the human factor needs to establish, drive and maintain the concept. However, humans, as discussed previously, are fallible, have different values, beliefs, and capabilities, and concede to different forces and powers that exert an influence on or affect them.

By employing an integrated approach, many environmental management approaches and concepts have been developed. The following appear very frequently in policies, research and applications in the South African context:

- Integrated water resource management (IWRM) (Ashton et al. 2006; Bourblanc, 2012; Dent, 2012; Merrey, 2008; Pollard and Du Toit, 2008; Schreiner, 2013)
- Integrated catchment management (ICM) (Ashton, 1999; Pollard and Du Toit, 2008)
- Adaptive capacity and adaptive management (Cundill and Fabricius, 2008; DEAT, 2004; Folke et al. 2002; Grecksch, 2008; Government of South Africa, 1998a, 1998b; Herrfardt-Pähle, 2013)
- Sustainable development of the socio-ecological system (Ashton et al. 2006; Bohensky 2008; Burns and Weaver, 2008; DEAT, 2004; Malzbender et al. 2005; Uys, 2008).
- Interdisciplinarity and transdisciplinarity (Esler et al. 2016; Pohl, 2010; Max-Neef, 2005; Jahn, 2008; Van Breda et al. 2015).

Typically, these management models involve the integration and commitment of different role players of various disciplines on different levels in the sustainable, effective execution of the model or approach.

An interactive trans-disciplinary approach, from the viewpoint and understanding of philosophy and development ethics described by Taljaardt (1997), corresponds with numerous studies of multi-stakeholder processes and participation (Aaltonen, 2011; Eriksson et al., 2014; Muller, 2012a; 2012b; Nysmith and Dent, 2010; Pollard and Du Toit, 2008; Turton, 2003; Van Breda et al. 2016; Van Beek and Arriens, 2014). The most notable is the cross-sectoral IWRM approach of the Global Water Partnership (GWP) (Jonch-Clausen, 2004; Schnellen and Schrevel, 2004), which is embedded in the water policies of South Africa, illustrated in **Figure 13**

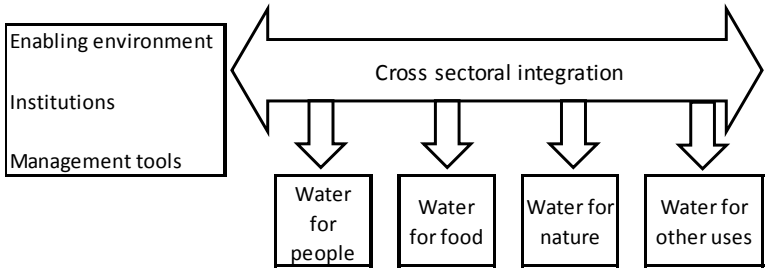


Figure 13: An illustration of cross-sectoral integration in the IWRM cycle.

(**Source:** Jonch-Clausen, 2004).

The interpretation of "buy in" in the concept of community development, from the viewpoint and understanding of philosophy and development ethics, defined by Taljaard (1997:114), corresponds with the two important steps of "commitment to change" and "commitment to action" in the seven step cycle model of IWRM, which was developed by the GWP. However, such an interaction in complex dynamic systems is non-linear and asymmetric, and experiences a constant flux in different positive and negative directions.

In its definition of "integration", the then Department of Environmental Affairs and Tourism in South Africa (DEAT, 2004), appeared to have moved very closely to the typical systems engineering fundamentals in that they described integrated environmental management in terms of:

- A full life cycle approach
- Different phases of a process from "cradle-to-grave"
- Integration of knowledge across different disciplines
- Integration of stakeholders and effective interaction and
- Decision-making and re-evaluation tools at the onset of new phases of the process.

Mistry et al. (2010) supported the relation of environmental management with the systems engineering fundamentals. Through a study in Guyana, theses researchers realised that an environmental management project would have been better managed if a "project management approach" had been followed effectively from the development stage. They concluded and emphasised that each stage in the project life cycle is important to prevent failures at later stages. The important difference between technical systems, as described in typical systems engineering and the human-technology-environmental system, is the intrinsic adaptive ability and self-organisation characteristics of the latter (Lister, 1998; Pahl-Wostl, 2007; Folke et al. 2010).

Numerous authors have shown that the integrated-participation paradigm contains certain risks. Large differences may not only exist in knowledge, values and needs, but also in actors that possess more time, skills and resources, but importantly, as Brugnach et al. (2011) contend, the way problems are framed by different stakeholders and emergence of complicating ambiguities. Furthermore, debates may reflect the views of those who deliver the most persuasive or dominant arguments (Schultz et al. 2011).

Schultz et al. (2011) executed a quantitative evaluation involving 146 Biosphere Reserves world-wide so as to test contradictory claims of how stakeholder participation and adaptive co-management correlated with management effectiveness to achieve conservation and sustainability objectives. Their findings show positive correlations between stakeholder participation, biodiversity conservation and legitimacy in the process and decision-making. They cautioned however, that stakeholder participation is no panacea. This caution correlated with the problems Ostrom (2002 in Muller 2012b) associated with management and

governance of common pool resources, such as free riding, over harvesting and over-crowding. This corresponded with the finding by Teisman et al. (2013) that acceptance of shared responsibilities and constructive co-operation is difficult. Stakeholder participation does not guarantee high quality plans and constructive actions. It has become evident that the types of stakeholder and volunteer categories, the extent of participation and knowledge are important determinants. Nysmith and Dent, (2010) and Schulz et al. (2011) supported findings of other researchers that "bridging" leadership of collaborating role players is essential to initiate, balance and sustain such a process to protect resources and reduce degradation.

Because of ever-present conflict potential in multiple stakeholder forums, objectives need to be clearly articulated and well presented in order to direct interactions appropriately.

Public participation in an integrative WRM process, is an iterative and continuous endeavour. The physical participation of the public is not viable in every step of the process. (Du Toit and Pollard, 2008). Collaborative engagement is time consuming, as noted, and comes at a cost, both in terms of money and the cost value by being away from individual core activities.

During current times of the Anthropocene era, accelerated increase in challenges of high impact non-linear complexities are experienced (Ferweda, 2012; Max-Neef, 2005; Tarolli et al. 2014). The natural water resource arena, comprises combinations of many different scientific disciplines or subjects, such as aquatic biology, soil science, botany, sociology, ecology to name a few. It follows that no single discipline, or subject, can understand and address such complex issues in its own subject silo. Reality suggests that the thinking of the majority of people and systems are still simplistic, linear and reductionist, purportedly due to current educational systems (Max-Neef, 2005). If the latter observation is more likely than not, it is argued, that to create epistemic communities and elevate thinking and debate amongst water resource stake holders towards more desirable non-linear and complexity thinking, implies a process of evolvement through iterative multiple stake holder engagement around complex issues. This option is an extension of an individual or single subject relationship (Van Breda et al. 2015). To add to the argument, successful constructive engagement of a multiple of stake holders around a complex environmental issue, depends on the capacity of the stakeholders to understand concepts as well as the capacity to take action in a sustainable manner (Jahn, 2008:2). Stakeholder engagement, however, reveals the discrepancies in the variance of knowledge, perceptions, interests of actors and methods or approaches taken or preferred. One approach, is the employment of a specific concept of multi stake holder engagement and collaboration, namely, the concept of a continuum of disciplinarities (Max-Neef, 2005).

Various and contested definitions of the concepts of disciplinarity exist (Pohl, 2010; Jahn, 2008; Van Breda et al. 2015, Esler et al, 2016; Max-Neef, 2005). The disciplinary continuum concept of Max-Neef (2005) appeals and purposefully blends with the critical realist concepts the author employs in this study.

The continuum of disciplinarities, refers to a progression from a mono-discipline, towards multidisciplinarity, pluridisciplinarity, interdisciplinarity and lastly transdisciplinarity (Max-Neef, 2005;

Pohl, 2010). The term disciplinarity, is the single subject matter that represents isolated specialization, such as chemistry, mathematics or aquatic biology. Multidisciplinarity, is a combination of different single subjects, without collaborative actions and synthesis between them. Interdisciplinarity, refers to a combination of single subjects that are in a particular two level hierarchical relation to each other, bound through a "sense of purpose". The higher hierarchical level, defines the purpose of the lower level. Interdisciplinarity between multiple stake holders, refers, according to Pohl (2010), to the use of respective skills and knowledge domains to address a common issue, by working together. An example is, that a discipline, water resource management (WRM), defines as the higher hierarchical level, the purposes of the lower level mono-disciplines such as engineering, soil science, ecology and chemistry, illustrated in Figure 14.

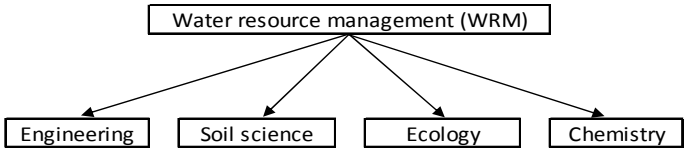


Figure 14: An illustration of the two level hierarchy interdisciplinary relationship of the discipline agriculture, defining the purposes of mono-disciplines such as chemistry, soil science, horticulture and electronics

(Source: Max-Neef, 2005)

Max-Neef (2005) describes a further higher hierarchical levels progression in the interdisciplinary relationship, namely: the empirical level, followed by a pragmatic level, then a normative level and finally a value level, each defining the purpose of the lower levels. This progression forms a simple but striking logic, illustrated in **Figure 15** through an example of subjects, related to water resources management.

The continuum evolves to transdisciplinarity. It is described as an orientation of thought around an overall purpose, by a transcendence of different disciplines that fuse together (in contrast to "working together" in the case of interdisciplinarity), to enable synthesis or development of a new approach (Esler et al. 2016; Pohl, 2010). The views of Jahn (2008:2) and Van Breda et al. (2015) concur by specifically describing transdisciplinary application, as a simultaneous balancing of the practical knowledge of society and the theoretical interests of knowledge, as the goals of science. It is in this context, knowledge is described by Jahn (2008), as understanding of context, (system knowledge), knowledge to determine the scope of decision making (orientation knowledge) and knowledge needed to put decisions into practice (transformation knowledge). The author posists that this can also be described as a process of mobilsining knowledge.

Max-Neef (2005), taking interdisciplinarity a step further, described transdisciplinarity ontologically, as a collaborative coordination between progressive hierarchical levels of; the purposive (or empirical), the

normative and finally the value interdisciplinarity. The lower purposive level, seeks to answer the question "what exists" and, stemming from learning from the empirical, "what are we capable of doing" The following normative level asks "what is it what we want

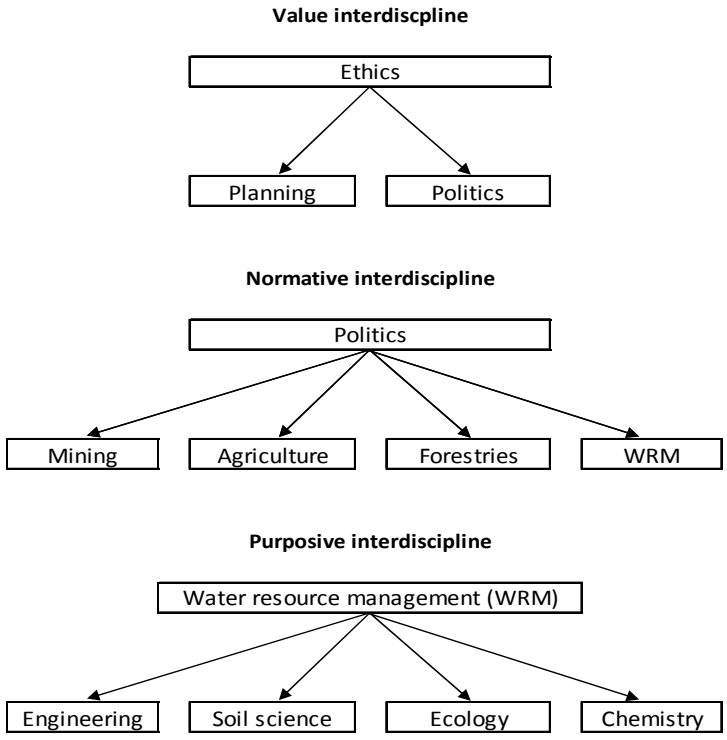


Figure 15: An illustration of the hierarchical progress from a base level purposive interdisciplinary relationship, through normative and value interdiscipline

(Source: Max-Neef, 2005)

to do?" resulting in planning and managing the things you wish to do. This forms a basis of normative actions. The final level of value, advances to what can be called the human quest, "what should we do" or "how should we do what we wish to do". This pushes thinking and understanding beyond the immediate, towards non-linearity and complex thinking, the stage required by the complexities of the Anthropocene. The notion here is to solicit reflexive thinking. This is, according to Homer-Dixon (2000 in Turton 2003:151) to address the unknown-unknown before it occurs. The author correlates this conceptual continuum of progressive hierarchies of interdisciplinarity and transdisciplinarity, with the concept of Bhaskar and the critical realist approach of the study, illustrated in **Figure 16.**

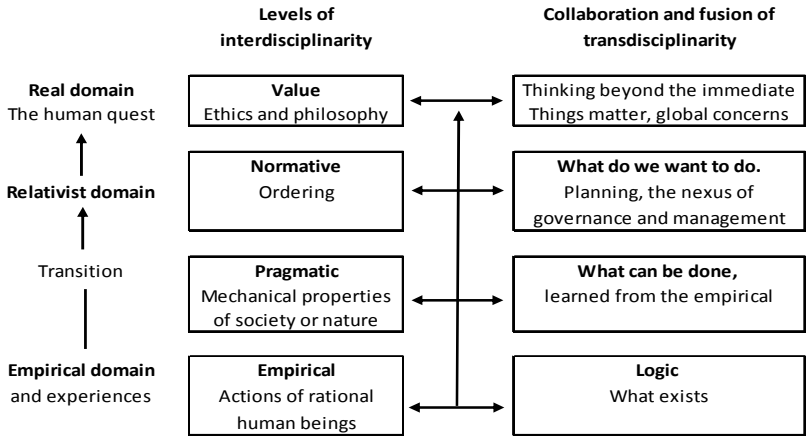


Figure 16: An illustration of a correlation between the critical realist approach and the concept of Bhaskar, in the left column, following with the hierarchical progress in the concepts of interdisciplinarity, and transdisciplinarity of Max-Neef

(Source: Adapted from Max-Neef, 2005; Tsoukas, 1994)

To make sense of the contemporary challenges in natural water resource management, an understanding and integration of system, orientation and transformation knowledge (Jahn, 2008) must first take place in the internal cognizance of the individual mind of the role player (Max-Neef, 2005). Subsequently, in the context of the disciplinarity continuum, a transition then takes place from the individual silo of knowledge (mono-disciplinaries), to a multi stakeholder platform (MSP) collaboration scenario. This collaboration is described as the interdisciplinary phase and is characterised by participants "working together". After a point of reflexive progress, when a transformation, synthesis and fusion of cognitive knowledge and perceptions between participants take place, collaboration then evolves towards new understanding and new knowledge, which is a next phase, described as the transdisciplinary phase. The instrinsic difference then is, according to Max-Neef (2005), the extent of knowledge understanding and synthesis. "Working together" between a combination of single subjects in a particular two level hierarchical relation to each other, bound through a "sense of purpose" be is interdisciplinarity. In transdisciplinarity, "fusion together" takes place synthesised by new non-linear thinking beyond the immediate. This distinct criteria, imply in essence an iterative interplay or transition process of evolutionary reflexivity to understand and co-produce (Jahn, 2008:5), which may be, as a defined objective between role players, be difficult to achieve.

This study uses the concept and logic of a continuum of disciplinarities (Max-Neef, 2005), and particularly the interdisciplinarity-transdisciplinarity transition, as the principles in the application of polycentrism and structured engagement with stakeholders.

2.7.3 Polycentrism and collaboration.

Humans and human development are interconnected through many fragmented disciplines such as agriculture, powerful industries like mining, the need for social development, and enhancing livelihoods; these disciplines all approach, use and treat the water domain differently. The different human stakeholders compete from various geographical and functional jurisdictions. Because of the complex and challenging nature of the water resources domain, its governance and management require a specific capacity to match its complexities, so as to resolve its challenges efficiently and legitimately in a sustainable way. In the 1960s, Hardin (1968) argued that centralised government and private property ownership were the only suitable arrangements that could sustain natural water resources over time. Contemporary thinking, however, has preferred decentralised power, the abolishment of private rights to water and transparency, as well as multi-stakeholder collaboration (Dietz et al. 2003, Hoogesteger, 2015). Muller (2015) observed that a dominant WRM view emerged, to return towards practical approaches to improve water resource security (Muller, 2015).

Bakker and Morinville (2013) and Merrey (2009) noted that it is presumed that social, economic and environmental decisions can be integrated via watershed governance instruments. It has been argued by others that such a watershed governance approach actually constrains governance contrary to the argument of a "problem shed". Teisman et al. (2013) warned that a "water centric" approach may focus on the "water sector" alone and ignore the fact that the majority of problems occur beyond the water domain. The latter are created outside of the water sector by other disciplines, such as agriculture, mining and urban development. However, an important concern emerges with the notion of a "problem shed". It is purported to "contain" and deal with social and political problems more effectively. Those problems are dynamic so that, over time, the "problem shed" may change and shift in its political context and effected area. This would lead to a frequent shifting of its locality. In addition, such a view also essentially contributes to converting a natural water resource or "water centric" focus into a social-political focus; this diverts attention away from the water and its related degradation and sustainable problems towards social problems.

The question is whether a "water centric" view, a "watershed" view or a "problem shed" view may contribute to water governance successes or failures. Because of differences in contexts of scientific disciplines such as the natural, social and engineering sciences, it appears that those most concerned about the environment are not able to solve real practical problems and degradation caused by society and development needs. Evidence suggests that in the absence of efficient governing institutions and/or systems operating on appropriate levels and scales, natural environmental and water resources are exposed to the overconsumption and degradation caused by anthropogenic activities (Burns and Weaver, 2008; Dietz et al. 2003; Lankford and Hepworth, 2010; Ostrom, 2002 in Muller, 2012b).

It is in this respect that a collaborative multilevel institutional approach and delegated authority make sense. Such a collaboration of different stakeholders around water, as a common pool resource, can be described as a multi stake holder platform (MSP). Multi stakeholder participation can solicits innovative thinking to enable improvement and/or conflict resolution. A MSP is defined as a forum of interdependent stakeholders from different disciplines that interact to exchange knowledge, negotiate to resolve issues and make collective decisions towards concerted action (Lankford and Hepworth, 2010; Röling 2002, in Warner et al. 2008).The acknowledgement of the differences between stakeholders regarding knowledge, education, experience and involvement in the functioning of society, suggests that participation will entail a system of layers that match each other and increase in level and scale with complexity, although it is desirable that they should reflect local realities (Regeer et al. 2009; Van Breda et al. 2015; Warner et al. 2008; Wester et al. 2003; Waalewijn et al. 2005). Bakker and Morinville (2013) indicated many authors who have shown that local partnerships in water resource management can improve efficiency and sustainability. In essence, the integration of various disciplines with the endeavour to create understanding and solutions, operate in a continuum of disciplinarities, described by Max-Neef (2005) as a progression from mono-disciplinarity to trans-disciplinarity.. This in itself requires capacity (Jahn, 2008) such as willpower, ability and a form of institutional arrangement (Bakker and Morinville, 2013) to achieve a balance between harmonisation and subsidiarity. Harmonisation is defined as the process of achieving regulatory efficiency and policy standardisation. Subsidiarity is the principle in which a central or higher authority does not take action (apart from its primary responsibilities) unless it could be more effective to do so than the action taking place at a lower level; excluding its primary responsibilities.

The operation in an interdisciplinarity and transdisciplinarity MSP illustrated above, create the platform that advances to the polycentric concept and approach, described by Ostrom (2010) and Muller (2012b).

The definition of the term “polycentrism”, which is followed in terms of this study, refers to the resolution of challenges and conflicts by an interacting process, involving a number of coherent collaborating centres of decision-making bodies, or mono-discipline role players, that are formally independent of each other (Bakker and Morinville, 2013; Lankford and Hepworth, 2010; Ostrom, 2010; Pohl, 2010). They may have overlapping jurisdictions that do not stand in hierarchical relationships to each other (Skelcher, 2005, in Van Rijswick et al. 2014). Ostrom regarded such a polycentric system as being characterised by a multiplicity of governing authorities at different scales that are better suited to respond to uncertainties and impacts, as opposed to mono-centric command and control management units or approaches. Ostrom further stated that each unit within a polycentric system exercises considerable independence in order to stipulate norms and rules within a specific domain such as a firm, local government, network of local governments or even a national government. The participants in such a polycentric system have the advantage of using local knowledge and enhance learning from others in the process, which supports on-the-ground management processes (Bakker and Morinville, 2013; Nagendra and Ostrom, 2012). Polycentrism is considered a more resilient approach to facilitate decentralisation of participation,

governance and management on different levels and lower scales (Bakker and Morinville, 2013). It is finally Galaz et al. (2012) that summarises a more practical application in this regard, where he referred to "polycentric order" as the processes, structures and collaborating mechanisms that allow complex divergent actor configurations, to self-organise, adjust and create learning and understanding across disciplines. It appears then that polycentrism is a structure (as a collaborative MSP), in which a particular mechanism of collaboration is to take place in the form of a particular process (the how and way discussions and mobilisation of knowledge take place). In terms of this study, the concepts of polycentrism, is accepted as the structural form and interweaving disciplinarity, the mechanism of collaborating mechanism and mobilisation of knowledge.

Derived from Max-Neef (2005), the role players take each other into account in an interplay between multidisciplinarity, interdisciplinarity or trans-disciplinary relationship, depending on the extent of purpose, understanding and integration. The collaborating role players enter into various contractual and/or cooperative undertakings, regardless of having various political and functional jurisdictions. It appears logical to deduct, that, in practice, this subsequent reflexive disciplinary collaboration progresses through different layers, in terms of knowledge deployment, scales of management, levels of authority and determinant hierarchies, being purpose, normative or value, illustrated in **Figure 15** and **Figure 16.**

Muller (2015) posits that no single organisational structure or knowledge entity is likely to serve the diversity of disciplines and knowledge involved in the WRM arena. Conrad (2015) demonstrated that an agent can bridge such a disciplinary divide. Bridging between multi disciplines and multi role players will most likely take place through organisational or institutional frameworks. He adds that frameworks, created to cross such divisions, may have very limited value, unless their governance and management power and authority are contextually formalised. Polycentrism enhances a better understanding of the variation in diverse outcomes of governance and management of common pool resources if based on the purpose, needs of society, complexity of resources and different levels of government involved (Nagendra and Ostrom, 2012). Muller (2015) argued that water as a common pool resource will best be managed as a common property regime by users who have a direct interest in sustaining the resource; this would function best if confined to relatively small groups (Muller, 2012b). This corresponds with the work of Ostrom (2010) which suggested that collaboration and communication between users of a shared resource may alter behaviour and the ability to optimise use depending on assumptions about costs and benefits.

Two South African incidents are presented that may furnish clear examples of collaborative failures that presumably resulted from a lack of proper understanding and cognisance of system-, orientation- and transformation knowledge of water challenges: one case in northern Kwa-Zulu Natal (KZN) and the other, the City of Cape Town water crisis.

The drought of 2015 and 2016 in KZN South Africa, resulted *inter alia* in no available water for 4 of the 5 towns in the region served by the Zululand District Municipality (ZDM) as the Water Services Authority (WSA) and Water Services Provider (WSP). Pongola, Paulpietersburg and their surrounding villages

receive water from the Pongola River system. The towns of Vryheid, Ulundi and Nongoma fall in sub catchments south of the Pongola River system. The WSP responsible for risk planning and supplying the 5 towns with water, failed to do so in 4 towns, which ran out of water.

Secondly, the water deficit threatening the metropolitan City of Cape Town[17] in 2017 resulted in constant poor constructive results and conflicts and bad-mouthing by the numerous high level role players involved around water supply and water use.

Cognisance should be taken of the dangers of the so-called "local trap pit fall" disadvantage. This happens when local actors (public, business, local municipalities or local NGOs) are seen as normatively better in water resource management (Bakker and Morinville, 2013).

Decentralisation is acknowledged as an efficient process to allow decision-making and administration at regional and local or ground levels (De Villiers, 2012). The actors on the ground level are the users of the resource and are, most of the time, directly dependent on the quality and protection of the natural water resource. Multi stake holder use of a common pool resource becomes more complex, especially when competition occurs that eventually results in accumulating and aggravating problems. This may affect other role players and the exclusion of some from the resource and/or consumptive rivalry, which will result in overexploitation and resource degradation (Giordano et al. 2014). This clearly emphasises the need for authoritative and enforceable legislative interdisciplinary policies and actions, emanating from the state or a government, to curb problems (Najam et al. 2003; Botsen et al. 2008). The main problem revolve around asymmetries of power and authority, which is always a central factor in the co-operation or negotiation of water use and water resource management (Balsiger and Debardieux, 2011; Bourblanc, 2012; Burns and Weaver, 2008). Legal authority and delegated legal authority, may be important to balance the presence of rational and irrational approaches and decisions in endeavours to act in the best interests of a community and of the water resource. However, governments seldom have the much needed resources available to address environmental governance and management challenges, and are forced to incorporate external knowledge and external actors; thus, providing an opportunity for society to play a role. The topic of legal authority will be elaborated on in section 2.7.4 below.

[17] The 2015 - 2017 drought was one of the worst in South Africa. The City of Cape Town is facing a serious water deficit after the 2017 winter rainfall did not bring any relief. While scrambling for solutions, role players are also heavily exposed to being blamed.

2.7.4 Institutionalisation and an institutional agent

> *"Nestor is the spokesman for the status quo, for the tradition-hallowed belief that institutional power equates with unquestioned authority."*
>
> ***Caroline Alexander,***
>
> ***The War That Killed Achilles: The True Story of Homer's Iliad and the Trojan War***

The South African water policy and legislation provides for a decentralised framework for water resource management in a WMA through a CMA and WUA so as to promote the objectives of efficiency, equity and environmental sustainability (DWA, 2013a; DWAF, 1998; Meissner et al. 2013; Muller, 2012b). Dent (2012) viewed the CMA and WUA in the South African water hierarchy as a direct interpretation of the IWRM approach. Dent (2012) and Meissner et al. (2013) debated that the CMA has an important role in the wider perspective of water resource management. The CMA is considered to play a leadership role so as to attract low to high levels of role players in dialogue and reflexive practice to build networks and relationships in the water resource arena. It was posited that it would be controlled by water users and other relevant stakeholders in a bottom-up approach (Dent, 2012; Muller, 2012a, b).

Because of the complexity and challenges of water resource governance and management as well as challenges that arise on various levels and scales, it is necessary to reiterate that governments do not have all the resources available and need to acknowledge and incorporate the role of external stakeholders (Burns and Weaver, 2008). The CMA, originating from decentralised regional offices from the DWS, may be exposed to the same situation. Other authors have argued that CMAs might be restricted by power politics (Bourblanc, 2012; Kemerink et al. 2011). For example, it was experienced that during the purported collaborative preparation of the business case of the proposed Pongola to uMzimkulu CMA in KZN, South Africa, no provision was made for the representation of agricultural advisors in the advisory committee to the proposed board and no provisions for the proposed board[18].

In a decentralised hierarchy as employed by the DWS, new institutions were created. The institutional description can be expanded in the form of an institutional agent model that transcends itself towards a self-organising system. It may even conform to the description of an entrepreneurial agent, which was proposed by Garud et al. (2007). The concept of "institutional entrepreneurship" was developed by

[18] The author participated in the process during 2014 as a stakeholder with the DWS regional office in Durban and its Consultant and provided various inputs in this regard.

DiMaggio in 1988 (Garud et al. 2007). This concept shifts the notion to that of an entrepreneur and moves the focus from a leader-follower relationship to the endeavour itself. It creates the imperative of seizing opportunities and mobilising resources through particular skills during different phases of a process, appropriate to the contextual demands of that particular phase in the transformation of the system. Similarly, the shifting of focus to an institutional level allows for the delegation and existence of legal authority, trans-disciplinary interactions, challenges imposed by transforming values, and economic and political systems.

In South Africa, other role players than governmental institutions, can execute certain delegated public functions by way of an "empowering provision" by the state (Quinot, 2015:86-87). The argument of a delegation of legal authority and functions to other institutions or organisations, goes hand in hand with question of increased or decreased state interference in certain activities of administrative law and public functions that affect its citizens and resources. It is aggravated by subsequent emergence in risks of mandates and affecting of rights (Quinot, 2015:42).

In the South African water resources context, legal authority to execute WRM functions as "public services", refers to the primary obligation of the state, which must take place in terms of section 195 of the South African Constitution and Administrative Law (Quinot, 2015:39). These impose values of fairness, equitably and without bias to promote the normative objectives of the Constitution.

Water resource management function obligations, are derived from section 27 of the South African Bill of Rights, that states, *inter alia*, everybody has a right to "…sufficient.... water;.." (Quinot, 2015:44). This obligation, via the South African parliament, imposes an administrative service, duty and authority on the state and the Department of Water and Sanitation (DWS) in the public interest. The question whether legal authority and functions can, and how, it should be delegated to other institutions or organisations, then holds particular critical elements and requirements. As it contains a public duty and entails the performance of administrative action, it is authorised and regulated by Administrative Law (Quinot, 2015:59-62). The decisive factor is the nature of the eventual function that is thought to be executed, namely the "what", rather than the "who" that will be executing the function (Quinot, 2015: 73-74; 83). This is a "functional" approach rather than an "institutional" approach. A complicating factor however, that may have certain consequences for a private or non-governmental entity, is the element of the consequences of decisions for citizens, or failure of a decision, that may affect legal rights that can then give rise to legal challenges (Quinot, 2015:p78-79; 87). These may be aggravated by perceptions of private gain, and servicing the interests of donor funders rather than the public (De Villiers, 2012; Frantz, 2015 in App I, I14; Mahood, 2017 in App I, I17).

As mentioned above, it is suggested that water as a common pool resource can best be managed as a common property regime by local users who have a direct interest in sustaining the resource. The critical role and value of institutional agents in stewardship, facilitating and democratising change management, and the interfaces between important role players and social learning are well-documented (Hoogesteger, 2015; Lindley, 2014; Ohlsson and Turton, 2000; Turton; 2003). The important benefit and focus of an institutional agent being positioned amongst the grassroots role players is to win trust and, being from the community and acting to their mutual benefit, take responsibility for its actions (Dent, 2012; Hoogesteger, 2015), and to create innovation to promote environmental value (Daily et al. 2009). The understanding of the value of natural capital and ecosystem services, in which water resources is embedded, forms a crucial foundation of institutional vision. Horta (2000) noted, in Turton (2003:146-147), that the internal dynamics of institutions determine how successful goals and sound practices are implemented and achieved.
Institutions contain the beliefs, rules and norms that describe reality for a particular group or organisation, and specify and justify formal and informal social behaviours and arrangements therein. Although institutional arrangements function to reduce uncertainty and mitigate opportunistic behaviour, institutions constrain behaviour as a result of processes associated with three institutional pillars. A regulative pillar guides action through coercion and threats of formal sanction, whereas a normative pillar guides action through standards of acceptability, morality and ethics. Finally, a cognitive pillar guides action through the frames, mind-sets and views by which actors know and interpret meaning and legitimacy in their world (Scott, 1995, in Garud et al. 2007).

Water institutions that progress towards self-organising systems develop the skills of governance and management on a local and catchment level through processes of learning and adaptive management. Accordingly, they balance culture, perceptions and societal relations for the purpose of co-existence. As the challenges incorporate scientific knowledge, industrial technology, social needs and livelihoods, it appears logical that sound trans-disciplinary interaction must be promoted.

Partnerships have played an increasingly prominent role in local governance. However, there has been considerable debate about the impacts, which the self-organising capacity of society and government intervention have on their effectiveness (Hoogesteger, 2015; 2016; Martin and Guarneros-Meza, 2013). The type of self-steering and organising partnerships of all institutional processes that organisations deploy, depend on the capacity of the leaders, the context in which they operate and the kinds of collaborative activities they attempt (Ker Rault et al. 2009; Muller, 2012a, 2015; Martin and Guarneros-Meza, 2013). Localisation of power, authority and influence are not always clear; this may contribute to inefficiencies and uncertainty (Muller, 2015). Hoogesteger (2015) and Martin and Guarneros-Meza (2013) showed that actor linkages are moving away from vertically integrated hierarchical bureaucracies towards networked organisational relationships so as to address complex issues in particular.

Depending on legitimacy and possessed authority, a strong focus on leadership, individuals and informal networks yields successful outcomes in dealing with environmental problems (Osterblom and Folke,

2013). Through networking, considerable collective capacity support and knowledge can be mobilised. This insight suggests that engagement communication and management of common pool resources need to take into consideration the expansion of an approach to improve participation, gap analysis and decision-making (Muller, 2012a, b). A possible success factor for the governance of a common pool resource includes a face-to-face contact and communication network, which may develop in such a system.

In their research, Martin and Guarneros-Meza (2013) studied "local leadership teams". They focused mainly on difficult problems, where these teams consult all partners in order to agree on goals and actions jointly for the benefit of all role players. Factors listed that enable agents in multi-sectoral networks to achieve their goals include: the capacity for self-steering, the extent of external steering or guidance by government, the capacity and drive of local actors to get activities moving, the interplay between external steering and local actor capacity, and the instability of the external environmental role player(s), which may impact on and decrease network efficiency (Martin and Guarneros-Meza, 2013).

Schultz et al. (2011) referred to numerous authors who found that the involvement of various stakeholders in natural resource management in complex multi-disciplinary SES improved efficiency, accuracy of information and knowledge, and increased the legitimacy of decisions and regulations as opposed to straight government-led, authoritarian practices. The capacity to enable communities to deal with water resource challenges, through knowledge and learning, is in essence a collaborative process, which culminates in the forms of organisations or institutions.

Within a complex problem domain, a strategic agent, as a form of guiding leadership, may be a way to address specific factors and challenges in the water resource arena.

Leadership realises and results in two forms; in the individual human person and the organisation or institution in its hierarchical level and/or setting. Both should exhibit two important values of leadership: integrity and competency, as described in the King IV report (King, 2016), and values of responsibility and transparency as described in the South African Constitution, section 1. Besides the ethical values described, leadership must possess the intellectual capacity to understand and interpret challenges. To be effective in a myriad of opposing forces and relationships, leadership must carry authority in law.

Leaders and organisations that deal with complex systems, which consist of various differences in knowledge, expertise and culture, entail layers that increase with complexity; these should match such complexity in terms of their own competence and, most importantly, reflect local realities (Sterling et al. 2010; Waalewijn et al. 2005; Warner et al. 2008; Wester et al. 2003).

In relation to leadership through a strategic agent, the focus is centered on the agent, who supports and/or facilitates, from a strategic position, the collaborative actions of a number of actors whose contributions help the system to progress through different stages of innovation and transformation. From the premise of experience and knowledge, the local institutional agent (IA) provides the opportunity to facilitate

discourse between grass roots stake holders and high level or powerful stakeholders. The physical interactive debates or deliberations between such groups (such as high level mining corporates *versus* farming communities) in a constructive functional MSP, which may at times be very challenging and volatile, can be described as "the transformation zone". In black townships in South Africa, such meeting places are called "war rooms" and depicts, according to local role players exactly that, "war" rooms. This is where dynamic interaction takes place where local challenges or disputes between role players are attempted to be transformed into sustainable solutions, illustrated in **Figure 17**.

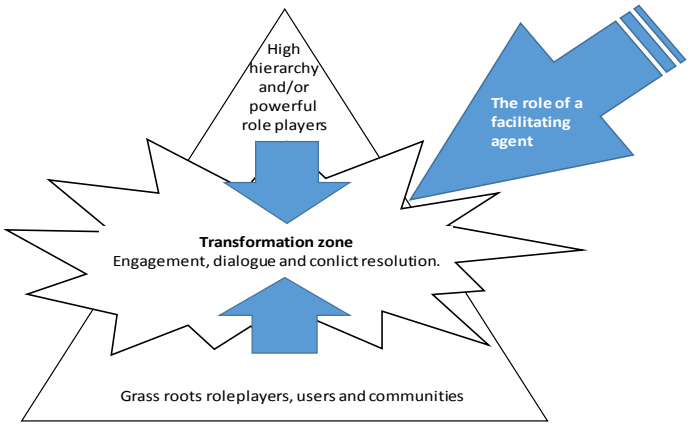


Figure 17: A simple illustration of the interactive "transformation zone", the process of discourse between different levels of competing stakeholders through facilitation of an appropriate agent

(**Source** An illustrative summary by the author)

It has been argued that a suitable agent with appropriate authority and delegated powers is able to facilitate and solicit rational thinking, functions and trade-offs to the benefit of a managing unit (Hoogesteger, 2015; Rogers et al. 2000). In a proper MSP where engagement takes place in terms of a polycentric inter- or transdisciplinarity setting, an agent will be able to act as a balancing centre between polarised views and politics, and facilitate the promotion of shared exposure, risks and values to benefit stakeholders.

The creation of balance and maintenance of control between different visions and multiple stakeholders in water resource utilisation, requires a good understanding of and rational thinking about social, political and scientific matters. It is accepted that efficient control of order and asymmetric power relations is eventually achieved through the application of normative and tolerant punitive measures, which emphasise the notion that the managing entity requires suitable legal authority (Dent, 2012). Such an institution should further reduce uncertainty, promote stability and legitimise support for decisions.

According to Prof. Dilip Menon, Director of Indian Studies at WITS University, South Africa could learn from India in that this country has a stable economic policy and an efficient civil service that outlasts prime

ministers and governments in power (Kyknet Verslag, 2016). Menon argued that this is a result of consistency in policy and solid institutional structures that ensure continued execution and enforcement over a long period.

2.8 CONCLUSION

The complex dynamics of various disciplines functioning in the socio-ecological system, that exert influence on natural water resources and its governance and management, were discussed in this chapter.

The ways in which insights gained through the literature review converge on the field of study, are summarised in **Figure 18.** This was done through correlating the different chapter content with the guiding questions proposed by Van Rijswick et al. (2014) and Dent (2012) for this study, presented in **Figure 2.**

Rife with challenges created by human activities during the course of the Anthropocene era, the resilience of the natural water resources and supporting natural environment is being threatened. Sustainability of natural resources, human livelihoods and animal life on earth is a necessity.

Despite the latter, the cruel reality of the perverseness of human behaviour, driven by needs, interests and power plays affects the integrity of the natural environment. The capacity and will of society to adapt certain behaviours to resolve these sustainability challenges are not only driven, but also burdened by socio-cultural evolution and political ecology. Adaptive capacity is largely dependent on intrinsic human characteristics and capabilities.

It has been argued that realities such as the intrinsic self-determination behaviour of humans that cannot be proved or disproved by observers, exist. For humans, intrinsic behaviour is the primary cause of actions. To argue in a critical realist manner that the reality is the cause, is to accept that the person has the power and ability to cause an event to happen (Easton, 2010; Scott, 2005). The preferences and values of a person, a critical and necessary component of a system, thus determine, reorganise and adapt his or her behaviour towards her or his group's culture of behaviour of a group. This eventually manifests in a larger system such as an organisation in which a new form of group and power dynamics emerges (Tsoukas, 1994). Accordingly, it is the discretionary powers and creativity of the manager that execute, control and maintain organisational activities. While the terms governance and management are at times freely and interchangeably used by practitioners in the water resources domain, they have specific meaning and application. Governance is not an activity that takes place by default only at higher hierarchical levels, just as management does not only take place at relatively lower levels. The processes of governance and management are interdependent. They revolve around the construction of a guiding strategy to be managed after proper interpretation of circumstances.

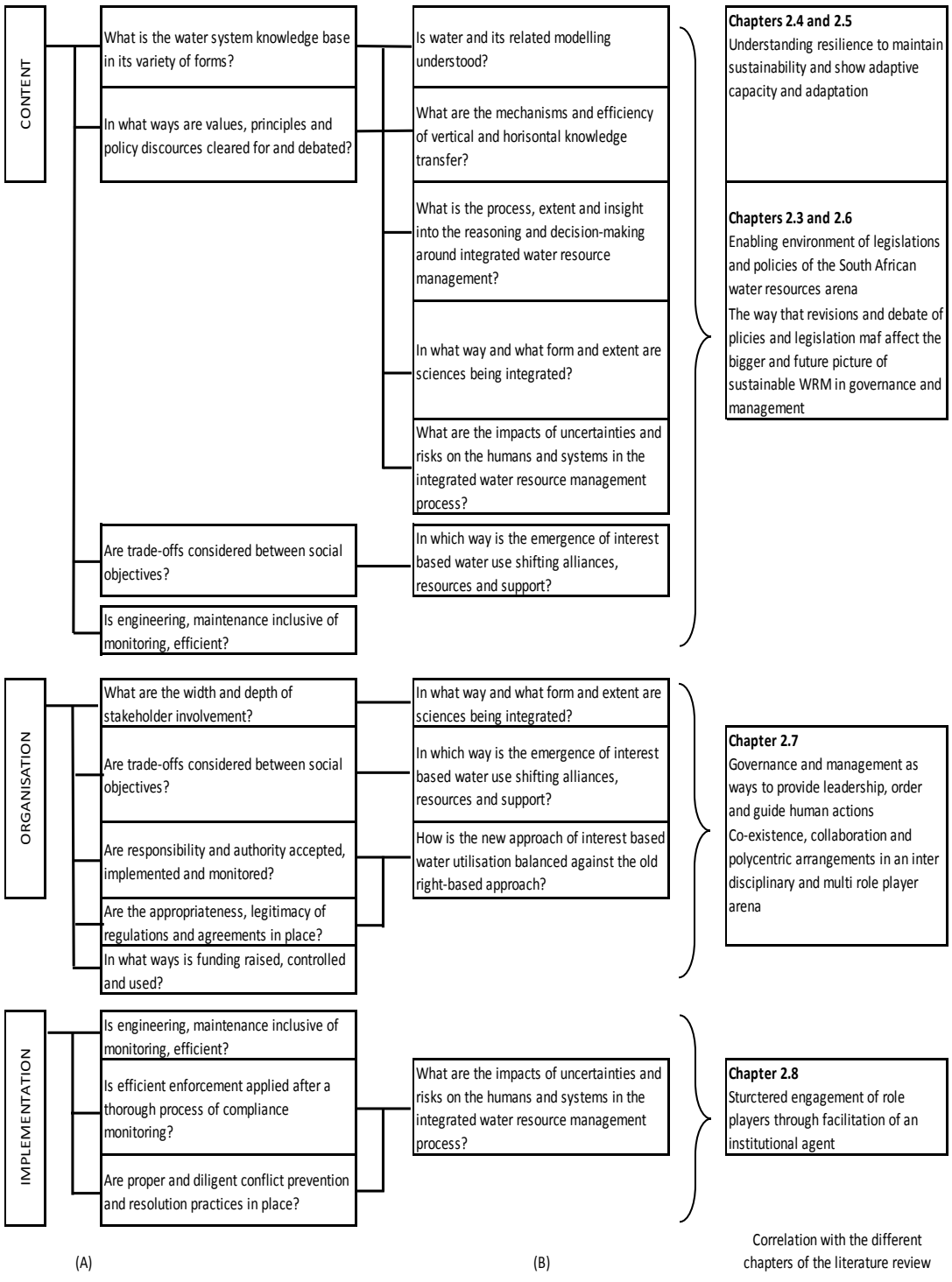


Figure 18: The convergence of the guiding questions from (A) Van Rijswick et al. (2014) and (B) Dent (2012) presented in Figure 2, with the different topics in the chapters of the literature review

To counter the influence of politics in and among humans in dealing with a common pool resource, different forms of legislation, policies, regulations and institutional frameworks are developed by nations. Values, norms and shared responsibilities if exposed to threats and the subsequent execution of constructive control measures, are important factors that characterise an efficient institutional arrangement (Balsiger and Debardieux, 2011).

In South Africa, the Government of South Africa, through DWS, is the custodian of water resources. After the new political dispensation of South Africa in 1994, excellent environmental and water legislation and institutional frameworks were developed. However, a disturbing phenomenon has developed in South Africa over the last number of years. Considerable uncertainty is being created in the water domain because of the loss of enabling governing institutional frameworks, together with an increase in inefficient management instruments, and infra-structure systems and resource degradation. This phenomenon is mainly attributed to the poor leadership and performance failures of the DWS as custodian of the South African water resources.

Many international and local researchers dwell on the need for a greater focus on more practical and constructive "closer to the ground" approaches to deal with the governance and management of water as a common pool resource. Because of a multiple of divergent role players (some users and other regulators), the concept of structured engagement through a polycentric mechanism was promoted by a number of researchers (Ostrom, 2010; Muller, 2012b; Nagendra and Ostrom, 2012). Polycentrism acknowledges the functional and authority domains of different role players. As an approach, it connects them around a mutual challenge. Through the effective employment of the multi-disciplinary abilities and resources, the objective is that rational and constructive collaboration will resolve the mutual challenge.

It is posited that this reasoning of institutional development pillars of Scott, has certain correlations with the critical realis approach, hierarchical levels of knowledge, described by Jahn (2008) and disciplinarity, described by Max-Neef (2005). This is conceptually illustrated in **Figure 19.**

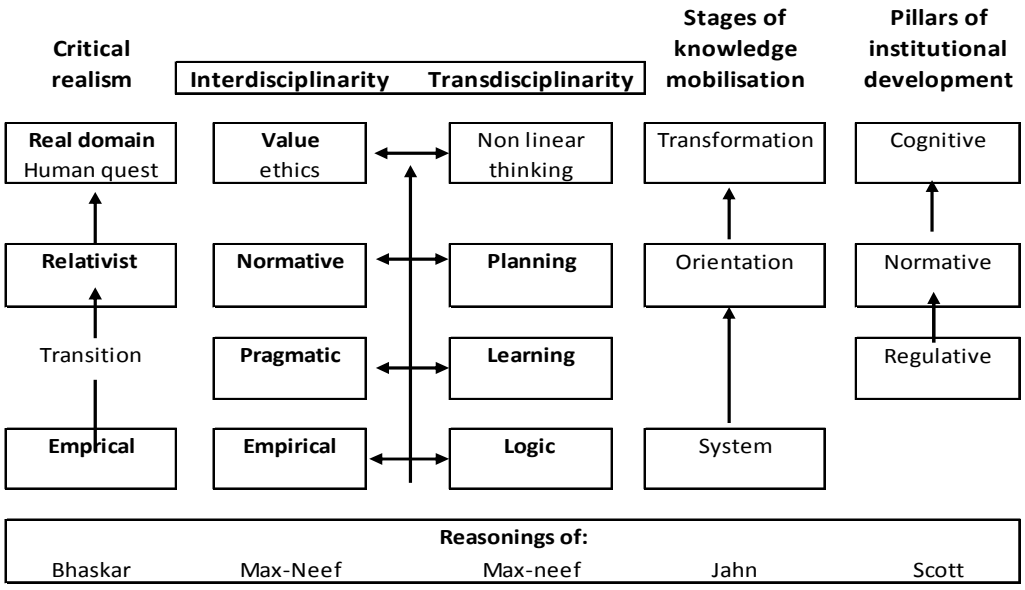


Figure 19: Correlations of the conceptual elements used in this study. The critical realist study approach containing the reasoning of Bhaskar, disciplinarity of Max-Neef,, the stages of knowledgement development Jahn, and pillars of institutional development of Scott

The characteristics of the role players that engage in terms of polycentrism can be summarised as presented in **Table 16.**

Table 16: The characteristics of role players and the contexts of their engagement in polycentric engagement

Role players are:	**to / in / from:**	**in respect to:**
independent	each other	jurisditions
knowledge entities	locally	area and systems
	scientific disciplines	knowledge, experience
	soft sciences	knowledge, experience
related to the issue	cause	causality
	being affected	impacts
	reach a solution	previous exposure
	soliciting support	sentimental relations
		value adding
		obtaining knowledge
		solicit funding
Role players have:	**in what / of:**	**in terms of:**
specific jurisdictions	*locus standi*	involvement
	authority	law
	ownership	access
specific scale	power	extent
	resources	people, plant,
	extent	networks
	distribution	communication
authority	authority	Law
	locality	exposure
	monitoring	Access, regulations
	compliance	enforcement
own networks	knowledge	local area, systems
	power	politicians
	support	resources, funding

Finally, human systems seldom work without good steering, leadership and facilitation, especially in a multi role player scenario. In the complex water resources domain, a knowledgeable leader, at the same time a facilitator, needs to be positioned at the most suitable position, scale and level. Such a facilitator can address challenges on a face-to-face level to ensure participation, co-existence and resource sustainability amongst end-user role players. An institutional agent, such as existing WUAs, offers potentially excellent suitability and positioning in this regard because of the capability of "localisation" (Swatuk, 2009) and "institutional entrepreneurship" (DiMaggio, 1988 in Garud et al. 2007).

The following chapter will attempt to synthesise the argument, in order to close a crucial governance-management process gap in a polycentric setting in the South African context through a facilitating agent.

3. SYNTHESIS AND CLOSING THE GAP

3.1 SYNTHESIS

Owing to the emerging, evolving and developing nature of knowledge and science, ontological and epistemological approaches and relationships are always relative to previous epistemological and ontological relationships used in earlier studies to describe these phenomena (Scott, 2005). In other words, old ways of thinking and descriptions have been replaced by new ones.

Humans created practices, institutions and regulations to deal with challenges in the natural water resource environment, from the premise of preservation and self-determinism, These are human constructs are ordered from the smaller to the bigger context. It follows logically that humans and what they create need to be governed and managed.

Governance and management comprise processes and activities that look at current as well as future processes and activities; both management and government consider the why and how. Both are characterised by hands-on-activities, how big or how small. Both function on various hierarchical levels of cognitive processes and understanding and carry specific levels of authority, associated with each level functions. Just as the functions of different hierarchical levels differ, the authority of governance and management differs distinctly. The latter is intrinsically close to the values and integrity of the people involved. Larger groupings of people and activities become governance systems further away from "hands-on" functions with less of a face. The people in the system begin to function according to the system's value, orders and integrity, whether these are moral or immoral. When two opposing groups or

larger systems interface, the question may be asked, who will succumb to whom, or who will save the system and turn it for the better.

In such a scenario, a system will and can do nothing in itself, as it consists of words on paper and rules in books. Strong and rational leaders may arise and build small strong core cells of individuals that develop cultures such as work or ethics. It starts on a small scale that will eventually grow so that the collectives become major forces to be reckoned with. The positive contribution of moral leaders will stimulate positive harmony, ethics and sustainability, or the opposite, in a case of immoral leaders.

It is emphasised, that thinking and consideration, both deliberate and informal, are the starting point of most cognitive activities for the purpose of understanding, making decisions and carrying out actions. Thinking and consideration purports to be the interpretation of circumstantial facts, understanding, design or planning that enables one to execute actions. To use a very simple example of setting up a business, a progression of events can be described as follows; from interpretation of facts and opportunities by an individual, a plan emerges regarding how to proceed to start up the business activities. The plan, coupled with the vision of the intended activity, eventually forms the basis of the strategy, just as the strategy is the framework plan of the action. The strategy may refer to the immediate mode of action or to create the future vision of the organisation. Once activated, the plan needs execution and steering, which initially starts in a form of management, in other words, to appointed or delegated people and assign responsibilities to execute functions. Once a threshold of complexity has been exceeded, (in another way, the size and extent of the organisation and number of divergent activities) another form of over-arching steering becomes important, namely governance. The latter attempts to maintain order and strategic viability for the long-term, in the form of rules, regulations and institutional structures.

This concept, illustrated in **Figure 20**, shows in a simple manner that activities which elicit management are informing higher levels about needs, guidance and processes. This fosters steering arrangements that culminate in governance. This interplay could be described as a "bottom-up" process, as it is accepted that an overseeing governance process rests at a higher level, whether cognitive or organisational. Similarly, governance provides guidance (in the form of the norms, regulations and boundaries of action and behaviour) to be managed at that level of activity. This can be described as a "top down" process of guidance.

Illustrated in **Figure 20,** this interrelated dynamic of interpretation and strategy that, it may be argued, ubiquitously exists both simultaneously and separately on all levels in dealing with challenges, forms a "governance – management nexus". The value of the generic concept of a nexus is that it provides a structured form in which a complex phenomenon can be explained or addressed (Muller, 2015). To efficiently execute tasks, it takes place on every level where eclectic practice needs to be directed through prescriptive judgements.

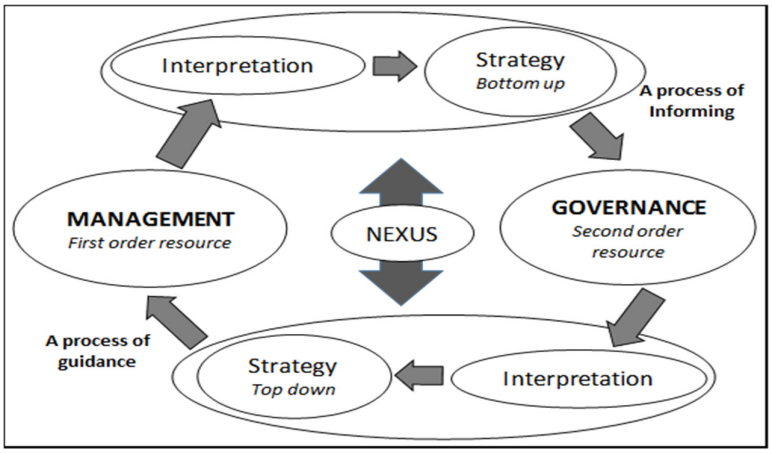


Figure 20: An illustration of the reciprocal dynamics of an interrelated process of interpretation and strategy, as the governance-management nexus

The simple narrative that follows, offers a practical demonstration of the arguments above.

A worker in a certain organisation was dissatisfied with the behaviour of a supervisor. After considering his own predicament, he lobbied fellow workers about his view and incited the formation of a support group. This support activity later transformed into labour action. Management considered the dissatisfaction of the worker, the resulting labour action and the alleged behaviour of the particular supervisor. After consideration, management informed the board of directors about the incident. The board reviewed the incident and current company policy and procedures and made recommendations to address such an incident. Subsequently, the board of directors formulated a revised human resources policy to guide management actions and the required code of conduct in addressing work-related grievances amongst personnel. Thereafter, the challenges were dealt with accordingly and sound work relations were restored.

An analysis of the above narrative, following the principles of Bhaskar (Tsoukas, 1994), is provided in **Table 17**. It illustrates that causal relationships between human and management actions lead to empirical constructs. It illustrates the relation between interpretation and strategising, as a logical nexus between management and governance of an issue on various levels.

Table 17: An analysis of the narrative describing the consequential incidents in terms of the causal relationships according to the model of Bhaskar.

	The narrative of incidents	Mechanism	Event	Experience	Real domain	Actual domain	Empirical domain
Worker level	Worker dissatisfaction	Intrinsic human emotion			X		
	Worker predicament	Interpretation			X		
	Lobbying	Decision	Strategy		X	X	
	Labour action			Empirical incident	X	X	X
Managemnt level	Manager behaviour	Intrinsic human emotion			X		
	Management consideration	Interpretation			X		
	Management resolution	Decision	Strategy		X	X	
	Management recommendation			Empirical incident	X	X	X
Board level	Board evaluation	Interpretation			X		
	Board enact revised HR policy		Strategy		X	X	X
	New work order and improved relations			Empirical incident	X	X	X

(**Source**: Tsoukas, 1994).

Understanding, interpretation of circumstances and strategising, are crucial cognitive activities that link the subsequent activities of governance and management to achieve sustainable desirable outcomes.

The above descriptions are more applicable to individuals and internal to mono-disciplines. This argument must however be extended towards interaction with and between a multiple stake holders (or subject knowledge domains) in complex situations that are posed by the water resources arena. The following crucial congruent elements are relevant, namely, engagement, disciplinarity and polycentrism.

In dealing with water resources and divergent stake holders, uncertainty, knowledge (or the lack of it) and interactions between the stake holders, play a decisive role in the process of dealing with issues. Interaction between stakeholders are a common approach. Engagement takes place in the context of disciplinarity, polycentrism, coupled with a strategy to physically deal with stakeholders.

3.2 CLOSING THE GAP

The fundamental research question sought to determine whether an institutional agent, in the South Africa context, could be parlayed to execute water resource governance and management in a local multi-stakeholder polycentric scenario. To arrive at the epistemological approach it was necessary to:

- determine what the drivers and cause of the South African natural water resource degradation were
- identify the role and relationship between the governance-management phenomenon and then to
- propose an institutional approach to resolve it.

There are two distinct parts to these questions: firstly, the visible and empirical observation that something, an event, is happening (the degrading environment) and secondly, the behaviour that led to such observations (actions such as governance or management).

Figure **21** by way of a chronological flow of events.

The intrinsic behaviour of self-determination and perseverance happens in the real domain. It evolves through group behaviour towards events taking place in the actual domain. In the actual domain, humans encounter challenges that play out through different activities which require different knowledge or discipline domains to resolve. As challenges and issues become more complex, constructs such as organisations, policy and regulations are established and formulated so as to guide and steer behaviour to maintain order and sustainability.

Finally, the argument concludes that these behaviours and divergences are addressed and controlled through a polycentric approach established in the multi stake holder environment.

A conceptual correlation was created for the critical realist approach between the concepts of Bhaskar, disciplinarity, knowledge mobilisation and institutional development illustrated in **Figure 19,** section 2.8. The reason is to synthesise a new concept in an attempt to close the gap (link the dots) between crucial elements towards addressing the research question of this study. Such a synthesis entails the following, namely; the challenge or specific purpose that requires role players to gather on a MSP, the condition (either by decision or circumstantial) that the collaboration evolves in polycentrism in terms of the objective, the relations between the entities and the relation to the issue. Through knowledge exchange and knowledge mobilisation, resulting in a "working together" collaboration, the role player's relationship is interdisciplinary. If the emerging result of the interactive collaboration breaks through a stage of understanding of knowledge through new non-linear thinking and a new co-production of solutions that fuse together, the relationship is transdisciplinary. This progressive continuum concept is illustrated in

Figure 22. The successful attainment of polycentrism and structured engagement with stakeholders should meet these characteristics.

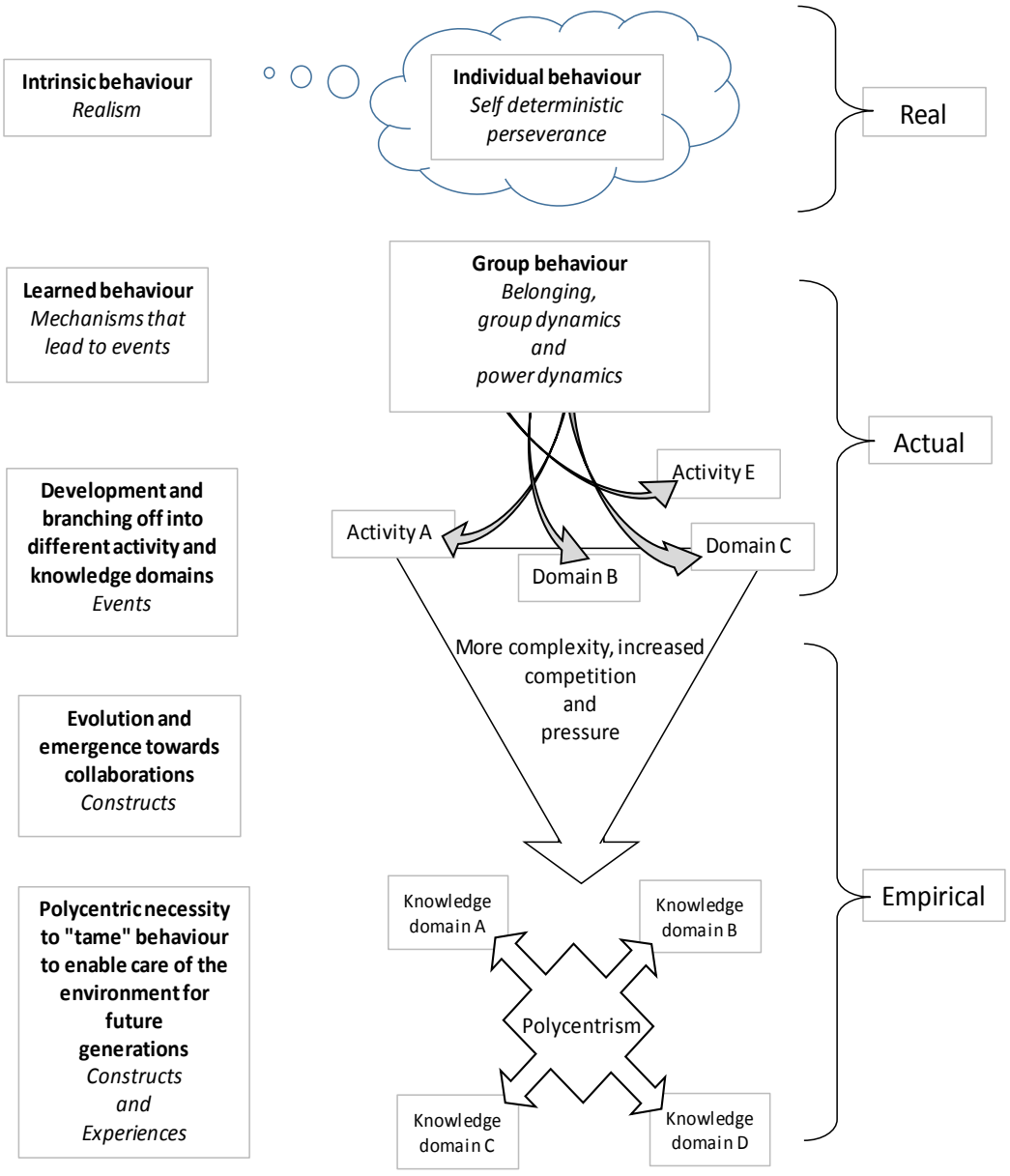


Figure 21: An illustration depicting a critical realist approach, following the description by Roy Bhaskar, of the progression from intrinsic individual self-deterministic behaviour as a cause, through learning by means of group/organisational behaviour towards the necessity of polycentric collaboration.

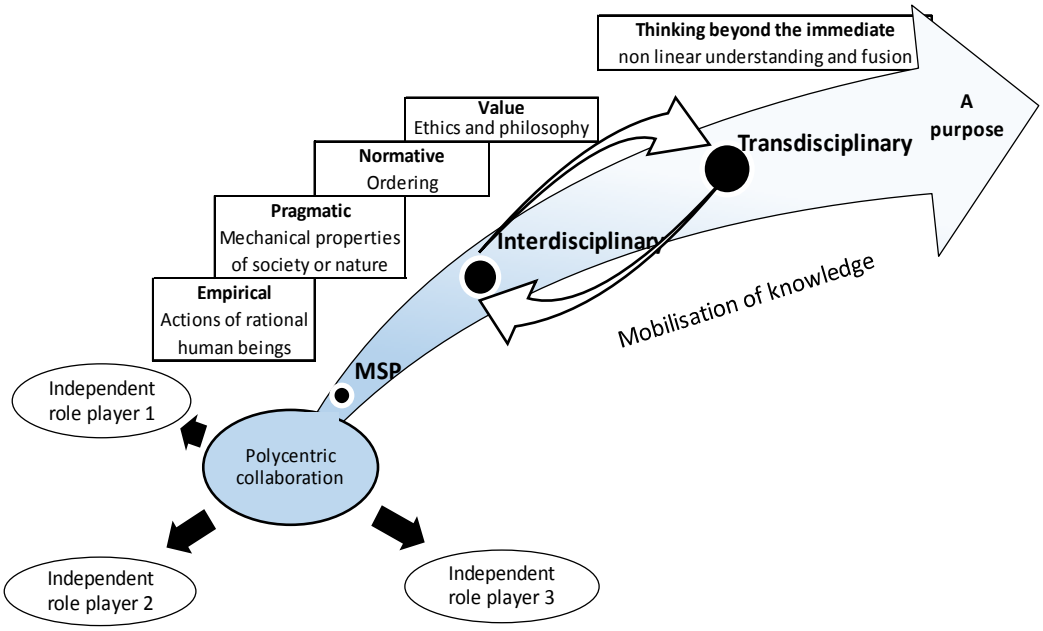


Figure 22: An illustration of a MSP of independent role players in a polycentric collaboration to attain a specific purpose through a process of knowledge mobilization through disciplinary engagements

3.3 A PROPOSED "POLYCENTRIC MANAGEMENT-GOVERNANCE" MODEL

"For I dip't into the future, far as human eye could see,
Saw the vision of the world, and all the wonder that would be;
Saw the heavens fill with commerce, argosies of magic sails,
Pilots of the purple twilight, dropping down with costly bales;
Heard the heavens fill with shouting, and there rain'd a ghastly dew
From the nation's airy navies grappling in the central blue;
Far along the worldwide whisper of the south-wind rushing warm,
With the standards of the peoples plunging thro' the thunderstorm;
Till the war-drum throb'd no longer, and the battle flags were furl'd
In the Parliament of man, the Federation of the world.
There the common sense of most shall hold a fretful realm in awe,
And the kindly earth shall slumber, lapt in universal law"

Tennyson: Locksley Hall

In the real world of water resources a network of conflicting and competing authorities and multiple role players co-exists. Many methods and ways have been developed to support and enhance understanding and collaboration. Addressing such challenges may result in either consensus over a resolution, followed by allocation of responsibilities, or a return back to separate operating silos.

The process for an approach to address such challenges may start on a MSP level in order to interpret circumstances, consider and debate options for a solution. In theory, if an approach is developed, accepted and its application committed to, it subsequently becomes a managerial process of operations and activities that take place on the ground to achieve constructive progress and results.

Behaviour amongst different role players in the water arena varies significantly in terms of their values, needs and objectives in how they perceive the way they will make decisions and conduct their livelihoods. Another important factor is the extent of their willingness to support or co-operate in addressing WRM challenges. A general problem hindering solution seeking and constructive action in a multidisciplinary environment on different scales and layers involving different organisations, relates to the issue of "waiting too long" during the process of debating issues, decision-making and changing behaviour. This is a common disadvantage of the procedures followed by governmental role players especially.

Numerous researchers have called for a more nuanced approach to governance challenges in the water resource arena (Anderson et al, 2009; Bakker and Morinville, 2013; Muller, 2012a, b; Ostrom, 2010, 2012b; Pahl-Wostl, 2011, 2013). This requires the creation of suitable arrangements, hierarchies, institutions, and power distributions among role players.

Structured engagement, as opposed to informal engagement (Du Toit and Pollard, 2008; Muller, 2012a), can be an approach that can guide multi role player collaboration and generation of suitable alternative solutions to cope with natural resource pressures, as illustrated in **Figure 22**. Similarly, a process of collective action (Ostrom, 2010) refers to a MSP approach to address inter-disciplinary WRM problems. If efficient, such approaches enhance learning and build the resilience of the community as well as the environment concerned.

Structured, from the meaning of the word, also implies a systematic ordering. It follows that a framework should exist to order the role players around common challenges to add value to the engagement process.

In an attempt to address these challenges in the local water resource environment in South Africa, an institutional model is proposed below.

As the empirical experience in the case study (of the following chapter) will indicate the regional office of DWS from Durban, South Africa, the first tier in the WRM hierarchy, did not appear to have been executing WRM functions in the area of operation of the case study since 2001 (Bohmer, 2015; Cronje, 2014; Endres, 2015, Filter, 2015; Hambrok, 2015). This appeared to be due to a combination of various reasons (Reddy, 2016a; 2016b), such as: distance, time, budget constraints and commitment to functionality. It appeared that over distance, offices such as a regional office of DWS cannot ensure efficient interconnectivity and maintain functional responsibilities to enhance progression on the ground. It is because of these reasons, that the to-be-established CMA would most likely also not be able to effectively fulfil the WRM role on the grassroots level. The CMA would likewise (as with the DWS regional office in Durban) not be in close proximity to the grassroots levels of users and abusers within a basin region. The national WRM approach in terms of certainty in current policies and hierarchy such as the NWA and NWRS2, is compromised, uncertain and aggravated because the recent notice from DWS, as mentioned, indicated that CMAs will be reduced to only 1 for South Africa (DWS, 2017; SAAFWUA, 2017). These incidents and conditions that developed, described in chapters above, render local WRM functions inefficient and incomplete.

The author therefore proposes an institutional agent to carry out such tasks, such as an existing strategically positioned one, the water users association (WUA). In South Africa, WUAs exist, they are ideally positioned at grassroots level between the local societies who create and sustain livelihoods and other major role players and may be a cost effective approach to fill the institutional gap. In terms of a strategic agent, the notion is associated with one suitable individual entity that carries sufficient knowledge, is accorded appropriate authority and is both permanent and in close proximity. It creates a central point of

reference, contact, administration and utilisation. Empirical experience suggests that real-life tensions, fears, needs, deliberations and an understanding of local issues cannot be experienced on higher levels, on large scales and over far distances (Dent, 2012). A WUA interacts on local level through a sense of collective, belonging and credible action and social learning, in close proximity with users and stakeholders in a catchment.

The approach through the facilitating institutional agent involves an interplay in interdisciplinary or trans-disciplinary collaboration between the relevant role players from various levels of power, knowledge and motives in the local water resources domain (Max-Neef, 2005; Pohl, 2010). Such a scenario, when acknowledging the different role player's own jurisdictions but experiencing mutual challenges, is a polycentric setting, alluded to in chapter 2.7.2 above. A polycentric approach creates an efficient operating base to employ a structured engagement process to mobilise knowledge to reach a purpose.

As a point of departure, the excellent "Trialogue model of governance", developed by Turton et al. (2007) is used as the theoretical basis, described in chapter 2.6.4. An improvement and expansion of this triangular model is proposed by developing a "tetrahedral" model. The crucial components of the proposed model, illustrated in **Figure 23,** describe a framework:

- An identification of five main clusters of role players in the local water resource environment. The characteristics of these clusters are summarised in **Table 18**.
- An institutional agent forms the pivoting basis of the model, supporting the four main role players
- The institutional agent is a crucial role player around which facilitation, bridging, educating and compliance, monitoring and enforcement can take place on local catchment level.

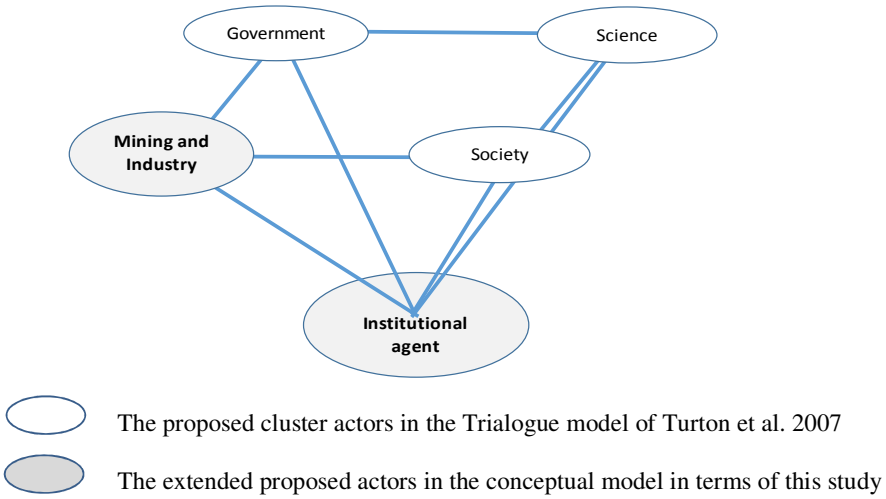


Figure 23: The proposed governance-management model for local WRM in South Africa in the form of a tetrahedron. Four clusters of main role players interact in a polycentric setting, with a facilitating institutional agent, through structured social engagement in the SA water resources context

Table 18: A description of the characteristics of the different actors in terms of the proposed governance-management model.

Government	Science	Industry and mining	Society	The WUA as the institutional agent
The SA Government as the legislative authority of the country. The DWS is the custodian of water resources in SA. Other governmental departments which are relevant and impact on the SA water resources. Statutory bodies such as provincial, regional and local government and municipalities.	In broad terms, the formal knowledge creating institutions such as universities, research institutions, and knowledge generating NGOs.	Industry and mining that operate in local areas and have an interest in water, such as direct access and direct impact on natural water resources as users and/or polluters.	All role players of civil society that are not part of the other clusters. They are the citizens of SA, the laymen and users utilising and relying on the water source for their own benefit in creating a livelihood. Members of this general and major portion of society do not have full knowledge and comprehension of governing legislation, regulations and scientific knowledge pertaining to water resources, but are affected by negative impacts on and mismanagement of the water resource.	The parlayed water management institution on local level, which is an arm length's reach from the physical resource, and livelihoods that depend on the resource. It has to possess delegated and assigned authority to exercise authority in management, monitoring, compliance and enforcement to protect the water resource and supply of raw water to lawful users.

- Polycentric interfaces take place between the four other main clusters of actors
- Engagement with role players takes the form of a structured process enhancing the governance-management nexus of natural water resources.

It is proposed that the institutional agent crosses the disciplinary divide through facilitating challenges on the catchment level (grassroots level) between:

- Civil society, the users that create livelihoods in the physical environment
- The layers of governmental role players, departments and divisions
- The local mining and industrial role players and
- The scientific communities that generate and produce knowledge and data.

In terms of current constraints in the South African water governance context, however, the WUA is a neglected third tier in the current institutional framework. It therefore needs to be parlayed in specific ways, which will be alluded to in the description of the case study.

In terms of this model, structured engagement is a crucial component and delicate process executed by the agent in the polycentric approach to address mutual challenges. Different role players look at experience and deal with perceived challenges in different ways.

It is therefore proposed that structured engagement be a process to:

- Acknowledge the separate jurisdictions of the role players and social learning
- Define and address a challenge within its particular but holistic context and impact
- Involve appropriate role players in terms of its extent of participation (described as "width") and extent of contributing potential (described as depth).
- Define the different role player responsibilities with respect to the challenge that evolves into joint support but with separate responsibility
- Deal with the challenge in terms of a life cycle approach, that is:
    - a definition of the challenge
    - planning and phased solution where appropriate
    - role identification and role distribution
    - initiation
    - execution
    - closure and completion assessment
    - retirement of the particular phase and/or effort
- Apply appropriate and diligent authority where suitable and needed towards the situation and or role players.

This proposed conceptual polycentric model, is indeed in the context of what Merrey (2008) suggested: that basin role players identify challenges and collaborate to find appropriate solutions and attempt to implement them.

4. RESEARCH CASE STUDY

4.1 INTRODUCTION

This study attempts to answer the fundamental research question, in terms of the propositions in the conceptual model: whether an institutional agent can be parlayed to execute water resource governance and management through structured engagement in a polycentric multi stakeholder scenario of a water catchment in South Africa.

For this purpose, the unique case of the Impala Water Users Association (Impala WUA) is introduced.

The characteristics, praxis and recently expanded role of Impala WUA, as a mature self-steering local water management institution, is evaluated in terms of the propositions of the concept model described and illustrated by **Figure 23** in section 3.3.

4.2 SITUATION DESCRIPTION

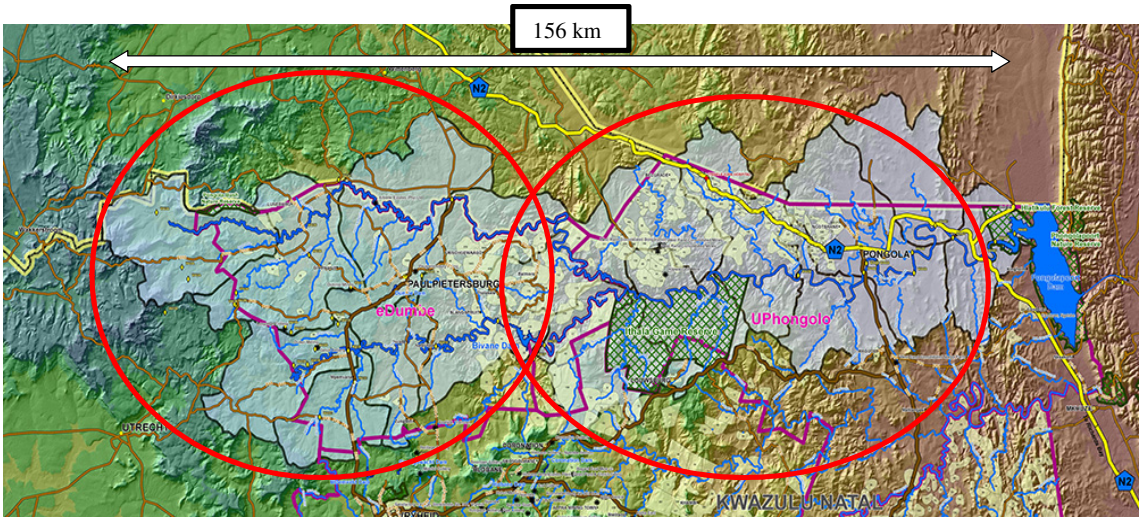
4.2.1 The Pongola River catchment in north KwaZulu-Natal

The location of the Pongola River catchment in South Africa is depicted in **Figure 24**. It forms the northern border of the KwaZulu-Natal Province of South Africa with the countries of Swaziland and Mozambique, shown on a larger scale in **Figure 25**. It is located in the tertiary drainage regions W41, W42 and W45. It was to form the northern boundary of the Pongola to Umzimkulu Catchment Management Agency (CMA), which was to be established.

The Pongola River catchment encompasses the Pongola River flowing east, parallel to the Swaziland border to Maputo in Mozambique. It also has a major and large tributary, the Bivane River, flowing 20 to 30 km south of the Pongola River. Both rivers originate below the high Enkangala Grasslands in the valleys and mountains below and east of Wakkerstroom and Utrecht. Flowing east, the Pongola River and the Bivane River pass Paulpietersburg to the north and the south respectively. The confluence of the Bivane and Pongola rivers, at the Ithala Game Reserve, is approximately midway between the towns of Paulpietersburg and the downstream Pongola. The Pongola River continues its east bound flow, passing the town of Pongola which is centrally situated in the targeted catchment area, then feeding into the fifth largest surface dam in South Africa, the Pongolapoort (Jozini) Dam. Thereafter, it continues north-east

through the Makatini flats until it meets the Usutu River, flowing from Swaziland, at the Ndumo Game Reserve on the KZN-Mozambique border from where it continues north-east towards Maputo.

Figure 24: The location of the Pongola River catchment in South Africa, outlined by the red rectangle



Western region of the catchment Central region of the catchment

Figure 25: A map illustrating the western and central regions of the Pongola river catchment, (delineated shaded area) from its source in the west only up to the Pongolapoort dam in the northern KZN, just south of the Swaziland and Mozambique borders. The Pongolapoort dam is the 5th largest in South Africa with a capacity of 2 445 million cubic meters. (**Source:** ZULMAP)

In terms of this study, only the western region and the central region of the catchment (from the headwaters up to the Pongolapoort Dam as shown in **Figure 25**), are considered. A number of factors illustrate distinct differences between the western and central regions, presented in

Table 19.

Table 19: Differences in the western and central regions of the Pongola river catchment.

Descriptors	**Western region**	**Central region**
Main town	Paulpietersburg	Pongola
Approximate catchment area (ha)	275 500	233 000
Average topographical elevation in meters above sea level	1923m with 1194m, between headwaters and Paulpietersburg	611m on western perimeter to 252m in Pongola
Approximate rainfall (mm p.a.)	1500	650
Climatic description	Mild summers and very cold winters	Extremely hot summers and cool winters
Main agricultural activities	Dry land maize production. Highly intensive piggeries Forestry Feedlot and field cattle	Irrigated sugar cane, citrus, mangos and vegetables
Gross agricultural production value dependent on water	R 1 500 million, dryland crops, animal production and forestry	R 1 200 million highly intensively irrigated cane, fruit, vegetables
Mining activities	Coal	None
Primary water source	Extensive network of tributary streams of the Bivane and Pongola rivers	The Pongola river system, buffered by the surface Bivane Dam
Natural water use control and monitoring	No formal body. Water use to be controlled and monitored from DWS regional office Durban	Statutory WMI, the Impala WUA
WRM activities and resource indicator monitoring	To be executed by the CMA, alternatively by DWS regional office Durban. Exposed to activities of Impala from 2014	Impala WUA from 2014 till to date

The Pongola and the Bivane River systems are still regarded as two of the most pristine and lightly moderated river systems in South Africa (Driver et al, 2011; Van Jaarsveld, 2016). Like other catchments in South Africa, this one is experiencing impacts from localised industries and, on a much broader scale, agriculture.

All forms of land use practices need careful consideration of a number of interdependent factors, which may play a role in enhancing protection of the environment or contribute to its degradation. Large areas under forestry in the western regions of the catchment, aggravated by dense and wide distributions of Black and Silver wattle (*Acacia mearnsii* and *A. dealbata*), pose potential threats as stream flow reduction activities in terms of sections 36(1) and (2) of the NWA. Irrigated agriculture is associated to a certain extent with unlawful water abstractions but to a larger extent with the irrigated return flow of fertilised nutrients back to the environment. Large rural areas of the catchment accommodate human settlements with poorly developed township infrastructure, sanitation and water supply. This, and the large extent of communal traditional land use practices, result in large scale land erosion and tributary degradation.

Potable water is supplied to rural areas and the five municipalities of Pongola, Nongoma, Ulundi, Vryheid and Paulpietersburg by the Water Services Authority (WSA) and Water Services Provider (WSP), the Zululand District Municipality (ZDM).

4.2.2 The Impala Water User Association – Pongola KZN

Historical background.

In South Africa, irrigation schemes were developed in productive agricultural areas throughout the country by the State. All these irrigation schemes, known as Government Water Schemes, were managed by the then Departments of Water Affairs. It is important to note that these schemes focus on abstraction and supply of raw (natural) water, mainly for agricultural use. As a result of decentralisation of decision-making and responsibilities, certain areas of management and functioning of government departments were transformed into Irrigation Boards (IBs) circa 1990 to 1992; for instance, most Government Water Schemes in South Africa. From the time of the new political dispensation in 1994 after promulgation of the new National Water Act, Act 36 of 1998 (NWA), all IBs were, in terms of the NWA, were to be transformed into new entities called Water User Associations (WUAs). Not all Government Water Schemes transformed into IBs and not all IBs transformed into water users' associations. The current distribution of such water user associations/irrigation schemes in South Africa, is reported in **Table 20**.

Table 20: The current number of different water/irrigation schemes in South Africa.

Type of scheme	Number
Government Water Schemes	28
Government Water Control areas	48
Settlement schemes	18
Irrigation Boards	141
Water User Associations	98
TOTAL	**278**

(**Source:** SAAFWUA, 2015, 2016)

According to the preamble of Chapter 8 of NWA (DWAF, 1998), a WUA is a water management institution operating at a restricted local level. It is described as a co-operative of individual water users who undertake water related activities for their mutual benefit (DWAF, 1998).

A water user association operates according to its primary and ancillary functions, guided by Schedules 4 and 5 of the NWA (DWAF, 1998), and stipulated by the constitution of the WUA or IB. Impala WUA's primary functions in terms of clause 4 of its constitution revolve mainly around abstraction, distribution, and supply of raw water to lawful water users in its area of operation, as well as the maintenance of abstraction and supply infra-structure. The water user association may undertake ancillary functions, if these do not interfere with its primary ones. According to clause 5.2.b of its constitution, ancillary functions may include WRM activities when authorised and delegated by DWS or CMA.

Scheme description.

The Impala Water Users Association (Impala WUA) is a large canal fed and riparian irrigation scheme of 17 000 ha in extent, located around the town of Pongola in northern Kwa-Zulu Natal (KZN). Its sole water source is the Pongola River and three very small tributary streams that flow from Swaziland. A very few boreholes exist which have meagre delivery capacity and poor, saline, water quality.

The scheme was constructed over the period of the 1930's to 1954. It was initially known as the Pongola Government Water Scheme and was managed and maintained by the then Department of Water Affairs. The Pongola Government Water Scheme was transformed to an Irrigation Board (IIB) in 1992 and a water user association in 2001 (DWAF, 2001). It became known as the Impala Water User Association (Impala WUA).

The profile of membership of Impala WUA, as stipulated in section 17 of its Constitution, comprises members with a lawful entitlement to use water linked to their title deeds and a water use in terms of section 22 of the National Water Act no 36 of 1998 (NWA), as approved and listed by the DWS.

Besides the members of Impala that receive raw water for agricultural irrigation, a number of other users also receive and use raw water from the resource, supplied by the Impala WUA. The different water users that receive raw water from Impala WUA, are presented in **Table 21**.

Impala WUA organisational features

The Impala WUA as an organisation consists of five departments, namely Finance and Administration, Water Control, Construction and Maintenance, Vehicle and equipment workshop and the Bivane Dam[19]. The total permanent personnel component is 74 people. During the winter months during canal and water related infra-structure maintenance, up to additional 80 seasonal workers are employed.

Table 21: The different lawful water users that receive raw water from the Impala WUA in Pongola.

Type user	**Vol (m^3 p.a.)**	**Type user**	**Vol (m^3 p.a.)**
Canal irrigating commercial farmers	139 000 000	Industrial entities	1 266 000
Riparian and tributary irrigating farmers	25 850 000	Local tourism and sport facilities	250 000
Pipe fed irrigating small scale farmers	530 000	Cattle and game water supply abstraction points.	262 000
ZDM as Water Services Provider and domestic use	3 060 000	**Total** 170 226 000 cubic meters per annum	

(**Source**: The assessment roll of the Impala WUA)

The author is the Chief Executive Officer (CEO) of the Impala WUA and runs the day-to-day operations of the organisation. Impala WUA is governed by a Board of Directors, called in terms of the NWA, the Management Committee. According to clause 13 of the constitution of Impala WUA, it consists of 12 members. Six are elected by the water user members of six irrigation wards. These are all commercial irrigating farmers. In terms of section 57 of the NWA, these members are paying compulsory water use

[19] Impala WUA obtained approval from the Minister of DWS in 1996 to privately construct a 115 mill cubic meter surface reservoir. The objective was to augment the low winter flow in the Pongola River to ensure sustainable supply to users in Pongola. The certificate of completion was issued in 2001, after which use of water from the dam started.

charges to Impala WUA (DWAF, 1998). The remaining 6 members of the Management Committee are nominated by different constituencies within the wider local community with an interest in water. Besides the local sugar mill and the small-scale farmers, they are not serviced by and do not pay for water use to Impala WUA. These are representatives from the local municipality, the local chamber of commerce, rural domestic water users, tribal authorities, the local sugar mill and the Pongola small-scale farmers.

In terms of clauses 13.5 and 13.6 of its constitution, the day-to-day operations are governed by an Executive Committee, consisting of the 6 elected ward members and the representatives of the local sugar mill and the Pongola small-scale farmers.

Identification of risk events, risk drivers and expected losses.

As indicated, a risk analysis in line with Smith and Merrit (2002:29-95) was carried out during 2014 by the author and the Impala WUA Management Committee to determine the latter's likelihood of exposure to risk events and the expected losses during its execution of functions and its position or relation to the public.

The outcome of this exercise is illustrated in **Figure 26** and the descriptors in **Table 22**.

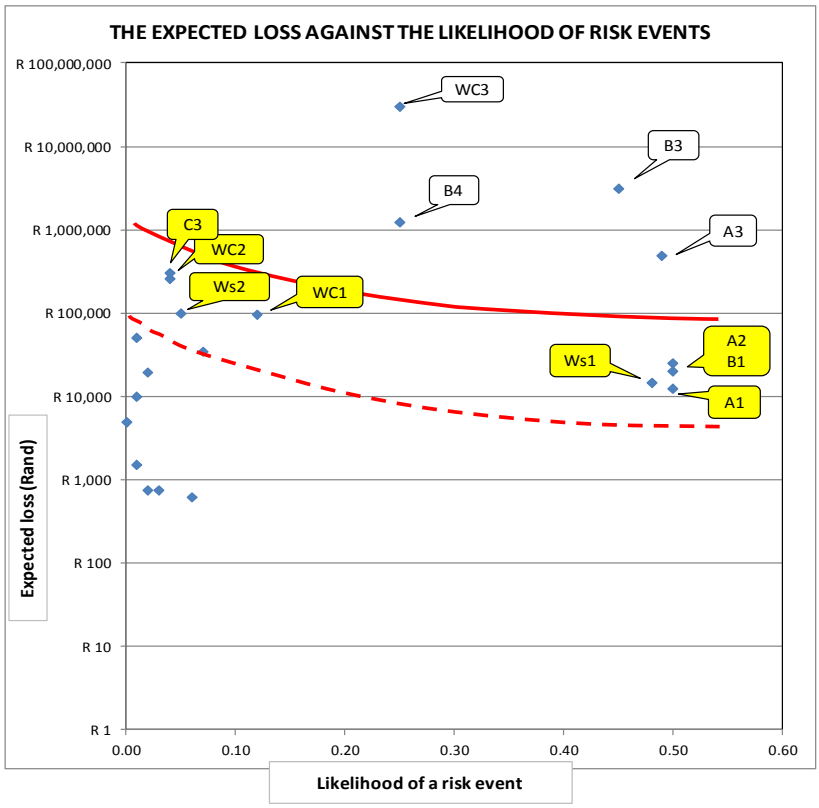


Figure 26: The likelihood of risk events for Impala WUA and the expected resulting loss.

(**Source:** Impala Business Plan 2014 - 2018)

Table 22: The descriptors indicating the different risk events that the Impala WUA is exposed to, the likelihood of the event and expected loss in Rand

Serious and strong focus events		Likelihood	Expected loss
WC3	Wrong interpretations/forecasts - water control	0.25	R 30,000,000
B3	Public liability claim - Bivane Dam	0.45	R 3,150,000
B4	Natural incident losses - Bivane Dam	0.25	R 1,250,000
A3	Loss of institutional memory - Impala WUA	0.49	R 490,000

Medium focus events		Likelihood	Expected loss
C3	Public liability claim - equipment - construction	0.04	R 300,000
WC2	People fall into canals - water control and operations	0.04	R 262,500
Ws2	Injury on duty. Operations	0.05	R 100,000
WC1	Overflowing of canals - water control	0.12	R 96,000
A2	Robbery of computers - administration	0.50	R 25,000
B1	Armed robbery of monies and/or equipment	0.50	R 20,000
Ws1	Long duration down time of old equipment	0.48	R 14,400
A1	Armed robbery cash. - administration	0.50	R 12,500

Smaller routine events		Likelihood	Expected loss
B5	Robbery, attack, sabotation - Bivane Dam	0.01	R 50,000
A5	Loss of data (admin and water control)	0.07	R 35,000
WC4	Labour unrest - water control division	0.02	R 19,500
C2	Public liability claim - construction	0.01	R 10,000
A4	Financial fraud	0.001	R 5,000
C5	Fire, injuries - construction	0.01	R 1,500
C4	Labour unrest - construction	0.02	R 750
C1	Theft of stock - construction	0.03	R 750
B2	Financial fraud - Bivane dam	0.06	R 625

(**Source**: The risk analysis working document of Impala WUA)

The outcome of this risk assessment exercise indicated that incorrect interpretations and forecasts of the water conditions and expectations for domestic, industrial and irrigating users are the most significant. These are followed by liabilities in the operations at and care of the Bivane Dam of Impala WUA and the loss of institutional memory. These are regarded as important indicators in terms of the crucial functions of an institution such as Impala WUA and the sensitive relationship with water users that depend on the natural water resource.

The importance and critical nature of wrong interpretations and forecasts of water conditions and expectations, together with failure to act timeously, are emphasised by the 2017/18 water shortage crisis facing Cape Town.

Statutory authority and jurisdictions.

The Impala WUA can be described as a well matured and independent organisation, serving the Pongola region communities and WSA with raw water from the natural resource.

Impala WUA derives its functions and authority from chapter 8 and schedule 5 of the NWA (1998) as well as particular delegations from the Minister of DWS. Although these functions do not particularly describe natural water resource functions, a WUA has a vague duty to care for the water producing environment. Described in Chapter 8 of the NWA (1998) and in clause 4 of its constitution, the main or primary functions of Impala WUA revolve around water abstraction, water distribution to lawful water users, infra-structure maintenance and creation of water supplying infra-structure.

Due to its statutory authority, Impala WUA has the power to monitor and control water use as well as to execute compliance in terms of water abstraction and use. Impala WUA may restrict water use depending on climatological conditions and may set rules to manage the scheme and water supply and use.

In terms of a water catchment and the delineation of the unit of analysis, Impala WUA is regarded as an institutional agent, established as a water management institution in terms of the NWA.

Impala WUA liaison network in official matters

Impala WUA has a close network of collaborating organisations in the execution and support in the implementation of its functions:

- Labour consultants registered at the AHI Employers Organisation of South Africa
- NB Systems of Dr. Nico Benade, creator and supplier of the Water Administration System, a software system to manage water abstraction, water flow and water user debtors
- The South African Association of Water User Associations (SAAFWUA)
- The NGO, Duzi – uMngeni Conservation Trust (DUCT) from Howick, KZN
- The WWF-SA
- DWS
- Department of Agriculture
- Department of Environmental Affairs.

The South African Association for Water User Associations (SAAFWUA).

SAAFWUA, established in 2004, is an over-arching representative organisation in South Africa for WUAs who are members of SAAFWUA. It originated spontaneously amongst a few WUAs. It has no statutory powers, but liaises with relevant stakeholders in supporting WUA members regarding their effective and sustainable local WRM challenges (aligning government acts, policies and strategies) and facilitates capacity building. It executes collective bargaining with government and other stakeholders on behalf of

WUA members and facilitates dispute resolution amongst various internal and/or external stakeholders. Impala WUA is a member of SAAFWUA. The author is involved as a member of the SAAFWUA Management Committee.

SAAFWUA is currently acknowledged by DWS as the only representative body to negotiate and undertake collective bargaining on behalf of WUAs who are members of SAAFWUA (Knoetze, 2017. Personal communication with author). There are currently no other formal similar role players and competitors in WMI environment.

As a strategic approach, a task team of SAAFWUA with the SAAFWUA Chief Executive Officer (CEO) drew up a future "roadmap" to outline its envisaged future for WUAs for the purpose of negotiation with DWS. By way of internal notice 24/1/2/P of DWS, this Roadmap was accepted by the Minister of DWS on 3 December 2016. SAAFWUA embarked on a comprehensive and diligent strategic re-organisation process from 2016 to 2017[20]. The objective was to improve its own role in its service to member WUAs and enhance a new focus towards the natural water resource environment. It further builds on the "Road map" to improve and strengthen the role and position of WUAs in South Africa. The author was a member of the five member task team that executed the strategic planning process. A diagram that summarises the essence of the roadmap and subsequent strategic plan for SAAFWUA and its support to WUAs in South Africa, is presented in**Figure 27**

The realisation of the necessity for drawing up a sound "roadmap" and strategy for SAAFWUA, as an over-arching support structure, rested on the basis that the crucial roles of WUAs *per se* as actors in the natural water environment of South Africa and of course WRM on a local basis, needed to be defined and strengthened. The latter was built into the strategic plan, depicted in Figure 22. The strategic plan was accepted on a SAAFWUA Management Committee meeting by all members on 7 December 2017 in Johannesburg (Appendix I, record I31). It was noted that while this change of paradigm is significant and important, there still remains a lack of intrinsic knowledge and cognisance among many WUA CEOs and role players about the real and true context and complexity of WRM as opposed to irrigation scheme management (Appendix I records I10 – 12, I14-17, I21-31).

4.2.3 The Department of Water and Sanitation.

The national DWS acts in the KZN Province through its regional office in Durban. This Durban office is the main link of Impala WUA with the DWS.

[20] The author was a member of the 5 member task team that drew up the strategic plan and was seminal to the broadening of the view towards natural water resource management as opposed to a narrow "scheme water management".

In terms of the Constitution of Impala WUA, DWS has one representative on its Management Committee who acts as the primary liaison officer between the two institutions.

The proto-CMA for the revised Pongola to Umzimkulu WMA operates from the DWS regional offices. However, since the acceptance of the CMA Business Case by the Minister of DWS in 2015, it has not been established and is not functional with respect to WRM in the Pongola River catchment.

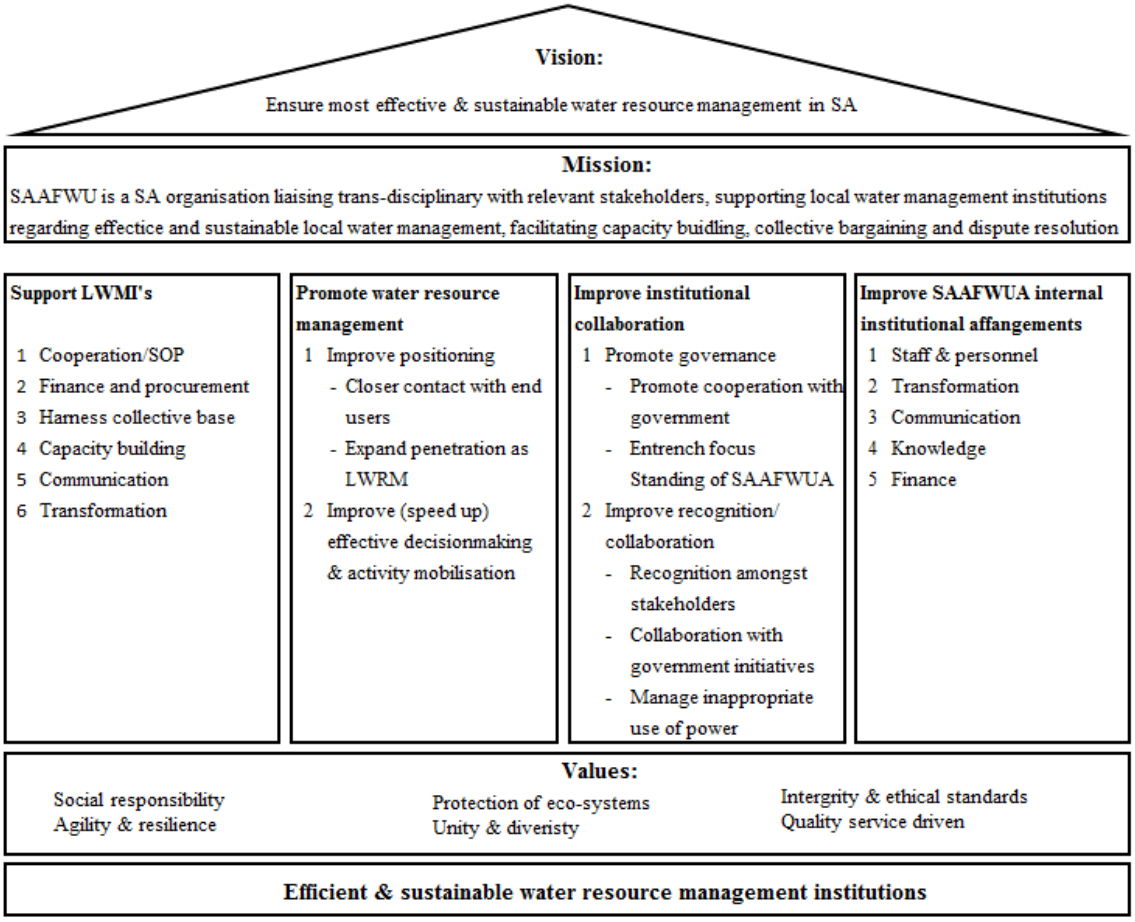


Figure 27: A summary of the accepted strategic plan of SAAFWUA in its role and support of WUAs in South Africa (Drawn by D. van Rooy)

In terms of sections 51 and 52 of the NWA (DWAF, 1998) and the National Water Pricing Strategy, implemented in April 2002 (DWAF, 2007), all water users in the three main sectors of use in South Africa, industry, agriculture and forestry are paying WRM charges to DWS (PMG, 2014). These charges are

differentiated for the different regions in each sector. The objectives of these charges are, amongst others, to fund the management and protection of the aquatic water resource reserves, create sustainable revenue for infra-structure maintenance and development and to ensure efficient allocation of scarce water resources.

In term of the Chapter 8 preamble in the NWA (DWAF, 1998) a WUA does not execute WRM, although it is a WMI. According to sections 8, 9, 77 and 80 of the NWA, the CMA performs WRM functions. Where a CMA has not been established, the Minister must, according to sections 3 and 72, execute WRM functions. A WUA may execute WRM in terms of section 5 (2) of schedule 5 of the NWA on behalf of a responsible authority.

4.3 THE CASE STUDY – IMPALA WATER USERS ASSOCIATION

In the following sections, the case of the role of Impala WUA in terms of the study objectives is presented. Since 2001 the author has been directly involved in all the matters presented in the case below, due to his designation and taking of ownership of his role as the Chief Executive Officer (CEO) of Impala WUA.

4.3.1 Triggering of expanded functions.

As alluded to above, a WUA has no particular jurisdiction and obligations to perform natural WRM functions. It may do so if delegated by the Minister or the CMA in its WMA.

During the period 2004 to 2005, efforts were made by the DWS regional office in Durban to establish the CMA for the then Usutu to Umhlatuze CMA[21]. The CMA was never established at that stage.

It was known that no WRM functions were executed by the DWS regional office in the western and central regions of the Pongola river catchment (Bohmer, 2015, Filter, 2015, Hambrock, 2015, Endres, 2015). In addition, responses were received by Impala WUA who made numerous requests to the Water Quality Division of the DWS for water quality analysis status reports of the catchment (Cronje, 2014). On 1 July 2005 and again on 24 October 2005, Impala WUA applied to the DWS regional office to execute WRM functions in the Pongola river catchment[22]. The application was rejected on the basis that

[21] The author was personally involved in the public process of consultations and deliberations regarding the preparation for the establishment of the Usutu to Umhlatuze CMA during 2004 - 2005.

[22] Official letters from Impala WUA CEO to the DWS regional office on 1 July 2005 and 24 October 2005.

such functions are to be performed by the CMA. The reality was that up to date of this study, no CMA was established nor became operational in this catchment.

Because of the vulnerability of the Pongola communities in their dependence on the Pongola river system as their sole water source, Impala WUA proceeded to perform annual chemical and biological water quality analysis during late winter and late summer in the Pongola River within its area of responsibility only.

During 2010, farmers in the Luneburg area west of Paulpietersburg, reported that a mining organisation was in the process of carrying out prospecting activities for coal on a number of farms. All these farms are located in the head waters of the Pongola river system. None of the landowners had any knowledge of these activities. They requested assistance from Impala WUA.

Impala WUA, being a downstream water user, is exposed to risks that are created upstream and immediately became involved. The Impala Executive Committee and the Management Committee committed the WUA to fully participate in the matter and carry out all actions necessary to protect the interests of the Pongola community (Minutes, Executive Committee, 2010, 2011a, 2011b; Minutes, Management Committee, 2011).

Based on findings of a study by Smith (2010) regarding the way South African Courts view interested and affected parties (IAPs) in their objections to prospecting or mining rights applications, a civil organisation was created, the Pongola River Catchment Protection Association (Afrikaans acronym, PROBA) on 7 December 2010 (PROBA, 2010a; Appendix F record F3). PROBA acted on behalf of interested and affected parties to evaluate prospecting or mining applications and engage with DMR or applicants in this regard (PROBA, 2010b). Impala WUA tasked its attorney on record to deal with the legalities of the matter. In the execution of the objections to DMR and appeals to the Minister of DMR[23], the WWF-SA and the Centre for Environmental Rights (CER) became closely involved and built a working relationship with Impala WUA.

4.3.2 WWF-SA and the Nedbank Green Trust.

The action campaign to object to the coal mining prospecting activities in the Luneburg area, led to 3 appeals to the Minister of DMR during 2010 and 2011. These activities resulted in close collaboration and active support between the WWF-SA, the farming community in the Luneburg, the Centre for Environmental Rights (CER) and Impala WUA.

[23] Advice from Strauss Daly Attorneys 2011.

The relationship between Impala WUA and WWF-SA led to the establishment of a contractual water security project on 12 June 2014, between the WWF-SA Freshwater Division and Impala WUA, funded by the Nedbank Green Trust, over a three-year period. It aimed to restore, support and protect the resilience of the natural environment that is critical for fresh water resources and to ensure sustainable long term water security of the Pongola River catchment.

This water security project was a significant determinant of a number of crucial events and altering of perspectives that took place since its roll out in 2014:

- It created the opportunity for Impala WUA to became fully involved in catchment wide WRM activities, despite the view of the DWS regional office that WRM functions should be reserved for the CMA
- It created the opportunity for Impala WUA to experience, test and gain insight into the execution of WRM activities in the catchment
- It created the opportunity to approach and engage a multiple of divergent role players, active in the catchment, that are dependent on and have an effect on the natural water resource
- It created opportunities to build up a significant quantity of water quality analysis data and to undertake a river health investigation for the Pongola River
- It enhanced and tested the application of authority by Impala WUA to act on undesirable activities and ensure compliance with water regulations.

4.3.3 Conducive factors.

It is important to take cognisance of some counter arguments of some Impala WUA members as well as Paulpietersburg farmers against the supporting of WRM activities by Impala WUA in the larger catchment area.

During a meeting with Impala WUA members on 26 August 2014, some argued that Pongola is located at least 150 to 200 km downstream of Paulpietersburg and could not be affected by activities in the western headwaters and Paulpietersburg area (Appendix D, record D126). Some also argued that the Paulpietersburg farmers could defend and protect themselves in matters that affect “their water resource”. The cost for Impala WUA to travel all the way west to the headwaters might be fruitless expenditure for, and an unnecessary burden on, the Pongola community.

Similarly, during a meeting with Paulpietersburg famers on 20 August 2014, some farmers were very antagonistic towards Pongola farmers due to the efforts of the Pongola farming community to convince the DWS in the 1980’s to build a dam in the Pongola River (Appendix D, record D125). The body of water in this dam could push back up into the farming area of Commondale and Paulpietersburg. This effort to build a dam did not succeed. Some Paulpietersburg farmers argued that they could not afford

support to Impala WUA and actions against mining organisations as they were dry land maize and cattle farmers, as opposed to "prosperous sugar cane farming under irrigation in Pongola". Another argument was a fear that involvement of a WMI such as Impala WUA could lead to "rules and regulations" and "restrictions" on their activities. Farmers from both regions were of the opinion, that to take on and oppose mining organisations in their mining endeavours would be fruitless efforts.

However, a number of significant conducive factors were manifested over the period 2009 to 2014 in the Pongola River catchment that were crucial to convince the various role players to support WRM actions:

- Impala WUA first encountered and successfully opposed an iron and manganese mining prospecting right at its Bivane Dam in 2009. At the end of 2010, the very large coal prospecting activities were discovered in the headwaters area of Luneburg along the Pongola River. Since then, up to the middle of 2014, the time of the start of the water security project, nine new investigations and applications for coal mining prospecting in the Paulpietersburg area surfaced that could affect the Pongola river system. Up to July 2017, the number of cases of mining interests in the western region of the catchment, grew to 19. A list of mining interests (up to July 2017) is presented in **Appendix B.** A list of all the different activities the author was involved in in dealing with the mining interest is recorded in **Appendix F.**
- This new interest and applications appeared against the backdrop of the legacy of a large number of old abandoned coal mines distributed all over and defacing the western head water region of the catchment. The author and his assistant have identified and recorded, with GPS co-ordinates, 19 such mine sites in the western region of the catchment (**Appendices B and F**).
- A short drought was experienced in the Pongola catchment in the summer of 2011/2012 while a very serious drought started in early 2015. To survive and be sustainable, a number of default activities and practices suddenly became risky and needed revision. Owing to the drought, an important focus became the quality and sustainability of the water resource.
- An unexpected higher silting was observed in the inflow from the Manzaan River into the Bivane Dam of Impala WUA (Cronje, 2012).

To reiterate, the Pongola and the Bivane River system was still regarded as one of the most pristine river systems in South Africa (Driver et al, 2011; Van Jaarsveld, 2016). The realisation of significant threats to the natural water resource and unsustainable practices in the catchment convinced the majority of role players to change their thinking and to collaborate to protect the water resources for the future.

In comprehension of the conducing factors, the Impala WUA Management Committee approved involvement of the Impala WUA in WRM activities in the larger catchment, as well as the establishment and roll out of the water security project together with the WWF (Minutes Executive Committee, 2014a, 2014b; Minutes, Management Committee, 2014a, 2014b).

A comprehensive project Business Plan was drawn up for the execution of the water security project with the WWF. It detailed all relevant background aspects, administration, staff, reporting entrance approaches and targeted focal areas to be addressed. After assessing the conducive factors enhancing the prospects of the water security project, critical success factors were compiled, based on the work of Slevin and Pinto (1987). These factors were supported by indications regarding the level of existence of the context or level of maturity associated with the factor, presented in **Table 23**.

4.3.4 Roll-out approach.

Slevin and Pinto (1987) and Lorange (1998) suggested models according to which organisations and projects can look at, effectively plan and approach opportunities and various challenges. It was realised that the project would be confronted by different and peculiar situations. These challenges could fall within and without one's knowledge, skills base and authority to bring about change. The entrance and engagement strategies described by Lorange (1998) were considered and employed in the different situations, presented in **Table 24**. These consist firstly of a description of challenges based on a threat, knowledge and peculiarity of the situation and secondly of employing one engagement approach that is best suited to address the challenge.

An important viewpoint set from the onset by the WWF for the project was that existing resources needed to be mobilised to achieve successful WRM and sustainable resource protection. It was therefore not envisaged that Impala WUA will execute certain, or all, on the ground activities. The roles, support and impacts of other relevant stakeholders such as the DWS, DEA or scientific consultants were acknowledged and would be incorporated where needed and crucial. A focus would be placed on the cognisance of stake holders about their shared responsibility and the importance of the mobilisation of their adaptive capacity.

An "environmental division" was created in the Impala WUA and a suitable candidate was employed by Impala WUA as an environmental officer (EO) to execute and support the variety of envisaged functions of the project.

The execution started in August 2014 by familiarising catchment tours, site visits and building of a knowledge base. Thereafter specific focal areas were being addressed according to appropriate entrance approaches described in **Table 24**.

Table 23: The critical success factors for this project as well as the indications of the level of existence and capacity maturity regarding each factor

	CRITICAL SUCCESS FACTOR		LEVEL OF EXISTENCE AND/OR MATURITY	LONGITUDINAL PROGRESS FROM THE OUTSET AND RUNNING OF THE PROJECT
Strategic planning stages	S1	Project mission	As described in the Business Plan to reflect aspirations for the project.	Started with application for WRM in 2005. A long period passed during which CMA never realised. Critical mass created with WWF support and project preparation in 2014.
	S2	Top management support	Full support exists from the governing boards of the major role players.	Negotiations with the Impala WUA Board, Farmers Associations, various state Departments in 2014.
	S3	Project schedule	Detailed fragmentation of the different disciplines in the water resource arena, action steps and milestones in the process were compiled.	During business plan preparation in May to June 2014.
Operational activities and stages	O1	Stakeholder consultation	Prime focus of the project. Numerous stakeholders were identified, being known to the author, support staff and governing boards.	Stakeholder engagement continued as time progressed and familiarity with circum-stances increased. It was possible because of proximity and permanence of role players.
	O2	Personnel competency	Existing in-house experience. Recruiting needed for key roles was provided for in the budget.	In house experience exploited. An Environmental Officer was employed in August 2014.
	O3	Technical capacity / execution	Existing in-house experience. Provided in budget for contracting specialist services where needed.	Specialist scientists and consultants were contracted throughout 2015 to 2017 as warranted by circumstances.
	O4	Stakeholder acceptance / commitment to action	Exploitation of the existing conducive conditions.	The 2009 and 2010 coal mine incidents together with the 2015 drought triggered realisation of potential threats to and dependence on the water resource.
	O5	Monitoring and feedback	As the project was run by the author and Impala WUA, a close knit and comprehensive reporting feedback and supporting administration was used.	The on-the-ground actions were followed up through continuous meetings, telephone conferences and presentations to the different stakeholder groups.
	06	Communication/ network	Utilisation, expansion and development of existing community and association networks.	Existing closed or limited networks of communication were enhanced and expanded as knowledge, activities and new threats emerged from 2014 to 2017.
	07	Troubleshooting	Implementation of efficient feedback loops and redirecting deviations. Support rendered by WWF and other experts in the field.	As WRM and related engagements are complex, continuous reconsiderations and re-evaluations needed to be done to maintain direction and progress.

(**Source:** Adapted from Slevin and Pinto, 1987).

4.3.5 Engagement and polycentric WRM.

Engagement with role players and challenges rolled out and developed according to the different entrance approaches. The employment thereof enhanced the penetration into a field or challenge and the growth of knowledge. Building familiarity and knowledge evolved during the course of time. Specific environmental problems were identified. If these could not specifically have been addressed and rectified by Impala WUA, they were directly introduced to the relevant role players (farm owner or organisation) involved. In doing so, knowledge of role players and their worth in terms of comprehension, participation and prominence was enhanced. This knowledge was used to construct a quantified perception of the prominence of a role player and his/her profile of drive.

Table 24: Four strategic entrance approaches to best engage and address different and peculiar challenge conditions

Strategic entrance approach	Description of peculiarity of the challenge
Pioneering approach	A potential opportunity is observed but is first tested through focus on development of organisational skills and capacity to engage and address the challenge.
Immediate engagement attempt with rapid expansion	Good knowledge, resources, networks and capacity exist. Take advantage, engage immediately and expand influence.
Dominance approach	Internal capacity, resources and capital and competitive advantage exist. Engage, implement and dominate the situation.
Re-evaluation and restructuring	Uncertainty, potential risks, poor capacity and/or unwillingness exist. Re-evaluate internal and external situations, restructure or step away.

(**Source:** Adapted from Lorange, 1998)

The prominence refers to the perceived importance of the role player and the impact s/he may have to influence thought or decisions in the organisation or community in his/her environment of work. The profile of drive refers to the reflection of comprehension of the matters, the support provided and the extent of participation. These are all listed and presented in **Appendix C**.

A consequence of engagement is the actual encountering of the behaviour and characteristics of the divergent role players around common pool resources, as alluded to before. Each gave explicit expression of his/her own perception of a challenge or problem. This was manifested through his/her needs that reflected expressions of power position, character, rationality and prospects for buy-in and support.

The consideration of the relationship dynamics between a challenge, the desired solution and the entities that need to address or support it, is crucial when operating in a multi stakeholder polycentric setting. This is especially decisive when some role players are dominant and powerful while others carry compelling authority. In this sense the approach of Hillson (2002) was employed in which he described different suitable responses to and between the opportunity posed by an issue or the threat posed by an issue, described in **Table 25**. Hillson promoted different response actions based on the identification of an opportunity posed by a situation.

Table 25: The relationships between different risk response strategies.

Risk (threat) response strategies		**Opportunity response strategies**	
AVOID	Make it impossible for the risk to occur. Reduce the impact to zero	EXPLOIT	Grab the opportunity and make it happen by aggressive measures
TRANSFER	Transfer the risk to someone who can better manage or carry the risk	SHARE	Transfer/share the opportunity to someone who can better manage it or who can better increase the benefits
MITIGATE	Reduce the size or impact of the risk to manageable or acceptable levels	ENHANCE	Seek to increase the probability of the opportunity and/or to maximize the benefit
ACCEPT	Accept the risk and manage it	IGNORE	Take note and adopt a reactive approach if needed

(**Source:** Adapted from Hillson, 2002)

Though Hillson studied risk responses in high stress conditions and uncertainty, careful assessment of these response strategies revealed that these can be correlated very constructively and usefully with the different entrance approaches described by Lorange in **Table 24**. In dealing with this case, a threat was for example considered as an opportunity. A real situation example to illustrate an application for a conjoining of the two approaches of Hillson and Lorange, played out as follows:

A severely polluted river section was identified that needed a swift remedial action. This boiled down to the following steps:

- engaging with the polluter
- putting up a convincing argument about the cause and effect
- persuading him to adjust long standing practices and
- taking water samples for proofing analysis and interpreting the argument.

Making use of the two models of Lorrange and Hillson, this real life incident (as an example and recorded in Appendix D as records D132; D136; D138), is dissected in its parts then synthesized in the eventual cognitive decisions and actions taken, illustrated in **Table 26**.

The crucial realisation, which stemmed from employing these approaches, was that they provided much comfort in considering the best action, utilising the best support and having a good standing when engaging with role players. It must be noted that the mental recognition of the challenge and the suitable response strategy to optimise its opportunities and threats, soon became a swift natural reaction in the work flow and support between colleagues.

A list of all the engagements with the different role players in the cluster groups of the government, civil society, science and mining and industry involved in the catchment, including the purpose of the engagement and a summarised resolution and/or outcome thereof, is presented in **Appendices D and F.**

4.3.6 Activities.

The WRM targeted focal points, envisaged as being addressed and developed to achieve the water security and WRM project objectives, are presented in **Table 27**. As knowledge and familiarity were gained in the field the specific focus and target areas were revised, developed and/or expanded.

Table 26: Reading from left to right, a simple real incident example illustrating the interactions of steps, approach decisions, actions taken, resulting opportunities and response according to the model by Lorange and Hillson.

The issue to be addressed	**The entrance approach (Lorange, 1998)**	**Action taken**	**Opportunity offered**	**Risk and opportunity response (Hillson, 2002)**
Identified a severely polluted river	Pioneering	Determine extent of impact and source	Immediate action at hand	Grab and exploit
Immediate engagement and execution	Dominant execution	Trespass on farm, to take water samples	Rather approach the taking of water samples by utilising a site at a road/river crossing	Mitigate
Contact laboratory, deliver cooled samples swiftly	Dominance	Separate sample, mark, cool down, pack, drive 240 km to the laboratory	Employ rapid courier services to transport water samples	Share
Interpret results in locality context	Immediate engagement	Discussion with landowner	Instruct the best orator to persuade	Transfer
Rehabilitate source of pollution	Pioneering	Upgrade facilities and waste control praxis of polluter	Insist on stopping further pollution	Avoid
Redesign upgrade facilities	Engage with rapid expansion	Consult with engineers for a facility upgrade	Negotiate optimum design of facilities to address waste praxis	Enhance

(**Sources:** Lorange, 1998 and Hillson, 2002)

Table 27: Targeted WRM focal points to be addressed and developed for achieving the objectives of this project.

FOCAL POINTS TO BE ADDRESSED	OBJECTIVES
River health base line	Health and early indicators of condition
Water abstraction control and risks	Over use and flow protection, especially in a drought
Wetland health	Safeguarding wetlands and restoration needs
Effluent returning to the system	Water and environment quality and health
River bank vegetation: alien species	River health and eradication of invasive species
Practices that may affect water resources	Water health and improvement of environmental sustainability
Education	Awareness creation, community engagement and support
Stewardship	Civil support
Land stability and soil erosion	Improvement of terrestrial environmental health
Land use practices	Improvement and environmental sustainability
Mobilising existing resources	Mobilise existing resources for sustainable care

Following from the above, the workflow and activities executed by the Impala WUA in the catchment, were differentiated between its primary functions and the additional new WRM functions by its purposive created "environmental division" in terms of the water security project. This work activities differentiation is illustrated by the diagram in **Figure 28.** By taking on this new additional WRM activities, Impala WUA expanded its influence and care from a scheme boundary area of 20 000 ha to an area of approximately 320 000 ha in the Pongola River catchment covering the western and central catchment regions of the total catchment (see **Figure 25**).

The actual activities carried out by Impala WUA during the course of the project, the number of cases dealt with, the localities, achievement of objectives and challenges experienced, are provided in **Appendix E.**

All the activities that related specifically to mining issues dealt with by Impala WUA, are chronologically listed in **Appendix F.**

The activities that focused specifically on identification and monitoring of sewer and potable water systems in the towns of Pongola and Ncotshane that affect the water resource are chronologically listed in **Appendix G**.

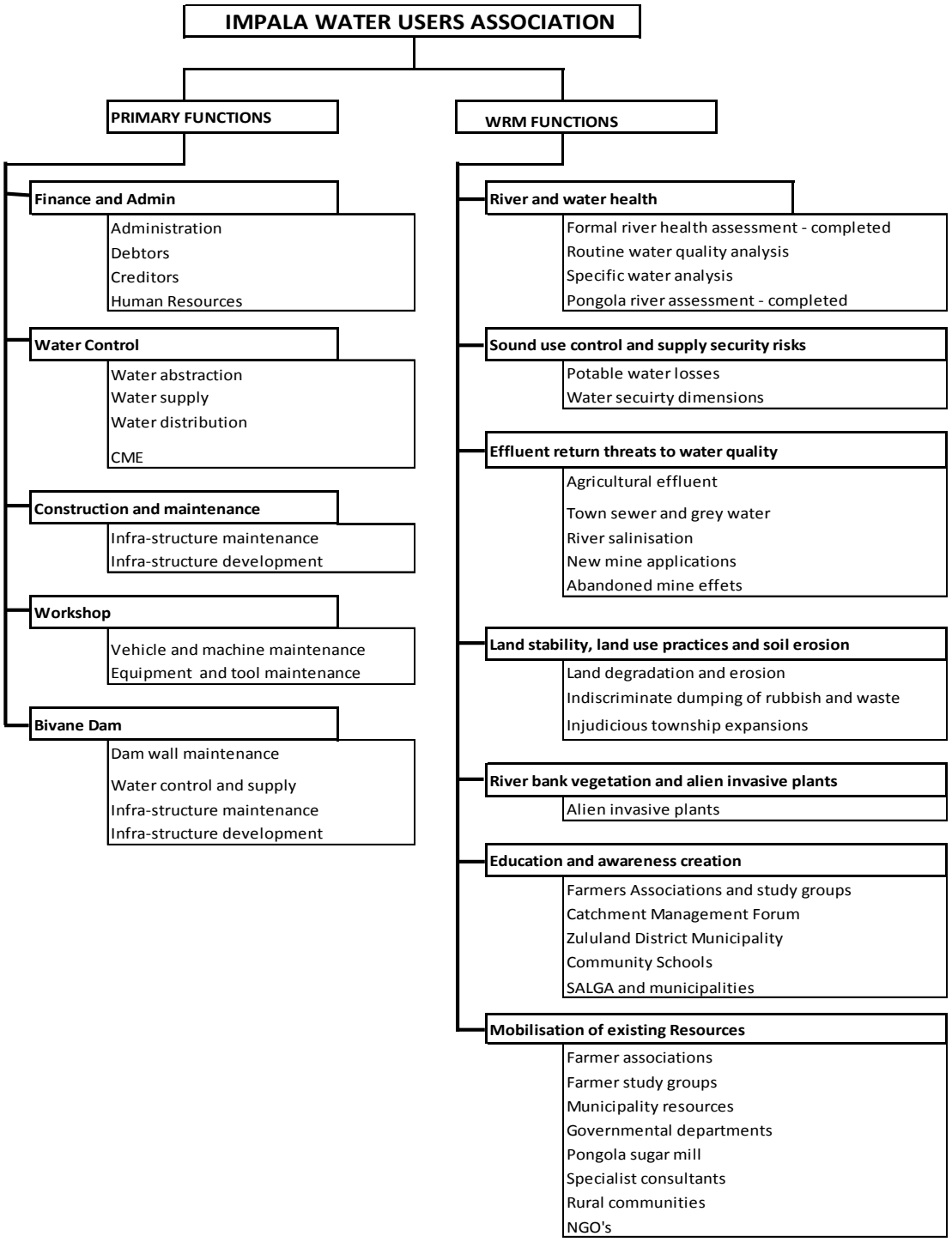


Figure 28: An illustration of the different primary functions of Impala WUA and the additional newly WRM activities embarked on in terms of the water security project

(Sources: Impala Constitution, 2001; Project Business Plan, 2014).

4.4 DATA ANALYSIS

4.4.1 Introduction.

As described in section 1.6.1, the data analysis was conducted according to the congruence analysis approach. The fundamental research question was described earlier.

In order to address the research question, this chapter assesses the different elements of the research title, the research questions and the deductive propositions regarding the feasibility of the conceptual model. The linkages between the elements of the research thesis title, the research questions and the propositions toward the data assessments, are illustrated in **Figure 29**.

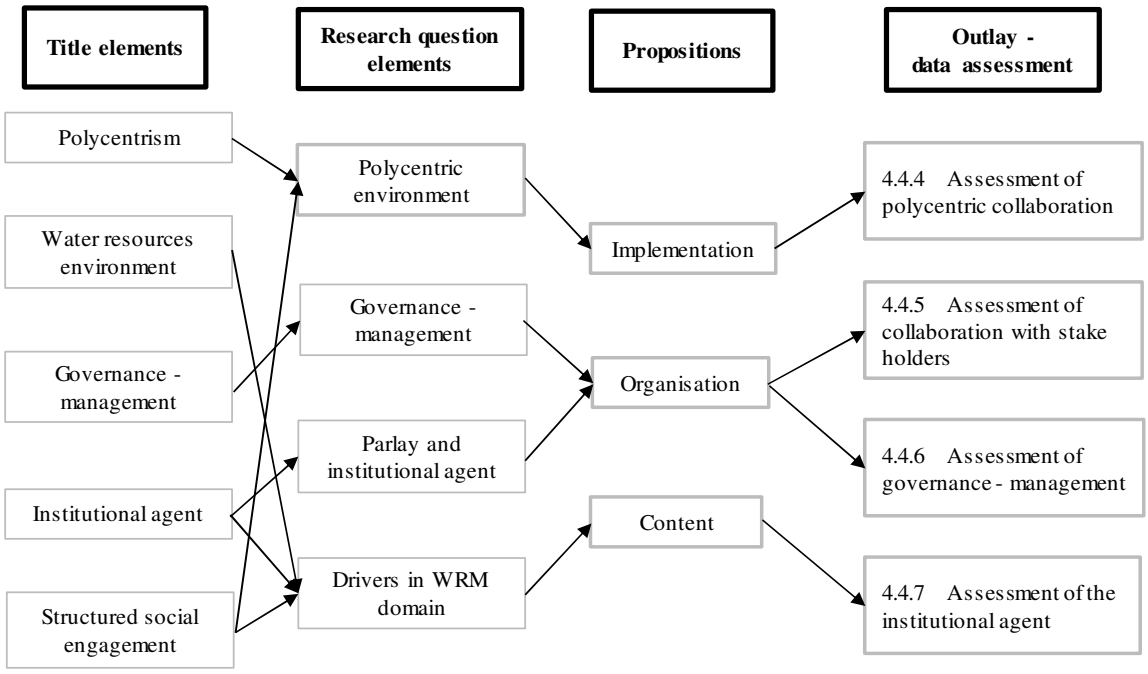


Figure 29: The linkages between the research thesis title, the research questions and the propositions towards the chapters of the data assessments.

4.4.2 Different sources of evidence obtained.

The following data, obtained as sources of evidence in terms of this study and for the analysis and evaluation are reported in **Table 28**.

Table 28: The type and variety of data obtained as sources of evidence.

Type data	What	Obtained from	Source of evidence
Primary	Attendance and minutes of meetings	Annotated meetings and workshops	Appendices D and F
	Discussions, evaluations of role players	Personal discussions and correspondence	Appendix C
	Semi structured interviews and workshops	With various individuals and groups	Appendix I
	The Impala WUA case study, including field notes, personal discussions and empirical observations	Comments on DWS 12 policy positions Mining activities Role player profiles WRM activities achieved	Appendix A Appendix B Appendix C Appendices E, G and J
Secondary	Literature	Peer reviewed articles	Literature references

4.4.3 Deductive propositions about the feasibility of the model.

The congruence analysis approach to evaluate the data was described in section 1.6.1.

Deductive propositions were compiled from the guiding questions in **Figure 2** and are depicted in **Figure 30.** Aiming at substantiating the suitability of the agent and the conceptual model to answer the research questions and compliance with the thesis title, the propositions are combined in three categories according to Van Rijswick et al. (2014), namely implementation, organisation and the content. The main categories are each further divided into sub-categories.

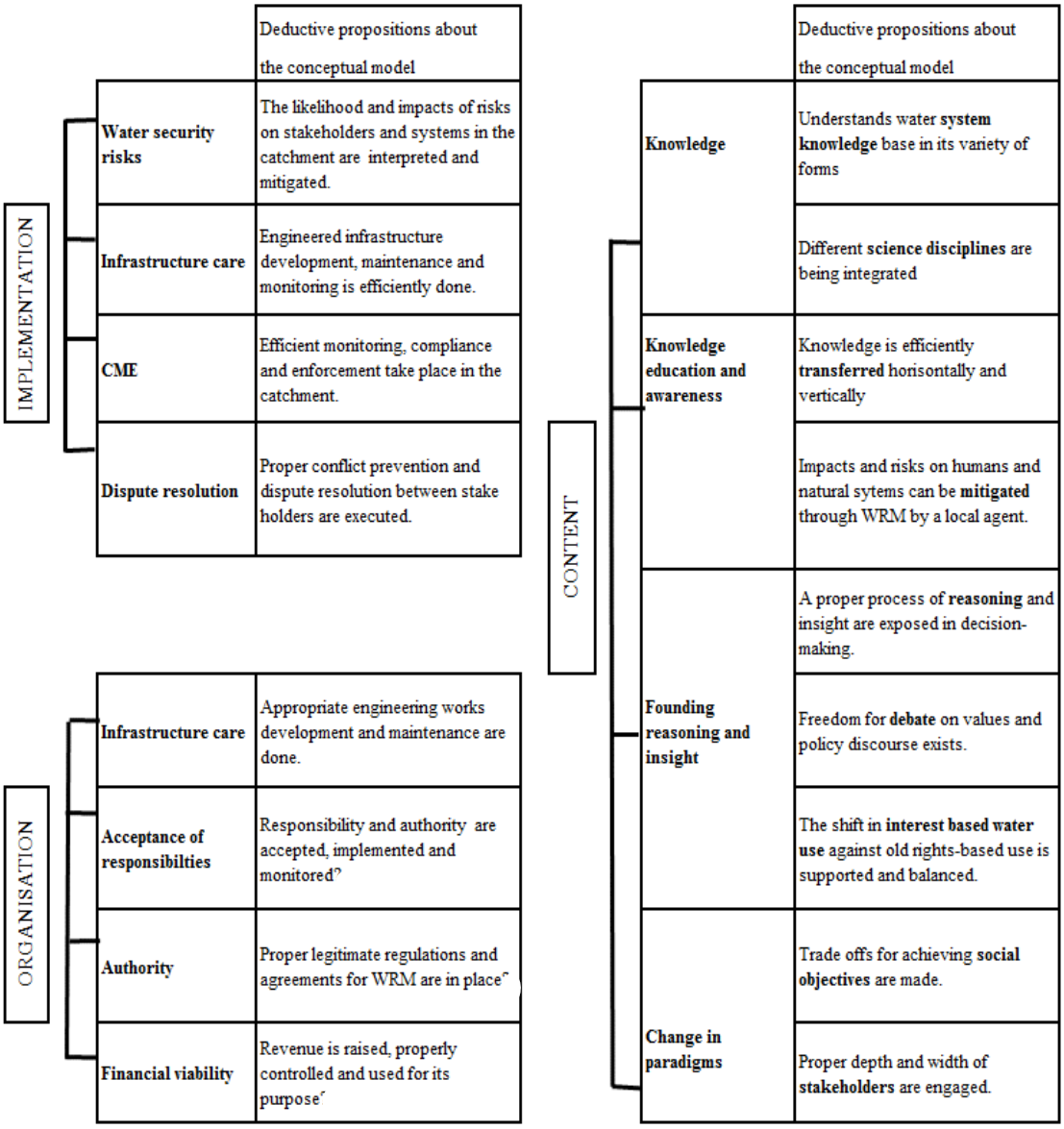


Figure 30: Deductive propositions in each main category and sub-category about the feasibility of the conceptual model

Implementation, revolves around the actual implementation of activities by, and collaboration with, the agent in a polycentric environment.

Organisation, refers to the external and inner workings of the agent. It refers to governance and management in terms of acceptance of responsibility, authority, financial matters, care of infrastructure and engagement with stakeholders.

Content, refers to the agent in what are considered the deeper and higher levels of knowledge, insight and reasoning of the agent and the embracing of new paradigms in the South African water resources arena.

The deductive propositions regarding the conceptual model were inductively evaluated for congruence with the empirical observations and evidence from the case study and data obtained. Alternative rival models and approaches were also considered in line with the execution of WRM functions by means of the application of the proposed conceptual model by Impala WUA.

The triangulated evaluation of congruence of the propositions against empirical data and sources of evidence compiled from the case study and interviews or observations, are described and tabulated in **Appendix H.**

4.4.4 Assessment of polycentric collaboration.

With reference to section 4.4.1 and **Figure 30,** the deductive propositions, which sought to justify critical functions that need polycentric collaboration, are grouped within the main category of "implementation".

With reference to section 2.7.3, the polycentric concept and approach *per se* is in essence a particular form of MSP to achieve a particular purpose. For an assessment of polycentrism in terms of this study, the Pongola River catchment is considered.

Compartmentalised approaches take place in institutional, scientific and practice interfaces of community and livelihood development, resulting in isolated and fragmented specialisation and creation of difficult challenges (Somjee, 1991, in Taljaard, 1997:23, 32). A more sustainable resolution of challenges and conflicts takes place through an interacting process of a number of coherent collaborating centres of decision-making bodies that are formally independent of each other (Bakker and Morinville, 2013; Muller (2012b); Ostrom, 2010). They may have overlapping or separate jurisdictions that do not stand in hierarchical relationships to each other (Skelcher 2005, in Van Rijswick et al. 2014). Ostrom further stated that each unit within a polycentric system exercises considerable independence in order to make norms and rules within a specific domain such as a firm, local government, network of local governments or even a national government. The participants in such a polycentric system have the advantage of experiencing local realities using local knowledge, and enhance learning from others in the process, which supports on-the-ground management processes (Bakker and Morinville, 2013; Nagendra and Ostrom, 2012; Wester et al. 2003; Waalewijn et al. 2005). Teisman et al. (2013) warned that the majority of problems in the water resources arena occur beyond the water domain such as in agriculture, mining and urban development. The multi stake holder nature and conflicting and competing needs, emphasise the need for exercising

authoritative and enforceable compliance, and enforcement of legislative policies and regulations (Najam et al. 2003; Botsen et al. 2008).

The category of implementation propositions, addresses factors that affect other stake holders and are considered crucial for sustainable co-existence between all stake holders which are exploiting the resource. These are also factors important for maintenance of the resilience of the natural water resource in the catchment. The sub-category propositions in this regard are depicted in **Table 29**.

Table 29: The deductive sub-category propositions drawn up that relate to the main category of implementation activities of the model.

		Deductive propositions about the conceptual model
IMPLEMENTATION	**Water security risks**	The likelihood and impacts of risks on stakeholders and systems in the catchment are interpreted and mitigated.
	Infrastructure care	Engineered infrastructure development, maintenance and monitoring is efficiently done.
	CME	Efficient monitoring, compliance and enforcement take place in the catchment.
	Dispute resolution	Proper conflict prevention and dispute resolution between stake holders are executed.

The Impala WUA performed significant work to carry out monitoring, recording and interpretation of various water related indicators. These are summarised in **Table 30**.

A good example where a lack of proper interpretations of data, water resource conditions and poor multi stakeholder considerations of water challenges failed, is to be observed in the Zululand region of the Pongola river catchment. A severe drought was experienced during 2015 and 2016 in this catchment. As indicated, the municipalities of Pongola, Nongoma, Ulundi, Vryheid, Golela and Paulpietersburg receive potable water and sanitation services from the WSA in the Zululand district.

Impala WUA communicated the expected declining water position and water control measures by way of regular data dissemination, information circulars and discussions with relevant stake holders. Despite the latter, poor application of good governance-management principles and lack of comprehension of the critical status of the water position by the WSA resulted in no water being available for domestic and sanitation use in Nongoma, Ulundi, Vryheid, Golela and Paulpietersburg. Only Pongola could maintain

sufficient water supply throughout the drought for both domestic and sanitation use as well as irrigation use. This was achieved because of very good monitoring, interpretation of data and restriction management of water supply to users by Impala WUA. This claim is validated because Impala WUA is the sole water supplier to the WSA.

Table 30: The confirmation of the proposition – sub-category water security risks.

Water security risks	**Deductive proposition:** The likelihood and impacts of risks on stakeholders and systems are interpreted and mitigated		
Type monitoring	**How executed**	**Results obtaining**	**Value added**
Chemical and biological water analysis	36 fixed points to take water samples across the catchment from source to Jozini dam. Samples taken by Impala WUA	Analysis by a SANAS[24] registered laboratory in Empangeni. Data interpretation by Impala WUA	Identification of several point source pollution activities that could be addressed (App D records 26, 28, 136)
			Sewer outpours from municipal WWTW systems flowing into the river system (App D records D26-27; E4, E84)
			Very detailed assessments of mining application (App F) Identify potential risk threats and discuss and educate IAPs
Rainfall and river flow	Extensive network of telemetric flow instrumentation at various weirs	Data monitoring by Impala WUA.	Drought forecast, already during January 2015, for the 2015 season Timeous water saving measures imposed and restricted supply implemented (Figure 26)
Monitoring the Bivane Dam level	Telemetric water flow and dam level instrumentation	Data monitoring by Impala WUA	Drought forecast already during January 2015 for 2015. Timeous water restricting measures imposed (App D records D148) Optimised the buffer capacity provided by the Bivane Dam

[24] SANAS (South African National Accreditation System) is a regulatory laboratory and system in South Africa to ensure *inter alia* consistent and reliable analytical methodology and analysis of registered laboratories.

Eight water security dimensions were quantitatively evaluated by Impala WUA in March 2015 during assessment of drought measures and reviewed in September 2016. These were plotted and compared on an octagram, illustrated in **Figure 31**. The risk exposure of the high rainfall western region, the drier central region and the services of the WSA in these 2 regions were considered. Four deterministic factors were evaluated to determine a score value for each of the 8 water security dimensions based on available records and empirical experience.

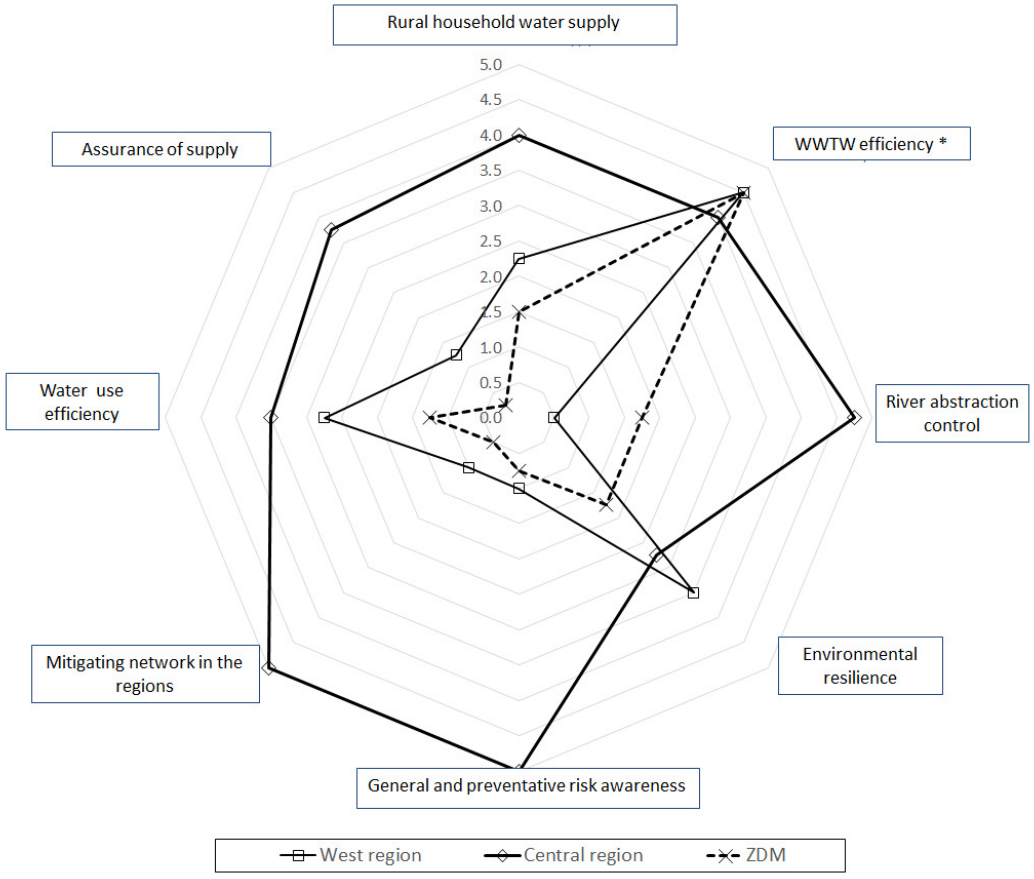


Figure 31: A comparison of eight water security dimensions of the western and central regions and the WSA in the Pongola river catchment.

It was interesting to realise that the drought revealed a much better resilience and adaptation to cope with water risks in the hot drier central region than in the cool high rainfall western region.

Impala WUA implemented, maintained and monitored several infrastructure components, reported in **Table 31**.

Table 31: The confirmation of the proposition – sub-category infrastructure development and care.

Infrastructure care	**Deductive proposition:** Engineered infrastructure development, maintenance and monitoring is efficiently done		
Type of structures	**How executed**	**Results obtaining**	**Value added**
Water measuring weirs of Commondale, Grootdraai and Mhlati Bivane Dam, property of Impala WUA, constructed 1996 - 2000. I.t.o. sect 120 of NWA, a Category C dam Monitor municipal WWTW structures for effluent return to source	High technology pressure transducers installed to monitor river flow and cell phone messaging results to a central data base Besides flow metering, physical inspections of civil structures, silt and vegetation clearing Physical inspections	Flow data via SMS to central data base. Daily monitoring and interpretation of current position and trends by Impala WUA Civil and electronic maintenance continuously done by Impala WUA Physical inspection reporting to DWS, WSA and Impala WUA	Optimising flow regulation for correct supply but maintaining minimum abstraction from the resource. Was extremely important during the 2015, 2016 and 2017 drought period
			Bivane Dam augmented flow in the Pongola river. Acted as flood and supply buffer in the Bivane river Reliable and sustainable domestic supply
			Maintaining own infrastructure and technology ensures efficient useful life Report condition of infrastructure condition to DWS and WSA. Assist in addressing WSA problems (App G) Monitoring result in obtaining much quicker service

Impala WUA executed compliance, monitoring and enforcement activities of various aspects in the catchment, depicted in **Table 32**.

Table 32: The confirmation of the proposition sub-category compliance monitoring and enforcement.

Compliance monitoring and enforcement	**Deductive proposition:** Efficient monitoring, compliance and enforcement take place in the catchment		
Type of activities	**How executed**	**Results obtaining**	**Value added**
Chemical, biological water analysis of point pollution Physical inspections by on-site visits Aerial photography or Google maps Follow up on whistle blowers Water use monitoring	Taking and analysing water samples Investigations and photographs of problem sites or activities Personal discussions with stake holder or by way of letters or directive Issue directives or institute legal action	Interpreting analysis or inspection results. Determine extent of risk or threat Determine mode of action Personal discussions solicit buy-in Legal action enforces discipline and a compliance culture to the benefit of other users	The local sugar mill effluent challenges were collaboratively addressed and brought under control (App D records 28-32 and App E record E85) Awareness and education prompted rehabilitation measures and improvement of practices amongst piggeries (App D records 136) Empower whistle blowers. Create trust in ordering behaviour. Create a culture of compliance with regulations and protection of users against transgressors (App D records D168-169 and App F record F4)

Dealing with various stakeholders in the water resource arena varies from delight discussions but also to serious and/or sensitive debates. The approach of a situation and stakeholders, need to be carefully planned in a structured way. Provision should be made that if a normal discussion is not possible, that concrete facts and statutory regulations can be proofed but also enforced where appropriate. Numerous disputes were dealt with during the course of time. Proper dispute resolution discussions took place of which some are presented in **Table 33**.

Table 33: The confirmation of the proposition sub-category dispute resolution.

Dispute resolution	**Deductive proposition:** Proper conflict prevention and dispute resolution are executed		
Types of cases	**How executed**	**Ways of engagement**	**Value added**
River pollution by piggeries Mining pollution threats Illegal abstraction of water	Through inspections and proof of problem by way of quality analysis or relevant data By way of good scientific research and intensive debate Identification and verifying facts	Site inspection visits, discussions and presentations on meetings and workshops Keep to regulations, insist on consultation. Good preparation for consultations Immediate consultation, followed by written notices and legal action where needed	Awareness of pollution. Accepted rehabilitation. 1 person sold piggery. Others significant upgrades. Sugar mill did significant upgrades. (App D records D28-32; 26-27; 136) Achieve good results to educate interested and affected parties (IAPs), keep mining applicants cautious and educate communities App D records D165; 170; 118-122). Very detailed and scientific assessments of mining applications. (App D records Engage in intensive consultations with applicants (App D, record D146) Create a culture of compliance with regulations and protection of users against transgressors App D records D168-169)

At face value it appeared that a few typical polycentric collaborations took place over the course of time, in other words, with reference to **Table 16,** a gathering of independent role players to address mutual challenges**.** Two such meetings were the quarterly Catchment Management Forum (CMF) meetings promoted and driven by DWS. One took place in Pongola and the other in Paulpietersburg. Much efforts was contributed by Impala WUA to identify, attract and engage those role players who could contribute constructively in the CMF discussions. It was, however, experienced, in the context of CMF meetings, that high prominence and high profile drivers or decision-makers of local role players were seldom involved (Appendix D, records D109; D115). It appeared that if a role player was sent by an organisation, the representative was in a lower level position which led to the situation that the role player could not participate constructively nor could he or she convince the principal about any of the discussions that were held and that led to follow up activities from this role player. Most of the time

many rural individuals attended one meeting but not others. This led to situations that continuity could seldom occur as, too often, arguments and debate had to be repeated to newcomers. Lastly the language barrier was a factor that could stretch meetings to extreme time limits.

A different approach developed through the exposure and different meetings, to look at a multi stakeholder meeting as a polycentric event. The components were as follows;

a. A polycentric meeting develops within a specific context and relates first to the specific challenges identified that need to be addressed.
b. Specific relevant role players were attracted for participation to address the challenge.
c. Once the role of each role player began to result in comprehension, and collaborative effort to dissect and synthesise possible options and decisions to rectify a challenge, from the perspectives of the different role players, it becomes a truly polycentric event.
d. The polycentric event is thus a focussed contextual evaluation, deliberation and development of solutions that could improve or rectify a situation. Each role player acknowledges his or her jurisdiction and authority. One or more role players then undertake, and strive to carry out, the necessary activities to achieve the objectives. Action may not be possible at that time, because of budget or manpower constraints, for example. But the polycentric group accepts that an action or actions was agreed upon and this will eventually achieve the objectives. The crucial factor is that the participants to a large extent acquire the knowledge and authority to make a decision and execute some actions.

The divergent role players with whom engagement with Impala WUA as a facilitating agent took place and with whom divergent challenges mostly unique in their own context could be addressed, are presented in **Figure 32** and listed in appendix C.

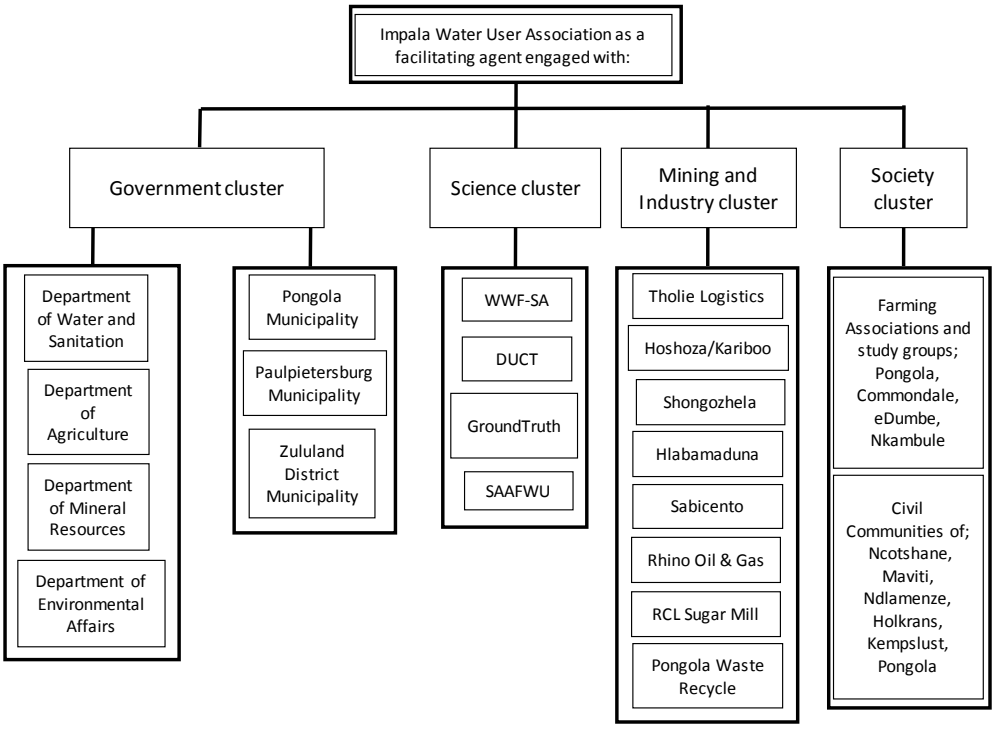


Figure 32: A layout of the divergent stake holders, grouped into the four clusters of main role players with which Impala WUA, acted as a facilitating agent, actually engaged with in polycentric liaisons during execution of numerous WRM functions.

The author concludes that a firm basis for polycentric collaboration was established and was possible between the Impala WUA and the stakeholders listed in **Figure 32** and presented in Appendices C, D and F. It is important at this stage to make a distinction between the event, the polycentric engagement and the achievement of a desirable and successful outcome. The latter is rather the extent of knowledge dissemination, understanding and mobilisation as illustrated in **Figure 19** and **Figure 22.**

Two examples will be provided that is regarded as a successful polycentric engagements with a co-productive outcome in terms of the concept, illustrated in **Figure 22.**

a. This first case is described and listed in Appendix F (records F5; F24; F61; F68; F69-70). Various role players that were, in terms of potential environmental impacts, affected and interested parties (IAPs), engaged with a coal mining Applicant. This Applicant was found to be in a process to prospect for coal mining on properties in the sensitive headwaters of the Pongola River. A series of engagements started between Impala WUA and the Pongola River Catchment protection Association (PROBA) as representatives of the IAPs and the Applicant. The engagements evolved from initially as aggressive and volatile towards understanding and co-operation through very intensive knowledge exchanges, very typically as described in **Figure 19** and **Figure 22**. Numerous interdisciplinary engagements took place between the two main role players, the IAPs

and Applicant, but also scientific task teams of both. In terms of South African regulations, this application was also debated in front of the so-called Regional Mining Development and Environmental Committee (RMDEC). The latter is a forum where different governmental departments evaluate the motivation of a mining Applicant as well as the complaints of opposing IAPs. It must be realised that coming to rational understandings and cognisance between such divergent parties are very difficult and demanding. However, a transdisciplinary relationship developed in the sense that, although the final decision to grant the mining license rests with the Minister of DMR, both parties worked to co-produce an outcome that will satisfy the concerns and/or acceptance of both.

b. This second case is described and listed in Appendix D (records D28-31)) and Appendix E (record E23).

   Impala WUA discovered a serious case of industrial effluent flowing into the river system. An investigation including chemical and biological analysis of the effluent and water followed. This led to engagement with the Mill CEO as well as various relevant department divisional heads of the Mill. Through a series of intensive engagements a transdisciplinary relationship evolved, which led to successful co-production of solutions and a commitment of very costly rehabilitation and upgrading of the waste management practices and infrastructure at the mill.

4.4.5 Assessment of engagement with stakeholders.

With reference to section 2.7.4, Schultz et al. (2011) cautioned that stakeholder participation in nature conservation is no panacea because it correlated with behaviour such as free riding, over harvesting and over-crowding around common pool resources (Ostrom, 2002 in Muller 2012b). According to Nijkvist (2014) and Teisman et al. (2013), stakeholder acceptance of shared responsibilities and co-operation is difficult and participation does not guarantee constructive actions. It is for this reason that Schulz et al. (2011) supported findings of other researchers that a “bridging” or facilitating leader amongst collaborating role players is essential to initiate, balance and sustain such a collaborative process. Du Toit and Pollard (2008) argue that a framework for operations provides a better basis for clarity and meaningful participation.

Bakker and Morinville (2013) cautioned about over emphasising the role of local role players, especially if they are seen as normatively better in WRM. A phenomenon known as the so-called “local trap pit fall” disadvantage may occur in such cases if it emerges that local role players (public, business, local municipalities or local NGOs) or individuals cannot maintain performance when confronted with the realities, challenges and complexities of WRM tasks.

In terms of this case, structured engagement as an approach and process evolved as a result of many engagements and deliberations throughout the WRM activities. A number of principles and a specific approach were applied as follows, namely;

a. An efficient facilitator or driver needed to exploit an entrance opportunity to engage with appropriate role players.
b. The following factors proved to solicit acknowledgement and buy-in from stakeholders:
    - Be active and visible in the environment with monitoring activities
    - Make acquaintance with prominent stakeholders such as community and farmers associations. Provide insight and create a broad communication and supportive base about contextual core values for a sustainable environment and future
    - Engage with relevant stakeholders regarding relevant challenges or issues and refrain from "shotgun" approaches in providing broad generic problems as entry points of engagement
    - Ensure that proper knowledge and facts are imparted regarding the nature, extent and risks of problems or challenges. The potential risks in terms of legislation or regulations as well as the effect for the stakeholder are important.

c. Determine the conceptual desired results to be achieved
d. Determine the stakeholders that are or should be involved in terms of the constructive difference that they could make and/or impacts that may be experienced
e. Attract only those role players that can influence the outcome and results of the challenge
f. Drive an iterative collaboration process relentlessly on the principles of a life cycle approach towards the desired result
g. An important challenge encountered in dealing with members of public society, is that when they are exposed to, or confronted with activities away from their own core business, they tend to back off, unless the challenge affects them in a direct way.

For ease of reference, the different stakeholders that Impala WUA engaged with grouped into the different stake holder clusters, depicted in **Figure 32**, are repeated here in

Figure 33. A list of all engagements is provided in **Appendix D.**

In terms of the WRM activities over the project period, the number of the various engagements with the different stakeholders, summarised from **Appendix D,** is indicated in **Table 34**. The number of engagements in the mining cluster is obtained from **Appendix F.**

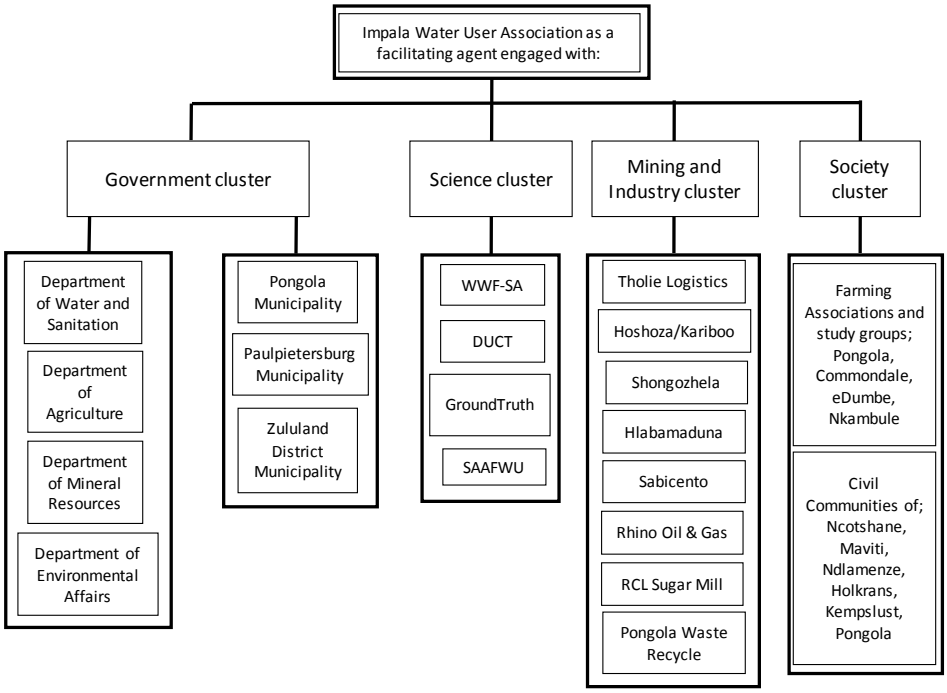


Figure 33: A diagram of the multiple stake holders, grouped into the four clusters of main role players that Impala WUA actually engaged with in the Pongola river catchment during execution of numerous WRM functions.

Table 34: The number of stakeholder engagements over the WRM project period, summarized from Appendix D.

Cluster	**Total number of engagements**
Civil society	63
Science and knowledge	41
Mining* and industry	91
Government and municipalities	27

* Specific mining engagements are obtained from Appendix F.

Appendix C contains an evaluation of 2 dimensions of 75 individual role players, which were engaged with. During the various meetings with management committees of groups of role players, such as the farmer's associations (Appendix D, records D134 and 135), PROBA (Appendix D, records D34 and 80), the municipality ((Appendix D, record D25), and the CMF (Appendix D, records D109 and 115), as well as individuals that were regarded as to be important in that particular context (Appendix D, records D1, D4 and D11), it was realised that regardless of the prominence and value of the role player, not all can be counted on to participate in the various causes. Because of the perceived importance of especially mining

activities in the sensitive headwaters of the Pongola River system, the participation of a number of role players was not satisfactorily. On a PROBA committee meeting on 17 September 2015 (Appendix D, record D33) a basis was conceived to quantitatively evaluate the prominence, participation and influence of role players regarding WRM threats and concerns. This was formalised by way of an assessment of role players through the course of time. On a scale of 0 to 3, each individual was, after meetings, assessed quantitatively by the Impala WUA Environmental Division, on the basis of the impressions and behaviour experienced in terms of the depth of prominence and the profile of drive of the individual, presented in Appendix C.

Depth of prominence evaluates the importance of the individual in his or her sphere of operation, the impact that his or her decision of opinion may have and the extent of penetration that the person might have to influence people in his or her domain of work. The profile of drive is an indication of the individual's comprehension of the concept and interlinkages of water security, the support provided and the extent of participation. A separate evaluation was done to determine the extent of active participation of the role players listed in the last (far right column) of Appendix C. The results are graphically presented in **Figure 34** and are summarised in **Figure 35**.

From **Figure 35**, it can be observed that the low score role players comprise two groups; 8% that only paid lip service or were incapable of participating and 47% that merely talked or may have been restricted in participation, a total of 55%. A total of 45% provided constructive background support (29%) and a core group (16%) were active in support to achieve the various objectives related to their circumstances at that time.

In most of the engagements that was arranged in the form of a meeting, more people attended the first than the follow-up meetings. The desired number of people also seldom arrived to participate than was hoped for. The latter was even also for example experienced for the meetings arranged by farmer associations for attending to their own matters. During this study, it was found that certain role players, such as farmers, community role players and municipalities, would rather give full attention to and spend their productive time on their own core business activities (appendix D, records D126, D135, D146, D147) than to use the time for external activities. Role players that did attend fully prepared and with representatives that were competent for the task at hand, were mostly parties that wish to achieve an objective of themselves, such as a mining application, or an engineering group that wish to promote improved waste management infrastructure. Engagement empirically proved and confirmed the notion in Muller (2012a), that people give attention to a matter when it affects them directly. It is however possible to be constructive and progressive with the core participants who show integrated cognisance about a challenge and ways or activities or efforts to address it.

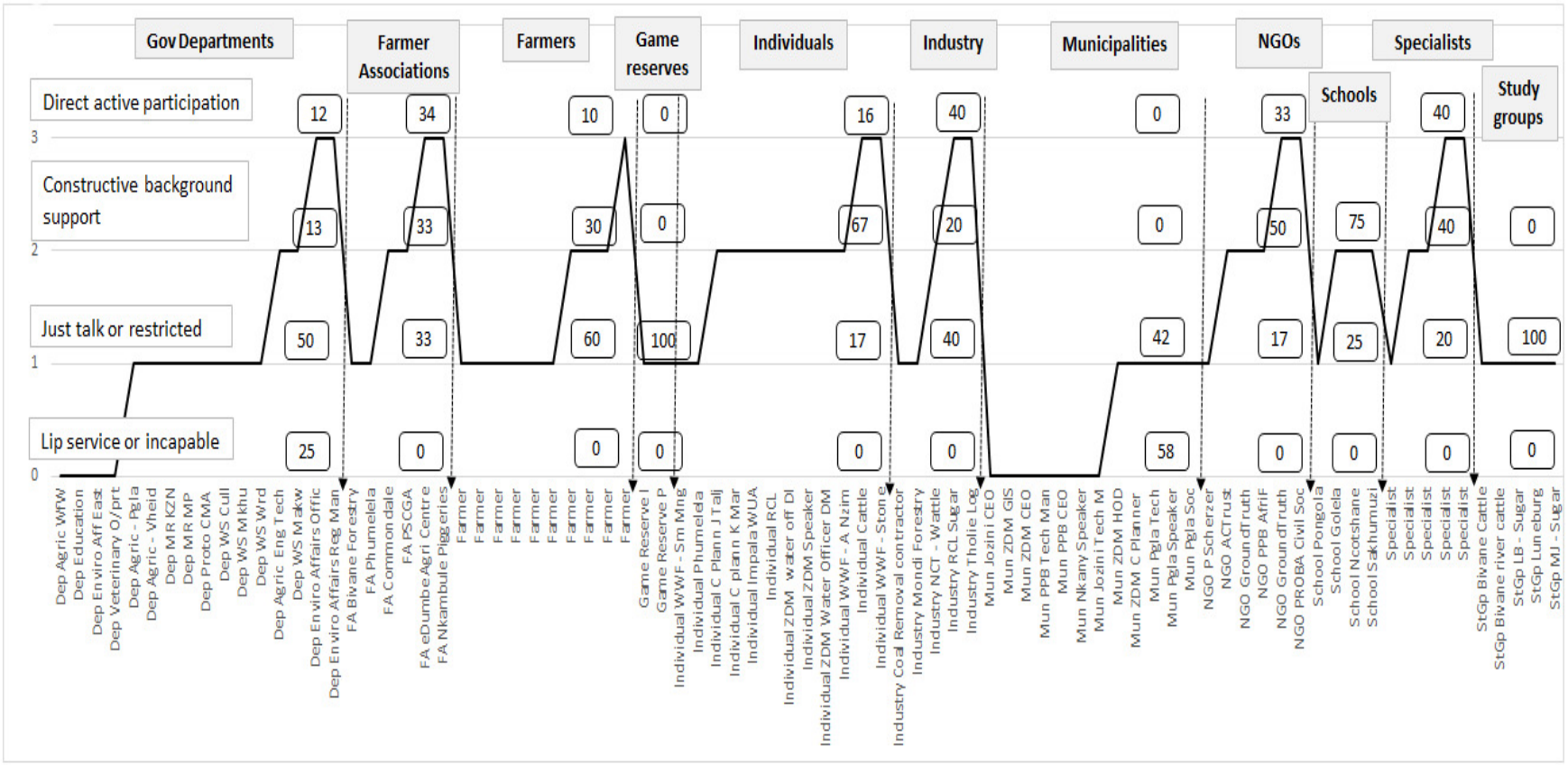


Figure 34: A graphical indication of the extent of participation of the different role players engaged with, expressed in a percentage per score per group, obtained from the "participation" assessment, presented in Appendix C.

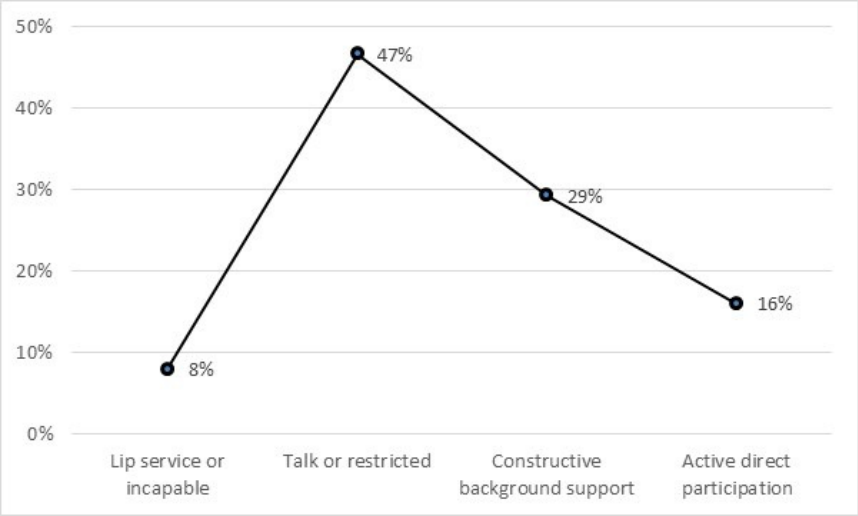


Figure 35: A summary of the Figure 33 data, indicating the extent of participation of all 75 role players engaged with, expressed as a percentage per score category.

It further confirmed the notions of Muller (2012a), Nijkvist (2014); Schultz et al. (2011) and Teisman et al. (2013) that stakeholder participation is no panacea and does not guarantee constructive actions. Understanding an issue from various perceptions and acceptance of shared responsibilities and co-operation is difficult. It is however possible and can have significant impact.

An example where stakeholder engagement and collaboration was, during the study period, not successful and did not result in efficient and satisfactory results, was that between Impala WUA and the WSA, the ZDM (Appendix D, records D26-27; Appendix E, records E7; E13; E20; Appendix G). Despite numerous direct engagements (between Impala WUA and ZDM) as well as polycentric engagements between relevant role players, for the effective addressing of sewer and potable water leaks from poor infrastructure systems, no significant constructive change was experienced from ZDM.

Discussions in dealing with the local and farming communities is complex and time consuming, while continuous deliberations with mining organisations, relentlessly driven to achieve their mining goals (Appendix F), revealed the following:

a. The relative disorganisation among civilian community people when compared with the diligence and in house knowledge of some mining houses
b. A total lack of knowledge in environmental, mining, administrative and legal matters
c. Lack of continuity in dealing with the matters mentioned above, as this is not a normal and core activity
d. Mistrust by some members as regards motives for financial contributions towards action campaigns (Appendix F, records F3, F45)

e. Fear and reticence concerning financial obligations if actions may result in litigation
f. Gullibility of local communities towards unrealistic promises of some mining organisations.

Experience with riparian irrigation farmers during the drought revealed that users will not save and restrict their own demand for water to assist lower downstream users, as they do not trust that other upstream or downstream users will do the same. (Appendix D, records D148, 161, 162).

Prominent factors experienced, were the perceptions and relationships within and between role players regarding power, interest and rights. Dominant role players tries to use power and perceived rights to manipulate arrangements their way. The balancing of these three factors are extremely important and sometimes, difficult, requiring the taking of very firm standpoints and application of knowledge such as appropriate aspects of law, authority and science. Most of the time, it evolves in debates that can be described as a "transformation debate" to even out polarisations in the discourse. This actual debate can be described as the "transformation zone", illustrated in **Figure 17.**

In general, as observed earlier, when engagement takes place, one of the first reactions of many role players, especially the local communities, was to inquire what authority one has to approach them and investigate a particular matter. It was realised that the possession of and power to exercise statutory authority was very important.

Another trend experienced and mentioned, typical of the catchment management forum (CMF) meetings of the DWS, was that organisations may send a low level official to a meeting. The person either does not understand the context or alternatively has no commitment or power to participate in decision making. This caused delays in the progress of some issues.

To maintain the progress of their work, Impala WUA resolved to pursue engagement as follows, namely:

g. Despite the above, maintain a well-distributed communication base to obtain local knowledge and understand local issues and conditions
h. To push towards getting activities or implementation on the ground, maintain links with good stakeholders that are able to understand, contribute to and build commitment and shared responsibility
i. Do not overstay one's welcome. Keep focus on the issues at hand through undisputed scientific or local onsite evidence, and demonstrate progress.

4.4.6 Assessment of governance-management.

With reference to section 2.6, the concepts of governance and management, both ambiguous forms of steering, cannot inherently take place within them, but involve the behaviour of humans (Scott, 2005; Tsoukas, 1994). Governance is viewed as a process that creates the strategic fundamental aspect of the purpose, goals and direction of a group working around a common challenge to enable efficient and sustainable management of its day-to-day operations (King, 2016:23). This requires the exercise of acquired authority to determine, approve and ensure compliance with policies and objectives (Ashton et al. 2006; Araral and Hartley, 2013:17; King, 2016:40; Van Rijswick et al. 2014).

In a practical sense and in the context of the definition of IWRM of the GWP, management is an approach that links water to the hydrological cycle, the ecosystem, the human practices and subsequent risks of these in maintaining resilience and sustainable water resources (Ashton, 1999; Bakker and Morinville, 2013; Hipel et al. 2008). It is exercised on different levels and to various degrees, depending on the context.

From a realist premise, human behaviour which exerts influence on others, needs ordering and control for sustainable mutual benefit. Such ordering and control are exercised by leaders and eventuate in governance and subsequently management (Bourblanc, 2012; Gerzon, 2003; King, 2016:23-26; Kumar, 2015; Schermerhorn et al. 2008:242-243; Rogers et al. 2000). Kumar (2015) argues that the eventual leadership role that an organisation may play are primarily based on its functions. The functions of an organisation are shaped by its vision, mission and strategy.

Figure 30, the deductive propositions that address governance and management in the water resource arena as well as stake holder engagement and participation, are grouped within the category of “organisation”. The propositions address factors that steer and guide the internal behaviour of the agent as well as external stake holders. The evidence to these propositions are considered indicative of proper governance and management as well as of the authority required in engaging with multiple stake holders around water as a common pool resource. The propositions in this regard are listed in **Table 35**.

Table 35: The deductive sub-category propositions drawn up that relate to the main category of organisation issues of the model.

ORGANISATION	**Infrastructure care**	Appropriate engineering works development and maintenance are done.
	Acceptance of responsibilties	Responsibility and authority are accepted, implemented and monitored?
	Authority	Proper legitimate regulations and agreements for WRM are in place?
	Financial viability	Revenue raised, properly controlled and used for its purpose?

The confirmation of the proposition sub-category infrastructure care, has been dealt with and set out in **Table 31** in section 4.4.4.

Acceptance of responsibilities is a crucial aspect of a leader, whether a human or organisation. The propositions in terms of acceptance of responsibilities, are presented in **Table 36**.

Table 36: The confirmation of the proposition sub-category acceptance of responsibilities.

Acceptance of responsibilities	**Deductive proposition:** Responsibility and authority are accepted, implemented and monitored		
Types of cases	**How accepted**	**Ways of implementation and monitoring**	**Value added**
Taking up and execution of WRM functions Support by the Impala Board Safeguarding and optimising of the water resource to sustain water supply during the drought	Executed various health assessments on the river system. Appendix E Addressed industry effluent. Appendix E Approval by the Impala Board to execute the WRM project and contribute in money and in kind Determined and managed the water security risk in the catchment Figure 19 Executed 7 main WRM functions comprising of 42 separate types of actions. Appendix E	Impala WUA entered into the WWF-SA project agreement on 12 June 2014 The Impala Board resolved to enter into the WWF-SA project agreement on 3 June 2014 The management and sustainable supply of water to the WSA and Pongola communities during the droughts of 2015, 2016 and 2017	It created a network of liaison, communication and a knowledge and support hub through the catchment with various stakeholders. (see Table 24 and Appendices C; D; F; G) A significant increase of awareness, knowledge and self-confidence amongst stake holders to deal with external threats to the water resources (Appendix F and G) Trust in the management of water resources

As described above, communities inquire about the authority on which one approaches to engage them to address issues. In practice certain challenges encountered are for example harmful practices that had been taking place over a very long time, such as communal grazing, irrigation or waste disposal by communities. Gumbo et al. (2003) in Swatuk (2005) pointed out that efficient institutional practices can only take place when supported and guided by sound legislative powers. Empirical experience showed that persuasion does not always work with difficult role players. In such cases the exercise of authority is inevitable and crucial.

The possession of authority is a crucial aspect when dealing with multiple stakeholders of a common pool resource. The proposition, in terms of authority, is presented in **Table 37**.

Table 37: The confirmation of the proposition sub-category authority

Authority	**Deductive proposition:** Proper legitimate regulations and agreements for WRM in place		
Type of cases	**Type of authority applicable**	**Ways of engagement**	**Value added**
River pollution by piggeries Illegal abstraction of water Factory effluent flowing into the natural resource Illegal waste dumping in the environment Illegal expansion of forestry activities (10 April 2017)	Impala derives its statutory authority from the NWA (i.t.o. sections 21, 22, chapter 8), delegations by the Minister of DWS (i.t.o. sections 53, 54 and schedule 3) and its Constitution (clauses 3, 4, 5)	Direct approach and engagement with role players recorded in Appendices C and D Instituted legal action against defaulting parties that abstracted water illegally (High Court of Pietermaritzburg December 2016 and Magistrate's Court of Pongola December 2016)[25] Direct liaison with the local municipality, DEA and DWS (App D)	Created awareness and caution amongst role players. Role players requested more information regarding statutory regulations and penalties (Appendix D, record D 168-169 and App E records E11; E85) Legal actions enforce regulations and create certainty, trust and equality amongst other users (App D records D39-41; D168-169) The position of having and being able to exercise statutory authority was found to be crucial when approaching communities, addressing rectifying of certain threats like pollution or land use practices (App D, records D 108; 160; 164; 167-9 and App F records F27; F58)

As an example where authority in law was utilised by Impala WUA to enforce compliance to regulations and statutory legislation, is as follows and described in Appendix D (records D161-162). During the drought of 2015 – 2017, Impala WUA communicated various appropriate water restricting regulations to all water users. Three cases were discovered where farmers illegally installed additional pumping

[25] Settlements were reached before the actions were brought before the Court.

mechanisms to abstract more water than allowed in terms of the drought regulations. Legal action were successfully instituted that confirmed a culture to ensure conformance to regulations.

The financial requirements for performing WRM functions are immense. Funding is required from diligent administration processes to undertake expensive periodic activities, such as water quality analysis, and long term activities, such as soil erosion rehabilitation or continuous follow up actions such as eradication of riparian alien invasive plants.

Financial viability and the access of funding is a crucial aspect in sustainable WRM functions. Ninety per cent of the funding for the execution of this WRM project was obtained from the WWF-SA through the sponsorship of the Nedbank Green Trust. The Impala WUA Board contributed ten per cent in money and several other contributions in kind such as a vehicle, office space and administration support. Expensive scientific evaluations and investigations were executed on the application documents of a coal mining license application. Funding for this exercise was obtained from contributions by the various farmer associations in the catchment (Appendix D, records D143; D147).

The proposition, in terms of financial viability, is contained in **Table 38**.

Table 38: The confirmation of the proposition sub-category financial viability.

Financial viability	**Deductive proposition:** Revenue is raised, properly controlled and used for its purpose		
Type of expenditure incurred	**Source of revenue**	**Ways of control**	**Value added**
Annual water quality analysis The water security WRM project Litigation in respect of mining organisations The outsourcing of expert scientific mining submissions	WWF - Nedbank Green Trust funding Impala WUA Board contribution in money and kind Contributions from Farmer Associations to carry legal cost for appeals to the Minister of DMR (Board approval 30 March 2011) and source specialist scientists (November - December 2015 and April – May 2017)	Proper business plan drawn up before the project Proper administrative and financial control mechanisms by Impala WUA (External audited statements by Lloyd and Jansen Chartered Accountants) External auditing Frequent feedback reporting to WWF-SA and the Impala WUA Board (WWF progress reports according to contract)	Funding made it possible to: ➢ execute catchment wide travelling ➢ identify problems ➢ carry out site investigations ➢ undertake chemical and biological water analysis ➢ Conduct meetings and engage with stakeholders. (Appendix E, F and G)

It was realised that had Impala WUA not been funded through the WWF – Nedbank Green Trust project, very little work and achievements would have been possible. If catchment wide WRM functions are executed, it is quite logical that all water users in the catchment should contribute on an equal basis towards such cost.

In terms of the NWA section 56 (1), (2), and section 57, provisions are made for WRM charges payable to the state. The DWS does indeed levy WRM charges on all registered water users in South Africa; these vary from region to region and between different type users. It appears that channelling funding from DWS to a WUA when executing WRM functions may be possible (App I, record I9).

The following example is provided which illustrates successful application of the governance-management nexus principle in the local WRM functions executed by the Impala WUA, described in table format in **Table 39**. This process is visually illustrated in **Figure 36.**

Table 39: An explanation of the progress of activities, illustrated in **Figure 36** from the start-up and execution of thereof, to illustrate the governance-management nexus taking place on all levels of the organization in the dealing with all the various activities

	Type interation	**Description**
1	Informing	The need for WRM in the catchment and the WWF opportunity, informed management
2	Interpretation	Management interpreted the information and submitted a proposal request to the Board
3	Interpretation	The Board interpreted the proposal requested
4	Management	The Board considered the proposed request
5	Inform an action	By way of the working of the Board they decided to approve the proposal
6	Governance	The Board decision contains the strategic and limiting framework in which to operate and to set achievement targets
7	Guidance	Management draw up a business plan for execution of activities
8	Infoming	Management are informed about challenges on the ground to deal with
9	Management	The activities are transformed into tasks and objectives
10	Action	Management employ staff and allocate tasks and jurisdictions
11	Governance	Management provide guidance to the supervisor in execution of activities
12	Management	The supervisor manages its tasks, time and equipment to execute tasks
13	Informing	The supervisor considers ways to deal with a challenge and engage with role players
14	Informing	Supervisor considers entrance approach and scope of engagement
15	Governance	The jurisdictions and project limitations guide the engagement activities
16	Informing	Supervisor informs management regarding findings and progress
17	Interpretation	Management interprets information. Prepares a progress report to the Board
18	Informing	The progress report informs the Board
19	Management	The Board interprets and considers the progress report
20	Governance	The Board revises or confirms the strategic objectives and achievements
21	Guidance	The Board provide confirmed or new guidance to management
22	Interpretation	Management interpret the guidance from the Board and transform it into management activities and performance targets
23	Informing	Supervisor interprets management performance targets and transforms it to tasks

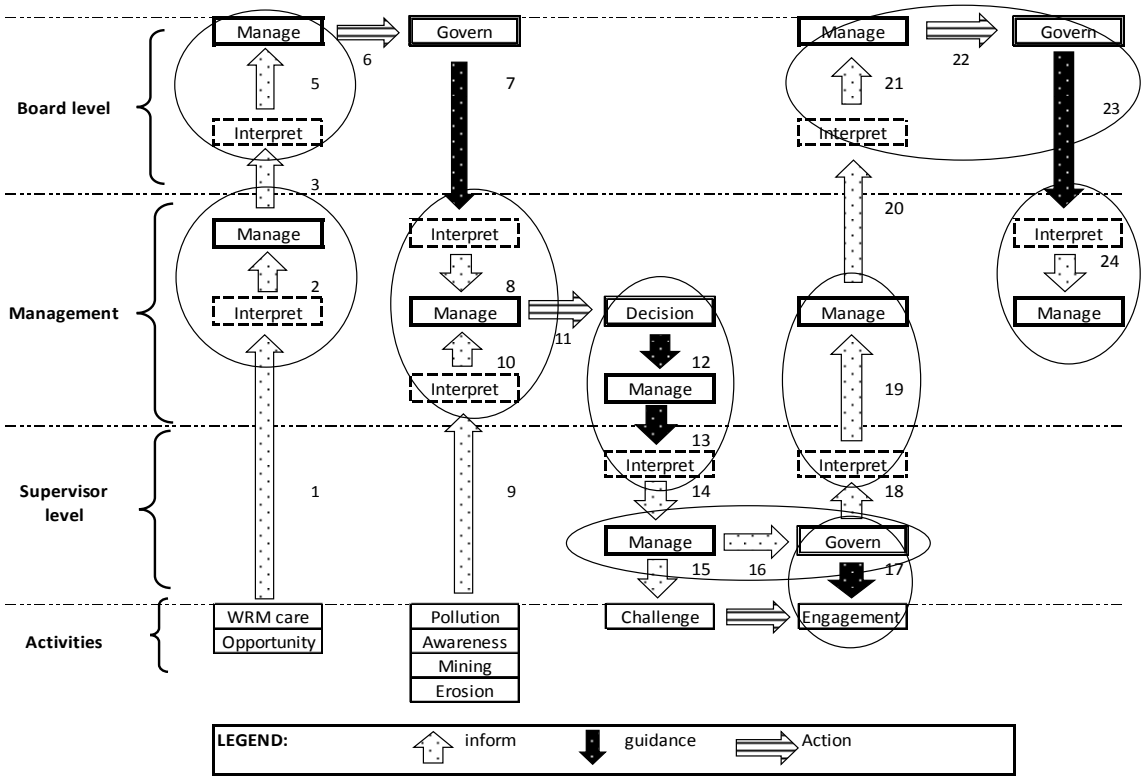


Figure 36: A visual illustration of a progression of activities and actions in the governance-management nexus, taking place on all levels of the organization as well as type of activity. The circles depict the management activities or governance activities

4.4.7 Assessment of the institutional agent

Taljaard (1997:114) defined community development as a process through which a community itself "*develops the will power to develop*". It therefore needs to exhibit the desire and perseverance to obtain the skills to influence its own destiny and quality of life. Subsequent management of its own resources is a crucial determinant for social resilience and sustainable development. It entails social learning, which is determined by the ingenuity of individuals, the community and intrinsic characteristics of the institutional forms that develop (Turton, 2003:147-170). Complex systems dynamics, such as livelihood development and resource management, require the solution of challenges through interdisciplinary, cross-sectoral and integrative approaches, particularly between state, sciences, civil society and practice (Anderson et al. 2009; Max-Neef, 1991 in Taljaardt, 1997:28; Taljaard, 1997:26, 78, 112; Turton, 2003: 133-134, Turton et al, 2007). With reference to the notions of participation in adaptive co-management in a complex SES, studies emphasised the importance of bridging institutional structures to coordinate and facilitate collaborative interfacing networks across different levels of knowledge and power systems (Hoogesteger,

2015; Hoogesteger 2016; Schultz et al. 2011)). Gumbo et al. (2003) in Swatuk (2005) pointed out that efficient institutional practices can only take place when supported and guided by sound legislative powers. As governments seldom have all the necessary resources available in their execution of governance on a wide scale, they make use of external actors (Bakker and Morinville, 2013; Teisman et al., 2013). It is in this context that the efficient utilisation of a suitable agent makes sense.

Figure 30, the deductive propositions that address the institutional agent as an efficient role player in local WRM and as facilitator between multiple stakeholders, are grouped within the main category of "content". These propositions address factors which are considered the deeper and higher levels of knowledge, insight and reasoning of the agent and the embracing of new paradigms in the South African water resources arena and are presented in **Table 40**. These are indicative of the feasibility of the applicability and actions of an institutional agent in a polycentric setting, in terms of the conceptual model.

Table 40: The deductive propositions drawn up that relate to the main category of content activities of the model

		Deductive propositions about the conceptual model
CONTENT	**Knowledge**	Understands water **system knowledge** base in its variety of forms
		Different **science disciplines** are being integrated
	Knowledge education and awareness	Knowledge is efficiently **transferred** horisontally and vertically
		Impacts and risks on humans and natural sytems can be **mitigated** through WRM by a local agent.
	Founding reasoning and insight	A proper process of **reasoning** and insight are exposed in decision-making.
		Freedom for **debate** on values and policy discourse exists.
		The shift in **interest based water use** against old rights-based use is supported and balanced.
	Change in paradigms	Trade offs for achieving **social objectives** are made.
		Proper depth and width of **stakeholders** are engaged.

The proposition in terms of the sub-category of knowledge, with respect to of understanding of water systems knowledge base in its variety of forms, and integration of disciplines, are presented in **Table 40**. An indication of the various knowledge disciplines encountered and needed during this study activities, are presented in the first column of **Table 41**. It further shows where the different types of knowledge disciplines were needed and or applied, and during which targeted WRM activities the type of knowledge could be allocated. It is important to realise, as mentioned earlier, that the water security and WRM project was approached holistically and systematically up to where the circumstances required a narrower focus. The logic in the process of knowledge understanding and mobilisation of Jahn (2008), as well as the concept of a disciplinarity continuum of Max-Neef (2005), illustrated in **Figure 19,** becomes clear and important to grasp the extent of knowledge and understanding needed.

Table 41: The different knowledge disciplines encountered and needed by Impala WUA during the execution of WRM functions and deliberations with stake holders in the Pongola river catchment.

	Knowledge discipline	Knowledge need and application	Targeted WRM activities
1	**Management and economics**		
	Organisation management	Impala WUA management	Applying for and implementing WRM
	Communications and negotiation	Polycentric liaison	Stake holder engagements
	Environmental economics	Ecological services and rehabilitation	Alien eradication, resource degradation
	Business economics	Understanding the business challenges	Finance and Administration
2	**Water and chemistry**		
	Water physics and flow dynamics	River, stream flow reduction and losses	River bank vegetation and alien invasives
	Water chemics	Quality analysis and interpretation	Effluent return threats to water quality
3	**Natural and biological sciences**		
	Plant sciences	Forestry, pasture and crop phenology.	Water use and risk determination
	Geography	Landscapes and climate interpretation	Sound use control and supply security risks
	Aquatic zoology	River health assessment	River and water health
4	**Engineering**		
	Civil infra structure design and construction	Structure development and maintenance	Construction and maintenance
	Hydrology	Water flow, losses, aquifer replenishment	Water Control
5	**Compliance, monitoring, enforcement**		
	Administrative Justice Act	Rational decision making, equal justice	
	National Water Act	Impala WUA authority	Polycentric engagement with divergent role
	National Environmental Management Act	Protection of the environment	players and divergent and competitive needs
	Mineral, Petroleum Resources Development Act	Dealing with mining interest.	
6	**Agricultural science**		
	Soil science	Land erosion and land use practices	Land stability, practices and soil erosion
	Crop production	Crop phenology and crop water need	Land use practices and irrigation
7	**Social science**		
	Socio-cultural evolution	Multi cultural communities	Mobilisation of existing resources
	Education	Address of environmental topics	Education, awareness creation, liaison
	Human society and halth	Pollution, effluent, degrading impacts	Effluent return threats to waer quality

The proposition sub-category knowledge education and awareness in terms of the efficient horizontal and vertical transfer of knowledge is presented in **Table 42.**

Table 42: The confirmation of the proposition sub-category horizontal and vertical transfer of knowledge education and awareness.

Knowledge education and awareness (1)	**Deductive proposition:** Knowledge is efficiently transferred horizontally and vertically	
Types of different knowledge activities required	**Cases of vertical and horizontal knowledge transfers**	**Value added**
Refer to Table 39	Vertical (internal to the WUA): Board meetings and debates regarding the participation with WRM, the threats of pollution, the potential threat of mining to the resource. (Appendix D, records D35, 56, 59, 60) Attendance of workshops for gaining and sharing knowledge Horizontal (external to the WUA) Training of the EC volunteers (Appendix D records D77 to D91) Education with communities (Appendix D, records D 108, 109, 112, 117, 118) Education with schools (Appendix D, records D 120 to 124)	Vertical: Approval and participation in the WRM beyond the Impala scheme boundaries. Approval and funding of appeal process with the Minister of DMR (App F, records F2, 4) and financing of expert scientists. (App D, records D 69, 71, 75, 76) Horizontal: Comprehension in communities and schools regarding the importance of the environment for water resource sustainability Participation from schools in the "clean-up" projects Acceptance and support by the Municipal Council for the objectives of the EnviroChamp activities (App D, record D161)

The proposition sub-category knowledge education and awareness regarding mitigation of impacts and risks on human and natural systems through WRM, is portrayed in **Table 43**.

Table 43: The confirmation of the proposition sub-category knowledge education and awareness regarding mitigation of impacts and risks on human and natural systems through WRM.

Knowledge education and awareness (2)	**Deductive proposition:** Impacts and risks on humans and natural systems can be mitigated through WRM by a local agent		
Risks identified	**Potential impacts**	**Mitigating measures through the WRM activities**	**Value added**
Water supply versus water availability estimations during the 2015 – 2017 drought Extreme river pollution by piggeries Mining right application on the farm Commissiekraal Sewer system leaks in the Ncotshane town sewers flowing to the Rietspruit	Because the Pongola river is the sole water source of the Pongola region, it faced the risk of running dry Downstream pollution and health problems for crop and domestic use Reduction of the Pandaan river flow and the underground aquifers because of mining underneath the river Rietspruit pollution and health problems for both domestic and vegetable irrigation	Timeous and efficient water control and restrictive measures (General Circulars 178 of 9 Jan ’15; 180 of 19 Feb ’15; 182 of 9 Apr ’15; 206 of 20 Oct ’16; 209 of 17 Jan ’17) Liaison with and buy in from the Nkambule Pig Farmers (App D records D134, 136, 138, 164) Intensive consultations with the applicant and RMDEC of DMR Durban (App F records F5, 24, 30, 40, 42, 56, 70) Alleviation of many problems through liaison with WSA (App D, records D14, 18; App G)	Created awareness amongst role players and society. Restricting the extent of risks during drought, river pollution by piggeries, and sewer system leaks

The confirmation of the proposition sub-category founding reasoning and insight relating to decision-

Table 44. A proper process refers to consistent methodology followed to ensure applying of the mind and understanding to be consistent in argument, considerations and to be informed by experience and knowledge.

Table 44: The confirmation of the proposition sub-category founding reasoning and insight relating to a proper process for reasoning, to enable decision-making as well as freedom for debate on values and policy discourse in Impala WUA

Founding reasoning and insight (1)	**Deductive proposition:** A proper process of reasoning and insight is exposed in decision-making **Deductive proposition:** Freedom for debate on values and policy discourses exists	
Platform for reasoning and insight	**Decision-making**	**Value added**
The Board meetings of Impala WUA consisting of nominated and paying representatives Annual General Members (AGM) meetings Water user workshops. Liaison with external role players	The divergent Board members utilise the opportunity to address water supply and different water demand requirements to safeguard the communities A process of AGM notices and of soliciting topics for discussions is applied (General Circulars 176 of 17 Nov '14; 188 of 11 Sep '15, 218 of 6 Sep '16) Frequent workshops are being held with water users and/or DWS officials to discuss challenges to gain insight (App F 19, 25; App D 11, 13, 35, 50, 52) Frequent discussions are being held with external role players such as the WSA, DWS which has a representative on the Board and other farmers associations (App D 11, 13, 35, 50, 52)	A healthy relationship exists between the Impala WUA with its water user members, the DWS, the DEA, local industries, communities of Pongola and farming communities of the western catchment region

The proposition sub-category founding reasoning and insight relating to support and balance of interest-based against old rights-based water use amongst the members of the Impala WUA as an institutional agent, is presented in **Table 45**.

Table 45: The confirmation of the proposition sub-category founding reasoning and insight relating to a shift in rights-based to interest-based water use amongst members of the Impala WUA

Founding reasoning and insight (3)	**Deductive proposition:** The shift in interest based water use against old rights-based use is supported and balanced	
Background	**Acceptance of the rights-based to interest-based use**	**Value added**
According to the previous Water Act, Act 54 of 1956, water use was allocated on a riparian rights base According to the new NWA, water belongs to the nation and is being protected by the trusteeship of DWS	Impala WUA applied for permission from the DWS to construct the Bivane Dam. Approval was granted in 1996. (Approval of Minister Asmal 31 January 1996 Reference 7/1/261/4) before promulgation of the NWA in 1998. In preparation for the increased water supply capacity and the amalgamation of the riparian water users with the canal water users, the principles of the NWA were accepted	The creation of more capacity and sustainable supply, led to the development of the Pongola Small Scale Farming project. 47 previously disadvantaged individuals were established on sugar cane farms. Together with this effort some commercial farms were sold by farmers to communal groups (Nkulindaba, Ntonga, Inyathuka)

The proposition sub-category change in paradigms relating to trade-offs during WRM functions and through Impala WUA, as an institutional agent, is depicted in **Table 46**.

Table 46: The confirmation of the proposition sub-category change in paradigms in relation to trade-offs for social objectives during WRM functions and through Impala WUA

Change in paradigms	**Deductive proposition:** Trade-offs for achieving social objectives are made	
Trade-off	**Background**	**Social objective achieved**
Sharing of new available water capacity by construction of Bivane dam Volunteering to participate and execute a mentorship program Selling of commercial farms to communities	Because of the additional water capacity created by the Bivane Dam, the Impala WUA established 47 PDI farmers on 530 ha of irrigated sugar cane farms (Report to the Minister of DWS 6 June 2007) A large number of commercial farmers volunteered to make their own time and knowledge available to act as mentors of PDI farmers in terms of farm practices, administration and financial management (E Rouillard, E. Holl, J.D. Richter, K. Stock, F. Brecher) A number of commercial farms were sold to accommodate the need of communities to become involved in sugar cane production (Nkulindaba, Maxwell farms, Ntonga, Inyathuka, Emvokweni)	The sharing of and access to water. Access to and participation in commercial farming and sugar cane production Training of PDI's in farming and husbandry practices, together with management and administrative skills

The proposition sub-category change in paradigms relating to proper depth and width of stakeholder engagement, described in section 4.4.5 during the WRM project activities is presented in **Table 47**.

Table 47: The confirmation of the proposition sub-category change in paradigms relating to proper depth and width of engagement with stakeholders during the WRM project activities

Change in paradigms	**Deductive proposition:** Depth and width of stakeholders engaged	
Types of stake holders in the catchment	**The MSP of engagements**	**Value added**
Refer to Table 33, Figure 27 Refer to Appendices C, E and F	The compilation of the Board of Impala WUA The annual AGM of Impala WUA Workshops. Meetings and discussions during the WRM project such as war room meetings, (App D, amongst others, records D 109, 110, 112, 115, 117, 118, 120-124)	Equal treatment of various type of stakeholders representing divergent disciplines and types of water use and type of water dependencies The application of the conceptual polycentric model utilising a facilitating institutional agent

4.4.8 Assessment of alternative rival organisations and approaches.

In terms of the rebuttal arguments of the model of argument analysis of Toulmin (refer to **Figure 3** described in section 1.6.1) and the congruence analysis (described in section 1.6.1), the prospects of possible alternative or rival approaches and organisations are evaluated.

The following section evaluates organisations which were potential rivals of the role and activities executed by the institutional agent, Impala WUA. It will be approached in terms of the following questions:

- What are the main characteristics of potential role players?
- Which role players are currently active in the Pongola river catchment?
- Why these rival organisations and role players are not geared towards executing local WRM functions?

During interviews with prominent officials of some NGO's (Appendix I, records I 1-8), as well as discussions and workshops dealing with challenges (App C, D and F), a number of characteristics emerged. These determine the way and extent of actions feasible for an NGO in a catchment wide setting regarding a continuous and complex activity such as WRM. Similar factors were experienced from numerous discussions with DWS and DEA (App D, records D 3, 6, 9, 12, 16, 17, 109, 115).

The characteristics of potential rival role players, active in different ways in the Pongola catchment, are presented in **Table 48**.

Table 48: An indication of characteristics of potential rival organisations active in the Pongola river catchment.

NGO's	**DWS/CMA**	**Private consultants**	**Social groups**
Funding from donors that has influence on project objectives Short project periods of 1 to 3 years. Then embark on new project dependent on donors Not geared as single station operational entities Use volunteer workers No authority Can operate with either donor funding or high expenses from the beneficiary	Has high authority Very much exposed to political interference Institutional uncertainty Cumbersome procurement Unpredictable Decision delays Lack of commitment Staffing shortfall Bogged down by line authorities Short duration "in and out" visits Current dire financial problem	Profit orientated Own specialised core focus Short term approach of "in and out" to the next customer WRM is not profitable Restricted knowledge base Paid service relationship with customer No authority	Own core business very important Work in free time Social intent Alternative focus Not inclined to incur cost Afraid of legal action No fixed permanent and comprehensive administrative base No authority

It is clear from **Table 48**, that private consultants and social groups do not have the inclination, the intent, and approach to conduct WRM functions on a fixed and continuous basis. The focus in evaluating potential rivals therefore falls on NGO's or the DWS or CMA, listed in **Table 49**.

Table 49: Potential rival organisations that may execute or execute WRM functions in the Pongola river catchment.

NGOs	**DWS/CMA**
World Wide Fund for Nature (WWF-SA)	DWS Regional
Duzi-uMngeni-Conservation Trust (DUCT)	CMA - Durban
Wildlife and Environment Society of South Africa (WESSA)	Catchment Management Forum
Endangered Wildlife Trust (EWT)	

An evaluation was conducted to determine the potential rivals for the conceptual model currently operating in the Pongola catchment, actually executed on catchment scale, compared to the actual functions executed by the Impala WUA. It is illustrated in the diagram in **Figure 37**. To evaluate the WRM functions from another perspective, it was compared with the WRM function list compiled by Muller (2012b) and presented in **Table 7.** Form **Figure 37** it can be calculated that Impala WUA executed 16 (89%) of the 18 functions listed by Muller, the DWS/CMA 11 (61%) and the NGO's only 5 (28%). It is therefore concluded that an institutional agent such as Impala WUA, is capable of executing more WRM in a catchment in proximity of the users and challenges than the potential rivals. This finding does not thereby exclude a rival such as the DWS but the local exposure and performance execution of the Impala WUA agent is considerably better. It should however be recognised that some functions listed, such as "resource allocation" are exclusively functions of the DWS alone.

In terms of the minimal number of functions executed by the NGO's they are ruled out and therefore do not represent a rival to an institutional agent in these circumstances.

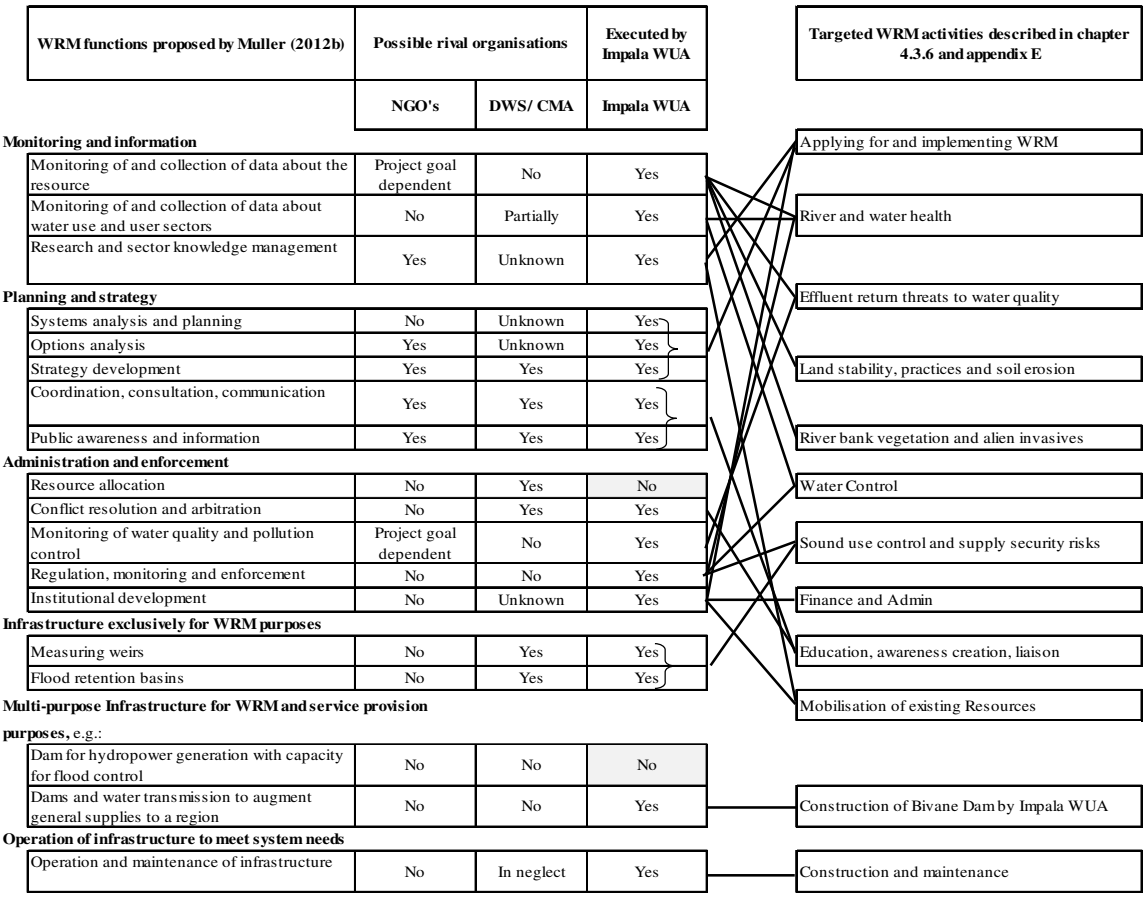


Figure 37: A triangulated correlation between execution of WRM functions existing between NGOs, DWS or CMA and Impala WUA listed by Muller (2012b) with the WRM activities targeted to be executed by Impala WUA.

4.4.9 Assessment of generalisability.

Interviews with CEOs of other WUAs and large IBs (Appendix I, records I 10 – 17 and I 21 – 31), confirmed that they are very similar in organisation, environment and functions to the Impala WUA. Theoretical extrapolation of the local WRM functions to the other WUA or IRBs is therefore possible.

As described in section 4.2.2 above there are 278 institutions similar to the Impala WUA across South Africa. For ease of reference, the data from **Table 20**, is repeated here for convenience in **Table 50**.

Table 50: The current number of different water/irrigation schemes in South Africa

Type of scheme	**Number**
Government Water schemes	28
Government Water Control areas	48
Settlement schemes	18
Irrigation Boards	141
Water User Associations.	98
TOTAL	**278**

. (**Source:** SAAFWUA, 2015)

The body of WRM functions that was compiled to execute in terms of this project is presented in **Table 27** section 4.3.6. A former Director General of the Department of Water Affairs, Mr Mike Muller, summarised crucial WRM functions from his DWS perspective as described in **Table 7** in paragraph 2.3.2 above (Muller, 2012b). This latter list serves to triangulate the various forms and activities to execute WRM between the envisaged focal areas proposed by this project, as well as the propositions derived from Van Rijswick et al. (2014) and Dent (2012).

To evaluate the possible execution of WRM functions by rivals, a comparison was drawn up and depicted **Figure 37** in section 4.4.8. For ease of reference this Figure 31 is reproduced again as **Figure 38.**

This comparison shows that all the listed functions were executed by Impala WUA except for the construction of large dams for power generation.

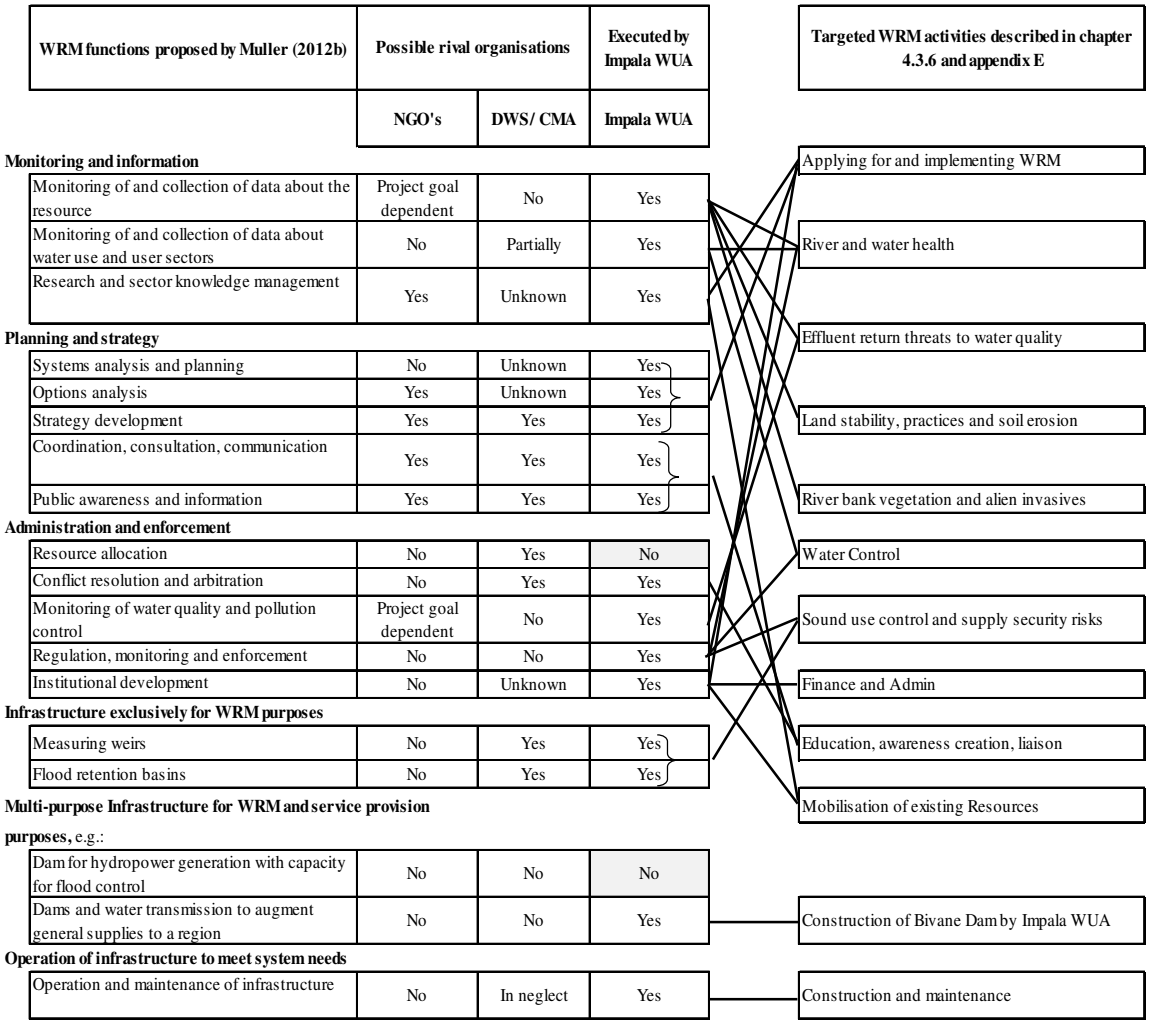


Figure 38: A triangulated correlation between execution of WRM functions existing between NGOs, DWS or CMA and Impala WUA listed by Muller (2012b) with the WRM functions targeted to be executed by Impala WUA.

This **Figure 38** serves as an indicator to confirm that local WRM functions can be executed on a catchment basis by other WUAs in terms of the conceptual model. It further concurs with the acceptable principle of SAAFWUA that WUAs should play a role in WRM. This principle in the strategic plan for WUAs through SAAFWUA is depicted in **Figure 27** and described in section 4.2.2. Because of the complexity and difficulty of WRM functions on a catchment scale, it is accepted that this generalisation will apply to well established and mature WUAs or IBs. Seen in the light of the strategic planning work and endeavours by SAAFWUA (App I records I21-25), this model is indubitably generalisable to all IBs and WUA in South Africa.

4.4.10 A detailed assessment of congruence.

A detailed triangulated assessment of congruence was conducted, described and tabulated in **Appendix H.** With reference to appendix H, each of the 17 propositions presented in **Figure 30** was evaluated as follows, namely;

a. Listing of evidence of activities that could be provided to proof that the various propositions had been tested
b. Three different types of sources of evidence were presented as triangulated evidence for each of the propositions. The evidence is compiled from all the relevant available information presented in the appendices
c. A conclusion was reached regarding the congruence provided by the sources of evidence
d. A comment was made about the challenge or deviation experienced on each proposition.

5. CONCLUSIONS AND RECOMMENDATIONS

"No calm sea ever produced a skilful sailor"

Anon

5.1 CONCLUSIONS

To answer the research questions, the characteristics, praxis and role of Impala WUA as a mature self-steering local institutional agent were examined and evaluated against the governance assessment model devised by Van Rijswick et al. (2014), and supporting questions by Dent (2012), presented in **Figure 2**. The study explored what factors necessitate and affect WRM, and which drivers affect the execution of functions of WRM. A conceptual model was proposed that offers a practical approach towards WRM in a catchment base by the use of existing institutions and polycentric collaboration with stakeholders. The study identified a number of vulnerabilities and weak points in both society and spheres of governmental authorities. A number of papers have called for a more practical framework that could help key actors to address their water challenges because the generic approaches and information are too general to inform practical responses. (Anderson et al, 2008; Muller, 2015; Uys, 2008). It is submitted that this study has shown through studying the Impala WUA case study that the proposed conceptual model offered an operational and practical grass roots level approach.

The study reached the following conclusions;

5.1.1 External drivers and factors that dilute the natural resource importance

With reference to the debate around WRM in terms of a water-shed basin or beyond the latter, towards a problem-shed, it is recognised that the dynamics of political and social challenges extend beyond the physical delineation of catchments as a WRM unit (Cohen and Davidson, 2011 in Muller, 2012b). The importance and role of socio-political challenges are not negated. However, it should, also be recognised that political and social content change constantly and dramatically in the South African context in terms of focus and locality. In the broad and larger context, socio-political dynamics are continuous and there is

a very widespread mix of wealth and poor in South Africa. However, it is argued that a dominant focus on the socio-political dimensions results in a dilution and masking of the seriousness and extent of impacts on the natural resources in its chemical, biological and structural forms. The gradual deterioration of natural and especially water resources in South Africa, and thus the argument for the need for adaptiveness, therefore resembles the analogy of "a frog in slowly heated water in a pot". When the intrinsic resilience threshold of the natural resource is passed, it might be too late.

5.1.2 Polycentrism, engagement and structured engagement

The concept of integrated WRM and collective cooperation in various forms are well known. Integration in essence means to bring together many different resources. How then does it differ from the concept of polycentrism as an approach in management? And if integration is implemented widely in many forms as far as natural resources are concerned, why is it not progressing in advanced strides to curb degradation and water resource challenges? It is argued that debates and concepts of integration and collective partnerships are mostly implemented amongst role players on high and educated levels. There is a lack of efficient mechanisms and suitable authoritative frameworks to yield constructive and sustainable effects on local levels.

With reference to sections 2.7.2, 2.7.4, 2.8 and 3.2 supported by **Figure 19** and **Figure 22** and **Table 16**, polycentric engagement refers to, what can be described as, the conditions under which a particular MSP engagement takes place. The role players rely on their independent jurisdictions, knowledge disciplines and functions. Importantly they also rely on their interdependence between each other as to rely on each other for the successful achievement of a mutual objective. The appropriate role players have influence or are able to implement change or activate a remedy, by exercising a function deemed necessary in the context of the situation to the mutual benefit of others.

This implies that role players in such a polycentric engagement, should exceed a cognitive, or memory judgment threshold, to understand the intricacies of the challenge under consideration and how each can co-create a desirable or sustainable solution. This in itself is a progressive process of knowledge development and mobilisation as illustrated in **Figure 19.**

During the study it was realised that engagement with divergent role players need to take on a specific form of deployment, as it entails different phases, such as to learn to know the role players, to define the challenge and exchange of knowledge, The appropriate way to approach this, what is proposed as a "structured engagement" is the interdisciplinary – transdisciplinary interplay, described in **Figure 22.** Structured engagement is the intentional design of activities to capitalize on the interactions between various stakeholders. It boils down to a balancing of the concept of "carrot – stick – loyalty", that hinges around communication, the perceived value of the participant, the perceived threat for the participant,

authority and the importance of own core business and time. Such a systematic engagement of the appropriate stakeholders in communities concerned in the planning process, to solicit buy in, is critical. It was shown that continuous informing and educative consultation with the clients, as well as service users and the broader group of stakeholders, became a learning process both for the community of resource users and for the resource managers themselves (Appendix D, E and I).

Polycentric structured engagement can therefore be summarised as to have the following elements, namely; A challenge, a number of divergent role players, a mutual purpose to achieve a desirable solution. The process to reach the desirable outcome is a relentless interplay of knowledge and insight exchange till a point of understanding is reach where subsequent activities evolves in a "working together" interdisciplinary relation, or a deeper comprehension takes place where knowledge and ideas fuse together to co-create a new and sustainable solution in a transdisciplinary relationship. It follows logically that during such a development process, a number of factors need to be taken into consideration which are; interpersonal, circumstantial, intellectual and background of the different role players.

5.1.3 A facilitating institutional agent

It was shown that to protect and manage water resources, the South African institutional hierarchy provides for the 3 tier institutional framework, the DWS, CMAs and WUAs. It was also shown that serious concerns about leadership, guidance, performance and institutional stability exist around DWS *per se.* South Africa finds itself in an era of institutional and guiding uncertainty. This consequently leaves the WUAs as the last frontier between the physical water and environmental resource on the one hand and the users and DWS on the other.

In terms of the NWA, the WUA is a cooperative of water users with limited primary functions in a delineated area of responsibility in a catchment. This study demonstrated that a WUA is a very strategically well positioned entity with a firm foothold in a catchment basin, as a facilitating agent. It was shown that Impala WUA was able lay a foundation and to execute polycentric WRM activities, which conforms to a large extent to the notion advocated by Ostrom, that water, as a common pool resource, can best be managed in terms of "common property regimes" by users who have a direct interest in sustaining the resource (Ostrom, 2002 in Muller, 2012a).

Integrating many stakeholders on a local or catchment scale around an issue is a challenging test on its own. Authority in terms of protection in, and application of, law, is a crucial ingredient when managing a common pool resource where many competitive role players are utilising the resource.

It was experienced during the course of 2014 to 2017 (Appendix C, records C4, 9, 12, 14; Appendix D, records D4, 11, 17, 21, 21, 23, 33, 34, 80; Appendix F, records F8, 9, 17, 25) in arranging meetings,

requiring inputs and participation, that stakeholders utilise manpower, resources and available time very much to focus on their own core business and perceived value of a challenge, threat or an activity. One needs to differentiate between the intrinsic characteristics of stakeholders during the normal course of life. Highly educated professionals work only where they are being contracted by external parties to fulfil the contracted functions in the shortest and quickest periods of time available. Other people who are role players, farmers and rural communities, do not possess either the knowledge, administrative capacity or privilege of taking time as often as they wish, to attend to WR challenges in a sustainable manner. They tend to act if the challenge is limited to a threat experienced in close proximity.

The complexity and nature of WRM challenges and activities do not cater for these variations: that is why a suitable stable and sustainable local agent makes sense. A local agent such as the Impala WUA interacted and operated on grass roots level and close proximity with users and stakeholders in the catchment. Such an agent, though not always popular among users due to issues such as making or enforcement of user regulations, creates a sense of belonging and credible collective action for mutual benefit. It possesses statutory authority and offers a stable base in a catchment for sustainable execution of WRM activities.

5.1.4 Application of the governance-management nexus in WRM

Governing and managing people and their activities, in a situation of addressing a mutual problem, rely on the recognition by stakeholders of their shared responsibility and the creative potential of their adaptive capacity. In general it appeared that amongst practitioners, the terminologies of governance and management are being used interchangeably, or alternatively to tag activities as WR governance. Governance and management are in essence a nexus of interpretation, information and guidance that takes place on all levels of seniority and activity as illustrated in **Figure 36**. The more complex the domain, the more dynamic and reiterative the government-management nexus becomes to interpret circumstances, to guide current and future actions and to keep track of operational performance.

It was found that effective WRM requires the management of a very specific penetration of knowledge to people. Such penetration is needed to catalyse awareness, cognisance and desire to change behaviour in people. It was discovered that the structured engagement, education and collaboration increased social resilience over a period of exposure to cope with common resource challenges. The approach as executed by Impala WUA has proven ways to put individuals and communities in a catchment into a cognitive phase to raise their awareness, to understand actions and consequences and a need to secure their aquatic resource for the future.

5.1.5 The need to parlay the proposed institutional agent

To achieve the objective of implementing a WUA as a facilitating agent to embark on WRM activities in a catchment, it is critical that the WUA needs to be parlayed to be able to execute these functions. A list, that contains the important aspects that need to be addressed in this regard, from the experience of the Impala WUA, is provided in **Table 51**.

The need to parlay the WUA as an agent arises from its likely current insufficient structures, operations, access to sufficient and sustainable funding and authority as prescribed in the NWA chapter 8 and schedule 4. It is not purported to be a complete list because context may differ substantially in other areas and contexts.

5.1.6 Final remarks

To show congruence between all the elements of this study, namely the research approach, the topics of the literature review and the polycentric governance-management nexus through an institutional agent, a compilation was drawn up and presented in **Figure 39.** It depicts the reality of human behaviour that the author physically encountered and experienced during the course of the case study activities.

In the actual domain, behaviour in a nation is being ordered by different statutes which are available and being used by the author in the execution of certain WRM functions. The final creation of the vision, mission, confirming of authority and setting of standards, has an iterative relationship with the actual execution through the use of knowledge and skills to achieve the desired objectives and standards. The governance-management nexus forms the important axis around which the polycentric engagement revolves.

The study concludes with a final test of the elements of argument contained in the model of argument analysis devised by Toulmin, presented in **Figure 3.** For ease of reference, it is redrawn in **Figure 40**.

The claim the author wishes the audience to draw, is that a WUA can execute polycentric WRM functions in a catchment as a facilitating institutional agent.

The data provided is the case study and research work of the WRM activities and experience of the Impala WUA, as well as the proximity to the resource and stakeholders.

The warrant, as the rational link of the data to the claim, is explicitly the fact that the Impala WUA is a well-established mature water management institution operating in the catchment, comprising divergent stakeholders all dependent on the natural water resource for a sustainable livelihood.

Table 51: A list of aspects that need to be implemented to parlay a WUA as an agent to enable it to execute WRM functions, drawn from the Impala WUA experience.

Functional division	**Parlaying aspect**	**Motivation and description**
Statutory arrangements.	Authority and power	The first question most role players, especially rural communities ask, is "who you are and what is your authority?". Statutory authority is extremely important as friendly persuasion is not possible in all circumstances. The agent must be able to gain access to areas/properties, do assessments and if needed, issue directives
	Locus standi	The position and role in a catchment to act for benefit of the environment and current and future generations
Knowledge	Knowledge	Good knowledge of a variety of disciplines and different statutory regulations and Acts is important to be able to deal with different challenges that involve various types of legislation
Finance and administration	Access to sufficient funding support	WRM functions can be grouped into two categories. One comprises the operational aspects in terms of assessments, meetings, research, sampling, collecting and working with data. The other is *in situ* rehabilitation projects of whatever challenge might present itself. The former is an in house cost that the agent needs on a continuous basis. The latter may be extremely expensive and may be obtained in the form of a project funding from government or an interested donor
	Sufficient suitable staff	The nature of WRM activities varies considerably. Staff must have the competency and nature to work with people in friendly and in hostile circumstances and to be comfortable in remote difficult terrain
	Communications network	Efficient communication implies that important role players and the agent must be contacted easily and quickly by items such as a cell phone and internet services
	Access to administrative facilities	Basic administration such as a photocopy machine, colour printers, and binding of large documents
	Fixed accessible address	Become a communication hub and reference point of communication and engagements
Operations	Basic equipment	Items such as a camera, laptop, GPS, water sampling devices, projector, public address system. Necessary to keep proper records. Areas to access water for sampling may be very difficult and hazardous. Addressing a number of people in various circumstances
	Suitable vehicle	To be able to drive to and transport equipment in rough terrain and difficult areas

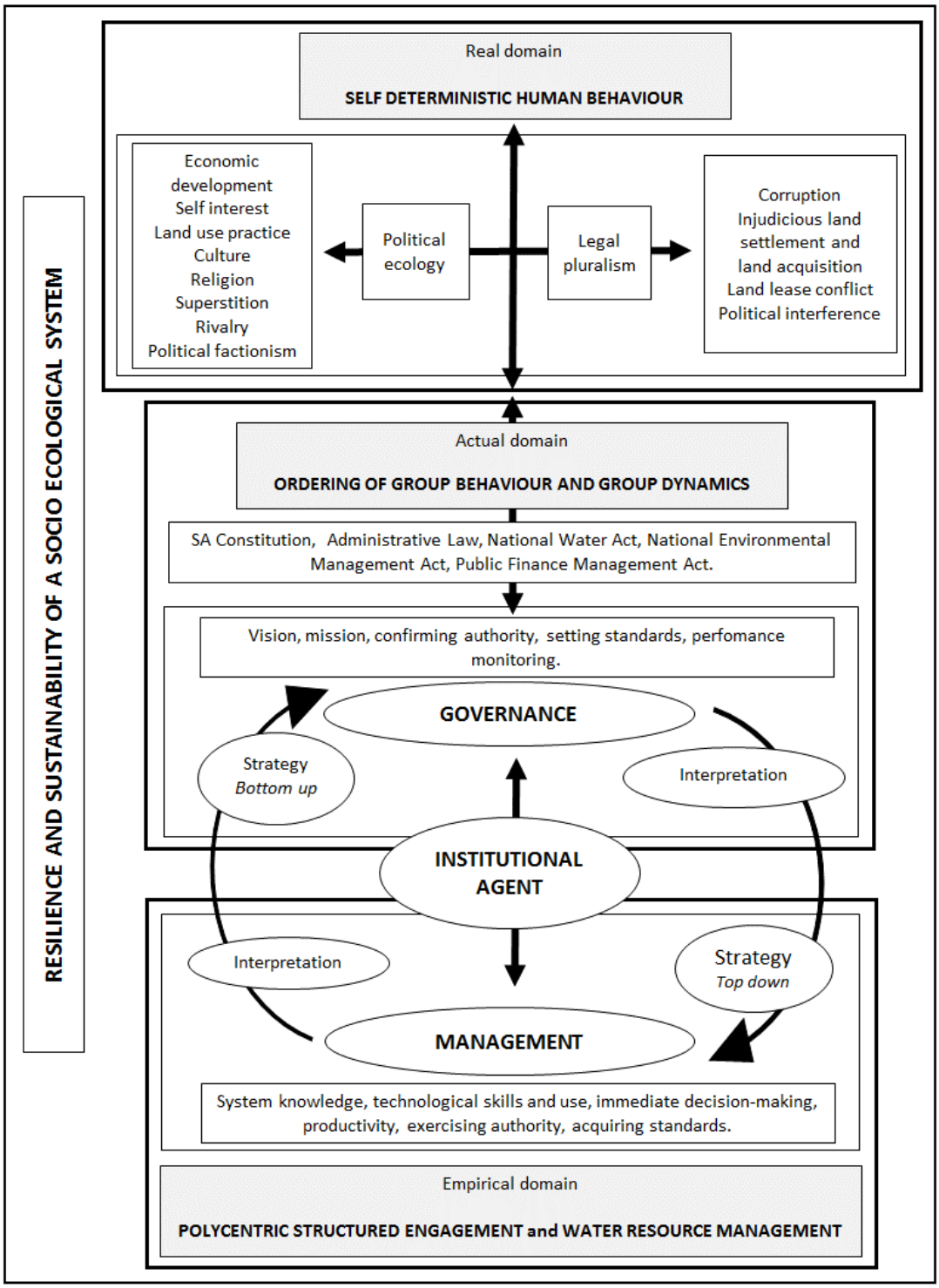


Figure 39: A summary of the evolving and congruent flow from the real, to the actual and finally the empirical domains with the interlinking dimensions of the literature review background and the research question.

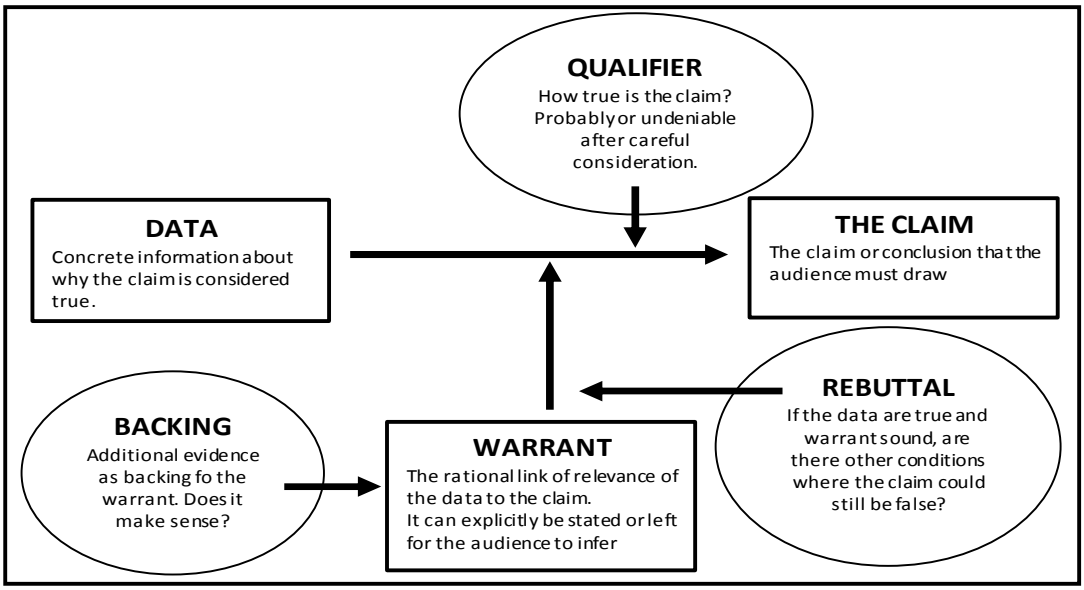


Figure 40: The model of argument analysis of Toulmin

Backing is provided by a substantial volume of peer reviewed scientific studies expressing concerns about:

- the deterioration of the natural water resources in a water scarce South Africa
- the concerns about poor leadership from DWS
- the institutional gap created by DWS in the execution of WRM and
- the need for more practical on the ground solutions.

The claim is qualified as undeniably true, based on the careful considerations of numerous factors: the strategic positioning of a WUA in catchments in South Africa, and the way in which Impala WUA conducted WRM functions in the Pongola River catchment. This is important if seen against the empirical facts that critical WRM functions and monitoring, had for considerable time apparently not been done in this parts of the catchment.

In countering a rebuttal of the claim, it is required that the following parlaying conditions must be met, namely:

- The WUA must be well established and matured regarding its administration, operations and capacity to conduct complex functions and liaison
- The staff must possess good capacity and competency and

- Funding must be available and could be rerouted or reimbursed from the current water resource management charges received by the state from all South African water users or from other sustainable sources.

It is concluded that the study successfully showed that the Impala WUA, as empowered and parlayed in certain ways through decisions of the Impala WUA Board, employment of a suitable environmental officer, the possession of authority and the funding by the WWF-SA and Nedbank Green Trust, was able to successfully answer the fundamental research question, in that;

- it laid a firm basis for, and was able to act successfully and constructively in a polycentric setting as described by the proposed tetrahedral model
- it was possible to act as a facilitating institutional agent
- it was able to successfully participate and commit in structured engagement with role players in the catchment to execute WRM and
- It was able to successfully execute policy implementation and execute enforcement of and compliance with water resource management regulations.

5.2 THREATS FOR IMPLEMENTATION AND LIMITATIONS

Considering the above, the following limitations in the study and threats may exist for the successful implementation of the conceptual model and of a WUA as a facilitating agent on a local catchment scale:

Interference from the Minister and DWS may be possible in terms of:

- Amendments to statutory jurisdictions and institutional framework to exclude, disband or alter the nature and functions of the WUAs to render them useless for WRM activities
- A decision not to amend and/or delegate appropriate statutory authority and powers
- A decision not to allow WRM on catchment scale by a WUA or a local WMI
- Prescribing functions to a WUA that do not address catchment WRM
- Poor leadership and lack of providing certainty in statutory guidance of WRM, and
- Poor or no financial support. WUA are authorised by the NWA to levy water use charges to users to cover its operations costs, with reference to its primary functions but not WRM functions as ancillary function. A way must be created to source funding from all water users in such a catchment to execute WRM on the wider catchment scale.

A lack of internal institutional support will render effort, motivation and funding null and void:

- If the Board of a WUA shows no comprehension and/or support

- If there are cases of incompetent and/or unmotivated staff or the WUA CEO.

A lack of sufficient funding, in that:

- WRM charges cannot or will not be reimbursed or rerouted from DWS or the state to a WUA for execution of WRM functions on local or catchment scale
- Refusal or restriction to pay water resource management charges from water users due to reasons such as dissatisfaction or reluctance
- The state-imposed compliance with difficult attainable or prohibitive conditions before reimbursement or funding from the state is possible.

If MSP role-players are bogged down due to organisational or leadership inefficiencies, the polycentric endeavour will be inefficient and unconstructive.

The researcher was deeply embedded in the research. To maintain validity, improved knowledge creation and learning, the researcher compiled a comprehensive amount of detailed longitudinal information from a wide variety of activities and nature. The researcher made effort to distance himself from the subject and focus of study.

However, it remains the prerogative of the reader to evaluate the validity, generalisation and contextual transferability of the study and study outcomes.

5.4 RECOMMENDATIONS

The following recommendations are proposed:

5.4.1 Further refinement of the concepts of polycentrism for integrated WRM on the specific local or catchment scale. Although the concepts of cooperative and collective partnerships are well understood and widely implemented, they lack successful and constructive application and mechanisms on local levels in South African conditions.

5.4.2 Sustainable funding mechanisms for local WRM activities would be an important consideration and is considered a crucial factor. Except for those who are educated specialists, it is still difficult for laymen and the general public to comprehend the value, especially the monetary value, of water and ecosystems. If an entity visits and assesses a community or farmer that is experiencing an environmental problem or degrading ecosystem it is extremely demoralising for the community or farmer if nothing happens thereafter. Empirical experience shows that such role players are very reluctant to allow “more scientists or environmentalists” onto the area as “nothing constructive to rectify the challenge or problem is happening”. Constructive actions or follow up apparently do not occur for the following reasons: either there is no known solution with current knowledge

available, there are difficult legal issues involved (for example abandoned mines) or there is no funding available to address and rectify the issue.

Discontent was also experienced from certain categories of water users which feel that they are the only entities which carry the financial burden by paying the compulsory water resource management charges due to DWS, although all citizens and industries are dependent on sound and reliable water resources.

5.4.3 The sufficient penetration of knowledge to reach all levels of stake holders in a catchment emerged as important to solicit sustainable buy-in. Much publicity is given to education and information provided to citizens relating to water resources. The question emerges whether this is penetrating efficiently enough in terms of pulling the correct triggers of cognisance and understanding to change human behaviour, in children and adults. With due acknowledgement of many efforts in this regard, empirical experience suggests that these are too weak to catalyse changes in behaviour.

5.4.4 Building capacity and incentivised avenues in and among professional entities may contribute to convince them of the necessity of involvement in various forms of WRM support, such as; training, monitoring indicators, upkeep of data in terms of new technology or data interpretations. These may typically be aspects that fall into expert knowledge domains which are very costly for citizens or small local entities to access.

5.4.5 A revision of performance of obligations and enforcement of policy and law, with regard to environmental impacts and degradation must be considered. Although certain issues are under investigation and are contained in principles or policies, such as the polluter pays approach, very little constructive progress has been experienced with historical aspects, such as the problems and liabilities of abandoned and poorly rehabilitated mines, and a significant increase in lower profile types of transgressions or degradation – such as the dumping of refuse by citizens.

In South Africa a very cumbersome and lengthy statutory process, exposed to and rife with bribery, needs to be followed for various authorisations to execute activities on the ground despite assurances of authorities of efficiency and short turn-around-times. Again, these are not the high level, overexposed industries but the large number of smaller yet important role players on the local scale. Most of these types of activities are of a short term and time bound nature.

The cumbersome process tends to deter people from following regulations and enhances a culture of non-compliance and indifference.

5.4.6 The systematic and continuous creation of important forms of useful data as well as access thereto, are becoming more important. Although much is taking place in this regard and various academic or knowledge institutions conduct surveys, empirical evidence suggests that some crucial information is out-dated or fragmented. Many of the data are related to a specific project or study which is not continued. It was further worrisome to experience that a certain governmental

department, responsible for crucial data collections, aimed to decrease the distribution and number of monitoring stations despite the importance of the information. Mechanisms and avenues can be investigated to delegate numerous projects of critical data collection to suitable agents currently available and in place in many catchments all over South Africa, as well as to support these agents.

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7. APPENDICES

Appendix A	A list of role players to which the author had access, that submitted comments on the Government Gazette Notice 888 (DWA, 2013b), notifying citizens that the Minister of the DWS intended to review the National Water Act, Act 36 of 1998, based on what is called the "2013 Proposed national policy review".
Appendix B	A list of mining interests by mining organisations in the headwaters and Commondale area of the Pongola River Catchment, dealt with by the author from 2009 to 2017.
Appendix C	A matrix indicating the depth prominence and an impression of personal commitment and drive to participate of 81 role players engaged with in the Pongola River Catchment.
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Appendix E	Water resource management activities and achievements in the Pongola River Catchment.
Appendix F	Activities relating to evaluation and consultation regarding mining in the Pongola River Catchment.
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Appendix H	Congruence through triangulation of the deductive propositions and empirical evidence to assess the suitability of the conceptual model.
Appendix I	Specific semi-structured interviews and workshop discussions carried out.
Appendix J	Photos and graphic illustrations of various WRM activities executed during the project.

APPENDIX A

A list of role players to which the author had access, that submitted comments on the Government Gazette Notice 888 (DWA, 2013b), notifying citizens that the Minister of the DWS intended to review the National Water Act, Act 36 of 1998, based on what is called the "2013 Proposed national policy review".

Date of submission	Author of submission	Organisation
13 September 2013	A. Collier and O. Rossouw	Labalelo Water Users Association
17 September 2013	C. Olivier, CEO	Hex Valley Water Users Association
18 September 2013	H. L. du Toit, CEO	Oranje Riet Water Users Association
25 September 2015	Q. Brynard, CEO	Wynland Water Users Association
26 September 2013	P. D. S. le Roux, Chairman	Holsloot Water Users Association
26 September 2013	L. Bruwer, CEO	Central-Breede River Water Users Association
27 September 2013	Me. L. Beukes, CEO	Oranje Vaal Water Users Association
28 September 2013	A.J. Layman, CEO	Durban Chamber of Commerce and Industry
30 September 2013	J. O. Fourie, Chairman	Calitzdorp Irrigation Board
30 September 2013	B. Louw, Secretary	Berg River Main Irrigation Board
30 September 2013	H. B. de Villiers	Stella Water Users Association
7 October 2013	Tony le Roux	Mooi River Water Irrigation Board
8 October 2013	Me. C. Colvin, Senior Manager, Freshwater Programmes	WWF-SA
8 October 2013	A. J.. Labuscagne, Chairman	South African Association for Water Users Associations
10 October 2013	J. F. van der Merwe, Executive Director	AgriSA
24 January 2014	N. Opperman, Director: Natural Resources	AgriSA

APPENDIX B

A list of mining interests by mining organisations in the headwaters and Commondale area of the Pongola River Catchment, dealt with by the author from 2009 to 2017.

	ORGANISATION	Year of ID or application	INTEREST	APPLICATION	DMR register number	PROPERTIES TARGETED
B1	Come What May Properties 35 (Pty) Ltd	2009	Coal	Prospecting	KZN 30/5/1/1/2/577PR	Farm Paris 750HU on Bivane River
B2	Tholie Logistics (Pty Ltd)	2010	Coal	Prospecting granted. Mining right application	KZN 30/5/1/2/2/10061MR	Commissiekraal 90HT, Klipplaatdrift 120HT, Pivaans Waterval 267HT
B3	BSC Resources	2010	Coal	Area inquiries	NOT AVAILABLE	Commissiekraal 90HT, Klipplaatdrift 120HT, Pivaans Waterval 267HT
B4	Variswave Investments (Pty) Ltd	2010	Coal	Area inquiries	NOT AVAILABLE	Commissiekraal 90HT, Klipplaatdrift 120HT, Pivaans Waterval 267HT
B5	Kebrastyle (Pty) Ltd	2012	Coal	Prospecting unlawfully granted	KZN 30/1/1/2/624PR	Pivaanspoort 10HT
B6	Impala Platinum Ltd - African Exploration Mining and Finance Corporation (Pty) Ltd	2012	Fe, Mn, Au, Al, Pn, Co, Pb	Prospecting application	MP 35/5/1/1/2/5633PR / MP 30/5/1/1/2/5547PR	Sulphurspring 14 HU and 13 HU
B7	Mashinini Trading CC	2013	Coal	Prospecting application	MP 30/5/1/1/2/10861PR	Imelkaar 102HT, Talaga 183HT, Nederland 202HT, Wetteren 176HT
B8	Conceit Investment (Pty) Ltd	2013	Coal	Prospecting granted	MP 30/5/1/1/2/10876PR	Talaga 183HT, Nederland 202HT, Tafelberg 188HT, Normandie 178HT
B9	Umsobomvu Mining Holdings (Pty) Ltd	2014	Fe	Prospecting application	KZN 50/5/1/2/10169 PR KZN 30/5/1/1/2/10141 PR KZN 30/5/1/1/2/10181 PR	Ontevreden 203HT
B10	Gwazela Hlabamaduna Trading CC	2014	Coal, Fe, Mn	Prospecting application	MP 30/5/1/1/2/11597PR	Neederland 202HT
B11	Lanodex Trade and Investments 4 (Pty) Ltd	2014	Mn, Fe	Prospecting application	KZN 10426PR	Farm Dwaalhoek 105HU
B12	Yzermyn - Atha Africa Ventures (Pty) Ltd	2015	Coal	Mining right granted DWS 16/2/7/W51 Wtr License application	Authorisation - 17/2/3/GS - 131	Mpumalanga/KZN Wakkerstroom
B13	Delf Silica (Pty) Ltd	2015	Silica	Prospecting application	KZN 30/5/1/1/2/10541PR	Rondspring 137HU Vryheid
B14	Sabicento (Pty) Ltd	2016	Coal	Prospecting application	KZN 35/5/1/1/2/10602PR	Farm Pivaanspoort 80 HT
B15	Rhino Oil and Gas Exploration South Africa (Pty) Ltd	2016	Oil and gas	Prospecting application rejected by the High Court	KZN 108 TCP	2 million ha - north, central and east KZN
B16	Shongozhela Mining Eploration (Pty) Ltd	2016	Coal	Prospecting application	KZN 38/5/1/1/2/10618PR	Holkrans 210HT, Bloemendal 538HT
B17	Frisbee Track & Investment 1171 cc	2016	Coal	Reneval/ proposed development	KZN 30/5/1/1/2/10074MR	Kaffersdrift 17072, eDumbe 436, Kempslust 81.
B18	Hoshoza Resources / Kariboo Colliery	Sep '16	Coal	Plant set-up and started to mine- MR 18 Jan '12 and WUL 11 Jun '15	KZN 30/5/1/2/2/233MR WUL 06/V32G/ABCGIJ/2865	Port 0 rem Farm Vryheid 159HT, Port 4 rem Vryheid 159 HT, Port 1 Zoetmelksrivier 86 HT
B19	Bombo Group (Pty) Ltd	2016	Rhyolite	Mining permit application	KZN 30/5/1/3/2/10481MP	Portion 1 of the Farm west no 16637, Jozini.

APPENDIX C

A matrix indicating the depth prominence and an impression of personal commitment and drive to participate of 81 role players engaged with in the Pongola River Catchment.

Note: 1. The score indicators were conceived by the PROBA committe based on the empirical experience of the role player during engagement sessions and executed by Impala WUA.

Scores on each of the criteria indicators except the last column of participation:

0	Insignificant
1	Low
2	Medium
3	High

2 The scores for the last column (shaded far right), are different and indictes specifically to indicators of participation, shown below.

Scores for participation:	
0	The individual paying lip service or is incapable to participate
1	The individual appears to be a talker or is restricted to participate
2	The individual provides constructive background support
3	The individual provides constructive direct support and participation.

	ROLE PLAYER	AREA	CONTACT PERSON ENGAGED WITH	DESIGNATION	Depth prominence of organisation or individual			Project team manner of liaison	Profile of commitment and drive of the role player		
					Importance	Impact	Penetration		Comprehension	Support	Participation
C1	Zululand District Municipality	Central	OV Mbuyisa	Speaker	3	3	3+	Y - personal	3	3	2
C2			J de Klerk	Mun Man	3	2	2	Correspondence	-	0	0
C3			D Marshall	Technician	2	1	1	Y - personal	3	3	2
C4			S Landman	Ops Manager	2	1	1	Y - personal	3	3	1
C5			P Mnguni	Water Utilisat	3	1	2	Y - personal	3	3	0
C6	Nkanyagude District Municip	East	-	Speaker	3	3	3+	Correspondence	-	-	-
C7			-	Mun Man	3	2	2	Correspondence	-	-	-
C8			-	Tech Man	2	1	1	Correspondence	-	-	-
C9	Town and Regional Planners	West/Central	E Cronje	Region Planner	2	2	2	Y - personal	3	3	1
C10		Central/East	J Taljaardt	Region Planner	3	3	2	Y - personal	3	3	2
C11		East	K Maree	Region Planner	2	2	2	Y - personal	3	3	2
	Local municipalities										
C12	Paulpietersburg	West	MM		3	3	2	N	-	-	-
C13	Pongola	Central	MP Khumalo	Social	3	3	2	Y - personal	3	3	1
C14		Central	K Villet	Technical	3	3	3	Y - personal	3	3	1
C15		Central	B Dlamini	Develop off	3	3	3	Y - personal	3	3	2
C16	Jozini	Central	Herbert	Speaker	3	3	2	Y-personal	3	3	1
	Farmers Associations										
C17	1 PROBA Civil Soc	West/Central	JHBoonzaaier	Chairman	3	3	3	Y - personal	3	3	3
C18	2 eDumbe Agri Centre	West	R Niebuhr	Chairman	3	3	3	Y - personal	3	3	3
C19	3 Bivane river cattle	West	E Benecke	Chairman	3	3	3	Y-personal	3	3	1
C20	4 Impala Water User Ass	Central	A Barnard	Chairman	3	3	3	Y - personal	3	3	2
C21	5 Pong Sugar Cane Growers	Central	K Stock	Chairman	3	3	3	Y - personal	3	3	2
C22	6 Phumelela Farmers Ass	Central	R Dlamini	Chairman	3	3	3	Y - personal	3	3	1
C23	7 Makatini Farmers Ass	East	The association as a role player		3	3	3	N	-	-	-

	ROLE PLAYER	AREA	CONTACT PERSON ENGAGED WITH	DESIGNATION	Depth prominence of organisation or individual			Project team manner of liaison	Profile of commitment and drive of the role player		
					Importance	Impact	Penetration		Comprehension	Support	Participation
	Farmer study groups										
C24	1 Luneburg	West	J. Hiesterman	Representative	3	3	2	Y - personal	3	3	1
C25	2 Commondale	West	H Hinze	Chairman	3	3	2	Y - personal	3	3	2
C26	3 Nkambule Piggeries	West	B Hambrock	Chairman	3	3	3	Y - personal	3	3	3
C27	4 Bivane Cattle	West	A Bohmer	Chairman	3	3	2	Y-personal	3	2	1
C28	5 Bivane Forestry	West	R Beneke	Chairman	3	3	2	Y-personal	3	2	1
C29	6 L Brecher - Sugar	Central	L Brecher	Chairman	3	3	2	Y - personal	3	3	1
C30	7 M Jacobsz - Sugar	Central	M Jacobsz	Chairman	3	3	2	Y - personal	3	3	1
C31	8 Young Irrigators	Central	K. Horn	Charman	3	3	2	Y - personal	3	3	2
C32	9 Phumelela Farmers Ass	Central	R Dlomo	Chairman	3	3	2	Y - personal	3	3	1
C33	10 RCL Mill Farmer Extension	Central	M Bekhi	Ext officer	3	3	3	Y - personal	3	3	2
	Government Departments										
C34	**1** Education	West/Central	W du Plooy	Director	3	3	3	Y - personal	3	3	0
C35	**2** Veterinary Onderstepoort	West/Central	Dr	Trainer	3	3	3	Y - personal	3	2	0
C36	3 Department of Agriculture	West	S v Greunen	Engineer	3	3	3	Y-personal	3	2	1
C37	4 Dep Mineral Resources	KZN	REMDC	Chairman	3	3	3	Y-personal	2	1	1
C38	4	Mpumalanga	REMDC	Chairman	3	3	3	Y-personal	1	1	1
C39	5 Department of Agriculture	Central/East	J vd Merwe	Tech Engineer	3	3	3	Y - personal	3	3	2
C40	6	East	P Mthembu	Ass Manager	3	3	3	Y - personal	3	2	1
C41	7	Region Pmb		WfW	3	3	1	Y-personal	3	1	0
C42	8 Dep Environmental Affairs	West	Delani	Reg Manager	3	3	3	Y-personal	3	3	3
C43	9	Central	Lungisani	Official	3	3	3	Y-personal	3	3	3
C44	10 Proto CMA	KZN	J Reddy	Act CEO	3	3	3	Y-personal	3	2	1
C45	11 Dep Water and Sanitation	West	B Mkhungu	CMF Chairm	3	3	3	Y-personal	3	3	1
C46	12	Central	Me B. Culles	CMF Chairm	3	3	3	Y - personal	3	3	1
C47	13	Central	N Ward	Chief Engin	3	3	3	Y - personal	3	2	1
C49	14	West/Central	Z Makwabhesa	W/Quality	3	3	3	Y-personal	3	3	2
	Individuals/Companies/Community representative										
C50	1 Paul Scherzer	General	P. Scherzer	Enviro consult	3	1	1	Y - Personal	3	1	1
C51	2 Petro van Jaarsveld	Specialist	P, Vos	River Health	3	3	3	Y - personal	3	3	3
C52	3 Ralph Klingenburg	Catchment	R. Klingenburg	Irrigation Cons	3	2	1	Y - Personal	3	3	2
C53	4 Rayno Holl	Central	R. Holl	Irrigation Cons	3	2	1	Y - Personal	3	3	2
C54	5 Kurt Stock	Central	K. Stock	Irrigation Cons	3	3	2	Y - Personal	3	3	3
C55	6 Pongola school	Central	S. Swanepoel	School master	3	3	2	Y - Personal	3	2	1
C56	7 Sakhumuzi school	Central	H. Klopper	School master	3	3	2	Y - Personal	3	2	2

	ROLE PLAYER		AREA	CONTACT PERSON ENGAGED WITH	DESIGNATION	Depth prominence of organisation or individual			Project team manner of liaison	Profile of commitment and drive of the role player		
						Importance	Impact	Penetration		Comprehension	Support	Participation
C57	8	Golela school	Central	A. McIntyre	School master	3	3	2	Y - Personal	3	2	2
C58	9	Ian Goss	General	I. Goss	Protoc spec	3	2	1	Y - personal	3	2	1
C59	10	WWF - Sam Mnguni	General	S. Mnguni	Protect area	2	1	1	Y - personal	3	1	1
C60	11	WWF - Ayanda Nzimande	General	A Nzmande	Cogta relations	3	3	3	Y - tel & mail	3	1	1
C61	12	Weed specialist/writer	General	C Bromilow	Weed special	3	3	3	Y - personal	3	1	0
C62	13	Concerned civilian	West	G Foster	Civilian	2	3	3	Y - personal	3	3	3
C63	14	Paulpietburg Afri Forum	West	E v Aswegen	Chairman	3	3	3	Y - personal	3	2	2
C64	15	African Conservation Trust	General	S Madonsela	Official	3	2	2	Y - personal	3	3	2
C65	16	Mondi Forestry	West	S vd Merwe	Enviro Man	3	3	3	Y - personal	3	2	1
C66	17	NCT - Wattle forestry	West	B Smith	Official	3	3	3	Y - personal	3	3	2
C67	18	RCL Sugar Mill Pongola	Central	K Endres	GM	3	3	3	Y-personal	3	3	3
C68	19	Kempslust abandoned mine	West	J Kemp	Landowner	3	3	3	Y-personal	3	3	2
C69	20	Makateeskop mine	West	R. Bohmer	Landowner	3	1	1	Y-personal	3	3	1
C70	21	Longridge/Kempslust mines	West	H. Joubert	Landowner	3	2	1	Y-personal	3	3	1
C71	22	Coal Removal contractor	West	O. Leen	Contractor	3	3	3	Y-personal	3	3	1
C72	23	Tholie Logistics Coal Applic	West	A. Pheiffer	EAP	3	3	3	Y-personal	3	3	3
C73	24	Advocate - Commercial	West	J.P. Snijders	Landowner	3	3	3	Y-personal	3	3	3
C74	25	Farmer	VALPRE	J. van Vuuren	GM/Director	3	3	3	Y-personal	3	3	1
C75	26	Farmer	West/Central	D. Hein	Owner	3	3	3	Y-personal	3	3	1
C76	27	Farmer	West	W. Tromp	Farmer	3	1	1	Y - personal	3	3	2
C77	28	Farmer	West	A Klingenberg	Farmer	2	1	1	Y - personal	3	3	1
C78	29	Pongola riparian farmers	Central	F Brecher	Farmer	3	3	1	Y-personal	3	2	1
C79	30	Pongola Pvt Game Reserve	East	K Landman	Owner	3	3	2	Y-personal	3	1	1
C80	31	GroundTruth	KZN	Me K. Mahood	Official	3	3	3	Y-personal	3	3	3
C81	32	GroundTruth	KZN	Me L. Taylor	Official	3	3	3	Y-personal	3	3	2

Notes: **West** refers to the western regions of the catchment in areas such as Luneburg, Bivane river, Paulpietersburg and Commondale.
Central refers to the central areas of the catchment in areas such as Simendlangentsha and Pongola.
East refers to the eastern region of the catchment beyond the Pongolapoort dam, the Makatini flats up to the Mozambique border.

LIST OF RECORDED ENGAGEMENT MEETINGS AND DISCUSSIONS WITH VARIOUS ROLE PLAYERS PER CLUSTERS

APPENDIX D

Society	**63 engagements**	**Science**	**41 engagements**	**Mining/Industry**	**91 engagements**	**Government cluster**	**27 engagements**
Communities	Sc	NGO's	Kn	Mining	Im	Government Departments	Gd
Individuals	Si	Specialists	Ks	Industry	Ii	Regional Municipality	Gr
Farmer Associations	Sf	SAAFWUA	SAAFWUA	Waste recyclers	Iw	Local municipality	Gl
Farmer Study groups	Ss						
Education	Se						
Internal		SAAFWUA engagements	**14**			**Total engagements**	**221**

	Date	**ORGANISATION/PERSON**	**DESIGNATION/ REPRESENTING**	**Category**	**Purpose of meeting**	**RESOLUTION / OUTCOME**
D1	28-Aug-14	Johann van der Merwe (D Agric)	Regional manager, Engineer, North Zululand	Gd	Makatini flats	Background information re. water use, development and practices in the Pongola catchment.
D2	1-Sep-14	P. Mtembu (Ass manager)	Dep Agric Makatini Flats	Gd	Makatini flats	Background information re. water use, development and practices in the Pongola catchment. Solicit support.
D3	4-Sep-14	J. Reddy (Acting CEO proto CMA)	Acting CEO proto CMA	Gd	CMA vs WRM	Background progress and concerns re. CMA and WRM activities.
D4	23-Sep-14	W. du Plooy, HOD Education.	HOD Education Zululand	Gd	Education	Role, curriculum and support of Zululand education for water security activities and focus.
D5	2-Dec-14	Officials of DWS and DTEA	DWS and DTEA.	Gd	Bottle Pollution Pongola Channels and Rivers	
D6	2-Dec-14	Officials of DWS and DTEA	DWS and DTEA.	Gd	Bottle pollution	Bottle pollution in the Pongola area. Plan to address.
D7	2-Dec-14	Officials of DTEA	DTEA	Gd	Enviro Legislation	Links and prax of NEMA and land use
D8	14-Jan-15	Officials on DTEA	DTEA	Gd	Discussion actions removing of Mental Retarded person	Assessing bottle pollution.
D9	20-Jan-15	Community and DTEA officials.	Impala EDTEA and farming community	Gd	Cleaning up environment	
D10	22-Jan-15	Community and DTEA officials.	Impala EDTEA and farming community	Gd	Bottle cleanup rivers and channels. EDTEA visited Pongola. Satified.	Successful bottle cleanup operation with DTEA
D11	10-Mar-15	P. Ruinard, Ithala Game Reserve.	Ezemvelo Conservation Manager - Ithala Game Reserve	Gd	WRM and water security threats.	Background re. activities, knowledge and incidents that impact water resources. Solicit support, collaboration and contact persons.

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D12	9-Jun-15	Me. Z . Makwabasa	DWS Environmental officers	Gd	Impala office	Water quality monitoring	Coal mining threat and DWS water quality monitoring programme need to support local efforts.
D13	6-Aug-15	J Reddy	Acting CEO proto CMA	Gd	DWS workshop Durban	WRM functions by WUA.	Debate WRM functions, WUL, V&V, water quality and quality monitoring practice and shortage of personnel for proto CMA.
D14	19-Aug-16	M Beukes and EDTEA	Impala Catchment coordinator	Gd	Ncotshane area	Impala and onsite visit Ncotshane	EDTEA. Investigate Continious Sewer problem at house B2360 and Illegal dumping.
D15	9-Sep-16	S van Greunen	Engineering Manager - Zululand, Vryheid	Gd	Agric office Vryheid	Soil erosion	Extent of soil erosion. What are focus and activities of Dep Agric in prevention/rehab. Solicit action and support.
D16	14-Nov-16	J. Reddy (Acting CEO proto CMA)	Acting CEO proto CMA	Gd	DWS office Durban	WRM support, resource degradation.	Inform proto CMA re. concerns of lack of diligent support and action from DWS/CMA Durban in monitoring and addressing water resource degradation and current mining threats. Solicit stronger and visible support.
D17	15-Nov-16	Me. T. Naidoo, S. van Greunen	Manager Landcare of Dep Agric KZN	Gd	Manzaan river area.	Soil erosion	Site visit and discussions re. extent and impacts of soil erosion in catchment and particular Manzaan area as a point to start. Promote and request rehab project.
D18	11-May-17	M Beukes and DWS	Catchment co-ordinator	Gd	Ncotshane area	Arrea visit and site assessments	With DWS. Show DWS sewer manholes and spots causing continius problems
D19	15-Jan-15	M. P. Khumalo (Councillor)	Pongola Municipality Representative	Gl	Impala office	Bottle pollution	Bottle pollution in the Pongola area. Plan to address.
D20	9-May-15	Jozini Tourism officials	Jozini Tourism	Gl	Impala office	Tourism and Waste Management meeting	ID impact that poor waste and lack of clean up services impact tourism.
D21	1-Mar-16	M. P. Khumalo (Pongola Municipality)	Pongola Municipality Representative	Gl	Impala office	EnviroChamp project	Solicit support and collaboration from Pongola Municipality for the envisaged EnviroChamp project.
D22	1-Sep-14	O. V. Mbuyisa.	Speaker ZDM	Gr	Impala office	ZDM support	Background information re. water use, development of ZDM in the Pongola catchment . Solicit support.
D23	3-Sep-14	S. Landman (HOD) , D. Marshall	HOD Planning ZDM	Gr	Impala office	Background info to ZDM and solicit support	Background information re. water use, development and practices/processes of ZDM. Solicit support.

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D24	6-Mar-15	M. Tengbeh	GIS ZDM	Gr	Impala office	GIS services	To obtain stats, maps, info re. population distribution and development re. water distribution of ZDM.
D25	7-Mar-16	M Beukes and officials	NGO, Municipality, ZDM	Gr	Pongola municipality	WRM and EnviroChamp	WRM, water security and EC project objectives.
D26	2-Feb-17	M Beukes and officials	Impala and ZDM	Gr	Ncotshane	Sewer infrastructure problems.	ZDM discussion. Sewer infrastructure problems in Pongola and Ncotshane Township
D27	19-Jul-17	M Beukes and officials	Impala and ZDM	Gr	Ncotshane	Follow up - sewer problems	Discuss infra structure and Maintenance problems at ZDM
D28	2-Feb-15	K. Endres	General Manager RCL Foods sugar mill	Ii	RCL sugar mill	Acquaintance and ID of waste effluent released into Rietspruit.	Discuss WRM and water security project. Solicit support and collaboration re. waste management.
D29	23-Feb-15	K. Endres, E. Wentink	General Manager RCL Foods sugar mill and engineer.	Ii	RCL sugar mill	Factory Effluent and Waste Pollution Rietspruit	Follow up on waste management and new release of effluent. Mill confrim support and rehabilitation.
D30	30-Dec-15	K. Endres	General Manager RCL Foods sugar mill	Ii	RCL sugar mill	Pollution and WWTW effluent release	Mill released effluent in residential area to safeguard natural system. Confirm rehabilitation.
D31	31-Mar-16	K. Endres, E. Wentink	General Manager RCL Foods sugar mill and engineer.	Ii	RCL sugar mill	Waste management concerns at overflowing PCD.	RCL confirmed major personnel changes, reallocation of responsibilities and undertook major rehabilitation of factory water circulation sytems and PCD.
D32	11-May-17	M Beukes and DWS	Impala and DWS	Ii	RCL sugar mill	Progress on PCD rehabilitation	Accompanied DWS by invitation on routine inspection visit
D33	17-Sep-15	PROBA	Committee meeting	Im	eDumbe Paul-pietersburg	PROBA preparation meeting	Preparation on the EIA of Tholie Logistics coal mine application
D34	4-Nov-15	PROBA	Committee meeting	Im	eDumbe Paul-pietersburg	PROBA committee meeting	Follow up and feedback regarding Tholie EIA
D35	13-Nov-15	SLR Consultants	Environmental Assessment Practitioners	Im	Newcastle	IAP consultation	Biodiversity - Water focussed Workshop
D36	6-May-16	SLR Consultants	EAP and Tholie Logistics	Im	Kempslust Abandoned Mine	IAP consultation	Rehabilitation suggestions from EDTEA, Landowner and Contractor.
D37	23-May-16	Impala and owner	Impala and owner	Im	Kempslust Abandoned Mine	Meeting with coal contractor	Confirmation of land owner's needs, objective and rehab plan of coal buyer.
D38	13-Sep-16	RMDEC Durban	DMR panel 1	Im	DMR Durban	IAP debate with RMDEC panel	Opposing mining right application Tholie.

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D39	28-Sep-16	Impala	Impala	Im	Kariboo Colliery	Site Inspection	Investigate illegal mining activities and abandoned mines in Zoetmelk river area.
D40	28-Sep-16	Impala	Impala	Im	Nkambula hall	IAP meeting with Hoshoza	Hoshoza Scoping meeting held at Kambula Farmers Hall regarding Kariboo Colliery
D41	12-Oct-16	C. Labuschagne, JP Snijders, K. Davel and P. Markram	Attorneys and farmers	Im	Office attorney Markram	Hoshoza mining activities	Review the meeting with Hoshoza and farmers and consider options to address alleged illegal open cast coal mining activities.
D42	13-Jul-17	RMDEC Durban	DMR panel 2	Im	DMR Durban	IAP debate with RMDEC panel	Opposing coal mining right application Tholie Logistics.
D43	16-Jan-15	J. Pienaar	Private Business owner recycling	Iw	Impala office	Recycling	Current recycling processes and extent. Solicit support and collaboration.
D44	17-Mar-15	G. Eichler	Recycling Business, Empangeni	Iw	Business Empangeni	Recycling	Recycling options and processes. Solicit support and collaboration.
D45	11-Jul-16	M Beukes	Impala	Iw	Ncotshane	Recycling	Investigate possible cooperation between Khabokedi Waste Management and EnviroChamps
D46	12-Sep-16	M Beukes	Impala	Iw	Ncotshane	Recycling	Follow up cooperation between Kwabokedi Waste Management and EnvironChamps
D47	31-Mar-17	C. Hill	Private Environmental Consultant	Iw	Impala office	Waste effluent and organic digestion	Background on waste effluent and extent of pollution. Options to enhance organic digestion through use of ameliorants.
D48	7-Aug-14	A. Burns	WWF Enkangala Manager	Kn	Newcastle	WWF project - Planning	Planning and co-ordination re. envisaged project activities and roll out.
D49	28-Aug-14	A. Burns	WWF Enkangala Manager	Kn	Newcastle	WWF project - Roll out	Roll out re. envisaged project activities.
D50	12-Nov-14	P. Cryer, S. Madonsela	African Conservation Trust	Kn	Impala office	Ecosystem services	Backgrounf of African Conservation Trust (ACT) re. WRM, ecosystem services and solicit support.
D51	25-Mar-15	Impala, WWF, EDTEA and DWS	Officials	Kn	Impala office	Feedback and information meeting	WWF - Impala Stakeholder feedback and information meeting with, EDTEA and DWS
D52	10-May-15	Dr. M. Graham	Director - DUCT	Kn	Telephonic	SASS 5 training	Background re. and suitability of SASS5 as a civil monitoring activity.
D53	25-Jan-16	WWF officers	WWF officers	Kn	Wakkerstroom	Catchment co-ordination	Common ground between porjects, mutrual challenges and support.
D54	25-Jan-16	Me. V. Stone	WWF field officer, Paulpietersburg	Kn	Paulpieters-burg	WRM support roll out	Discuss experience of WRM actions with public, options in approach and roll out. Network expansion.

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D55	14-Apr-16	Me. G. Forster, Me. V. Stone, D. Cronje	D Agric, WWF and Bivane Dam	Kn	Manzaan river area	Extent of erosion	Area reconnaissance and nature and extent of soil erosion in the Mahlone and Manzaan areas.
D56	25-Apr-16	Me. K. Mahood, A. Lephyani and T. Luvano	DUCT & GroundTRuth	Kn	Pongola area	EC project	Discuss functions of the EnviroChamp project, community visits, training and community education.
D57	31-May-16	Impala, Ayanda and Thandanani	DUCT & GroundTRuth	Kn	Local communities	Training and education	EnvironChamp training With Ayanda Lipheyana and Thandanani Luvuno from Groundtruth
D58	1-Jun-16	Impala, Ayanda and Thandanani	DUCT & GroundTRuth	Kn	Local communities	Training and education	EnvironChamp training With Ayanda Lipheyana and Thandanani Luvuno from Groundtruth
D59	21-Sep-16	WWF	National Freshwater Division	Kn	Johannesburg	CMA Waterstewardship workshop	CMA water stewardship and water resource protection workshop
D60	25-Oct-16	Mpumalanga Wetland Forum	Organising Committee	Kn	Swadini Hoedspruit	Wetland seminar	Wetland Seminar at Swadini 25/10/2016 - 28/10/2016
D61	12-Dec-16	Impala Telecon Christene Dean Vaughn	WWF officials	Kn	Impala office	Feedback meeting.	Feedback report on status,focal points envisage achievements and challenges
D62	28-Jun-17	Kirsten Mahood	GroundTruth	Kn	Impala office	Funding meeting	Groundtruth discuss future funding options for EnvironChamps
D63	22-Aug-14	Kobus Maree (City Planner)	Jozini Municipality - City Planner	Ks	Impala office	Jozini Municipality	Information re. Municipality planning, contact persons that have impact on water. Support and collaboration.
D64	27-Aug-14	E. Cronje (City Planner), B Dlamini	City Planner ZDM	Ks	Impala office	ZDM city planning and background meeting	Background information re. water use, township development and processes of ZDM in the Pongola catchment .
D65	5-Sep-14	Kobus Maree (City Planner)	Jozini Municipality - City Planner	Ks	Impala office	Jozini Municipality	Follow: Municipality planning, contact persons that have impact on water. Support and collaboration.
D66	24-Feb-15	Paul Fairall	Consultant	Ks	Home Kemptonpark	Wetland Rehabilitation Specialist	Investigated artifical wetlands for pollution rehabilitation.
D67	3-Mar-15	Me. J. Taljaardt	City planner consultant	Ks	Impala office	Acquintance	Information re. Municipality planning, contact persons that have impact on water. Support and collaboration. Role and functions of COGTA and MISA.
D68	7-Apr-15	R. Holl	Irrigation consultant	Ks	Impala office	Water use and irrigation scheduling	Water use, sound irrigation practices. Solicit support and collaboration.

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D69	3-Aug-15	P. Vos-van Jaarsveld	Water Health consultant	Ks	Impala office	River health assessment	Plan a river health assessment base line and abandoned mine impacts.
D70	12-Aug-15	Mark Meyer	Geohydrologist	Ks	Paulpieters-burg	Geo hidrologiese projekte Proba Evaluering (Engeolab)	Solicit support and insight for assessment of coal mining applications.
D71	9-Sep-15	P. Vos-van Jaarsveld	Water Health consultant	Ks	Impala office	River health assessment	Plan a river health assessment base line and abandoned mine impacts.
D72	10-Sep-15	P. van Jaarsveld	Water Health consultant	Ks	Impala office	Review of SLR EIA	Review of the reports and studies contained in the EIA and EMP of Tholie Logistics mine application.
D73	15-Jul-16	Me. J. Taljaardt	City Planner	Ks	Impala office	Service delivery	Discussions and addressing of problems with service and water delivery in ZDM region and Pongola Municipality.
D74	29-Aug-16	Me. J. Taljaardt and M. Schoeman	City Planner and GIS	Ks	Impala office	RMDEC planning	Request catchment data and maps for presentation at RMDEC Durban re. Tholie Logistics
D75	19-Nov-16	Liaison with 8 scientist experts	Various studies	Ks	Pretoria Johan Maree office	Review of SLR EIA and EMP for RMDEC 1	Review of the reports and studies contained in the EIA and EMP of Tholie Logistics mine application.
D76	22-May-17	Liaison with 4 scientist experts	Various studies	Ks	Internet and e-mail	Review of SLR EIA and EMP for RMDEC 2	Review of the reports and studies contained in the EIA and EMP of Tholie Logistics mine application.
D77	30-May-16	Impala	Catchment co-ordinator	P	Impala office	EnvironChamp training	Training and techniques for EnviroChamps
D78	26-Aug-16	Impala and Kirsten Mahood	GroundTruth	P	Impala office	Planning education and NQF training	With EC Supervisor. Possible involvement with schools and NQF2 training
D79	22-Nov-16	M Beukes	Catchment co-ordinator	P	Community wards	Feedback reporting	Status report and feedback to role players regarding EnvironChamp project
D80	18-Jan-17	PROBA	Committee	P	eDumbe Paul-pietersburg	Proba committee meeting	Feedback and review meeting re mining activities
D81	10-Nov-16	M Beukes	Catchment co-ordinator	Pt	Impala office	EnviroChamp training	Impala training and completing NQF2 workbook
D82	19-Jan-17	M Beukes	Catchment co-ordinator	Pt	Impala office	EnviroChamp training	EnvironChamps training. Completing NQF2 Training Workbooks
D83	24-Jan-17	M Beukes	Catchment co-ordinator	Pt	Impala office	EnviroChamp training	EnvironChamps training. Completing NQF2 Training Workbooks

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D84	26-Jan-17	M Beukes	Catchment co-ordinator	Pt	Impala office	EnviroChamp training	EnvironChamps training. Completing NQF2 Training Workbooks
D85	30-Jan-17	M Beukes	Catchment co-ordinator	Pt	Impala office	EnviroChamp training	EnvironChamps training. Completing NQF2 Training Workbooks
D86	31-Jan-17	M Beukes	Catchment co-ordinator	Pt	Impala office	EnviroChamp training	EnvironChamps training. Landfill site visit
D87	1-Feb-17	M Beukes	Catchment co-ordinator	Pt	Impala office	EnviroChamp training	EnvironChamps training. Completing NQF2 Training Workbooks
D88	3-Feb-17	M Beukes	Catchment co-ordinator	Pt	Community wards	EnvironChamps training.	EnvironChamps training.
D89	14-Mar-17	M Beukes	Catchment co-ordinator	Pt	Community wards	EnvironChamps training	EnvironChamps training
D90	22-Jun-17	Impala/EnvironChamps/WESSA	Officials	Pt	Howick	EnviroChamp training	Role of the Key performance Areas (KPA) Toolkit for WESSA
D91	28-Jun-17	Impala and WESSA	Officials	Pt	Community wards	EnviroChamp training	Door - 2 - Door roleplay training
D92	5-Sep-13	SAAFWUA MC, Elsenburg	Management Committee meeting	SAAFWUA	Elsenburg	Capacity building re. WRM, NWA. National water policy review.	Roll out of training prgrammes for WUA's and MANCOs. Assess policy review.
D93	21-May-14	SAAFWUA MC, Belville	Management Committee meeting	SAAFWUA	Bellville	Policy review.	Attempts to engage with DWS. Assess and promote transformation, alternative structures and support existing WUAs.
D94	31-Jul-15	Acting CEO Forum, Nelspruit.	proto CMA forum	SAAFWUA	Nelspruit	Presentation of SAAFWUA on proto CMA forum.	Background provided on WUAs, WRM. ID challenges for CMAs and key drivers for restructering.
D95	18-Aug-15	SAAFWUA MC, City Lodge OR Tambo.	Management Committee meeting	SAAFWUA	OR Tambo	MC agenda	SAAFWUA strenious negotiations with DDG A. Singh re. WUA's, billing agent and DWS accounts. Envisage due diligence investigation. Confirm importance of WUA role and functions. Boonzaaier presentation and focused group discussions.
D96	27-Nov-15	SAAFWUA MC, Belville.	Management Committee meeting	SAAFWUA	Bellville	Policy review. IB and WUA restructering. Collaboration with CMAs.	Further considerations re. policy review. Promote suitable restructering to enhance WRM and role of DWS/CMA.
D97	22-Sep-16	SAAFWUA MC, Southern Sun OR Tambo.	Management Committee meeting	SAAFWUA	OR Tambo	Capacity building for CEOs. SAAFWUA and WUA "roadmap" for DWS.	Negotiate implementation of "roadmap" with DWS. DWS delaying liaison with SAAFWUA and CMAs. Boonzaaier comments and focused group discussions.

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D98	5-Oct-16	Strategic Task team, Worcester.	Task team	SAAFWUA	Preparation for presentation of support for revised strategy to AGM.	
D99	6-Oct-16	SAAFWUA AGM, Worcester.	Management Committee meeting	SAAFWUA	Future of CMAs and WUAs. Issues of neglect and negotiation with DWS.	Future of CMA's, WUAs and WRM. DWS neglect of WRM and WUAs. JHB presentation in motivation for strategic change.
D100	5-Dec-16	SAAFWUA MC, Southern Sun OR Tambo.	Management Committee meeting	SAAFWUA	Formalise strategic task team.	Strategic task team set out to execute SWOT and revise strategy.
D101	28-Mar-17	SAAFWUA MC, City Lodge OR Tambo.	Management Committee meeting	SAAFWUA	Management Committee	Developments in DWS and CMA.
D102	4-Oct-17	SAAFWUA MC, Cape Town.	Management Committee meeting	SAAFWUA	Management Committee	JHB presentation and focused group discussion re. WUA role, MSP collaboration and WRM and governance.
D103	21-Jul-15	Strat Task Team, Kimberley	Task team	SAAFWUA	Strategic planning on WUAs and SAAFWUA. Consider future roles.	Lying process and principle foundations.
D104	27-Mar-17	Bloem Strategic Task team	Task team	SAAFWUA	SWOT analysis.	SWOT analysis and consideration of factors ID.
D105	19-Apr-17	Strategic Task team, Boksburg.	Task team	SAAFWUA	Task team proceed.	Processing and assessing data.
D106	7-Aug-14	Upper Pongola Stewardship Initiative	Role players	Sc	Protected area initiative	Progress report - Protected areas
D107	28-Aug-14	E van Aswegen	Chairman AfriForum Paulpietersburg	Sc	AfriForum	Background re. activities, knowledge and incidents that impact water resources and collaboration.
D108	25-Nov-14	Nkosi Ndlamenze		Sc	WRM	WRM, water security, mining threats.
D109	18-Feb-15	CMF Paulpietersburg		Sc	CMF	CMF agenda - WRM and mining threat.
D110	23-Mar-15	Nkosi Ndlamenze	Nkosi for Ndlamneze community	Sc	WRM	Info re. rainfall, drought, mining threats.
D111	26-Mar-15	J. Kleinhans	Head Environmental Affairs AfriForum	Sc	Coal mining threat	Background re. coal mining threat and water impacts. Solicit support and collaboration.
D112	20-May-15	Me. G. Forster and S. Nguni	D Agric cattle disease programme	Sc	Cattle practices	Background re. cattle farming practices, land practices and WRM. Solicit support and collaboration.
D113	18-Sep-15	DA representatives	DA representatives	Sc	Water supply	Water supply problems and land degradation in the Maviti community. Poor support and services from Pongola Municipality and ZDM.

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D114	18-Apr-16	Impala	Impala	Sc	Impala office	EnviroChamp programme	Implimenting EnvironChamp program in Pongola meeting with role players
D115	11-May-16	CMF Pongola	CMF role players	Sc	Impala office	CMF	CMF matters and resource threats
D116	20-May-16	Impala	Impala	Sc	Ncotshane Wards	Launch meeting of EnvironChamps	Launch meeting with EnvironChamps and introduction of Project GT708
D117	4-Feb-17	Impala	Impala	Sc	Holkrans	Public consultation	Meet with community to discuss proposed mine on the farm Holkrans
D118	10-Oct-17	Community radio	Presenter	Sc	Community radio	Community radio talk show	Pongola FM 107.9 Invited EnvironChamps to participate in an environmental talk show
D119	5-Sep-14	S. Swanepoel	School Head master	Se	Pongola School	Education	Backrgound re. school support, curriculum contribution for water resource protection.
D120	31-May-16	Impala	School	Se	Dwaleni High School	Education	Visit Dwaleni High School in Ncotshane with Ayanda Liphenyana and Thandanani Luvuno
D121	1-Jun-16	Impala	School	Se	uPhongola High School	Education	Visit uPhongola High School in Ncotshane with Ayanda Liphenyana and Thandanani Luvuno
D122	18-Sep-16	Impala	School	Se	Masiphula High School	Campaign	Clean up campaign and Environ Education to pupils
D123	5-Jan-17	Impala	Impala	Se	Bivane Dam and Impala	Information exchange	Information exchange with Virginia Commonwealth University, USA tour
D124	17-Jul-17	Impala	Community	Se	Arise and Shine Church	Information exchange	Evaluative reflection on Ncotshane Cleanup initiative
D125	20-Aug-14	Impala	Paulpietersburg farmers.	Sf	eDumbe Agri Centre	Information exchange	Background re.mining activities, knowledge and incidents that impact water resources and collaboration.
D126	26-Aug-14	Chairman, Pongola Sugar Cane Growers Association	Sugar cane farmers.	Sf	Impala office	Information exchange	Sugar Cane Growers Association support for WRM project and presentation on their Exco meeting.
D127	27-Aug-14	A. Klingenberg	Farmer	Sf	On farm	Farmer	NWA, Lawful water use, mining
D128	14-Nov-14	Can v Zyl	Farmer/developer	Sf	On farm	Development meeting.	Development and environmental considerations
D129	12-Jan-15	K. Landman, M. Thomson	Pongola Private Game Reserve	Sf	On farm	Game ranches	Background re. activities, knowledge and incidents that impact water resources. Solicit support and collaboration.

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D130	12-Feb-15	A. Barnard, K. Stock	Chairmen Impala WUA and Cane Growers	Sf	Impala office	CMA process.	Background to CXMA, establishment and advisory board nominations.
D131	18-Feb-15	R. Bohmer	Farmer	Sf	On farm	Acquaintance and assessment	Background re. Makateeskop abandoned mine and water impacts.
D132	18-Feb-15	B. Hambrock	Farm Manager	Sf	On farm	Acquaintance and assessment	Background re. piggary practices and evidence of water pollution. Solicit support and collaboration.
D133	3-Mar-15	Farmers and DWS	Riparian farmers.	Sf	On farm	Exploring nature of support from Work for Water	Background re. alien invasives, practices and eradication. Solicit support and collaboration.
D134	4-Mar-15	North Natal Pig Study group	Nkambula pig farmers study group	Sf	Nkambule hall	Waste practices and impact	Solicit buy in and support. Piggery waste impact and management review.
D135	12-Mar-15	Farmers Association	Paulpietersburg farmers.	Sf	eDumbe Agri Center	Strategy meeting	Discuss strategy for SLR scoping meeting 26/03/2015
D136	20-May-15	D. Filter	ESCO Feeds Manager	Sf	On farm	Piggery pollution and impacts	Discuss and reveal piggery pollution to the Penvaan river. Solicit background info and practices.
D137	11-Jun-15	Farmers Association	Paulpietersburg farmers.	Sf	eDumbe Agri Center	Assessment planning meeting	Identification of abandoned Mines Paulpietersburg area.
D138	11-Aug-15	D. Rasiti with DWS WQ	Director - ESCO Feeds	Sf	On farm	River pollution impact	Follow up on piggery pollution to the Penvaan river. Need action and rehab.
D139	12-Aug-15	Farmers Association	Paulpietersburg farmers.	Sf	eDumbe Agri Center	AGM	Address the AGM and update on matters.
D140	25-Aug-15	Impala	Farmers	Sf	On farms	Pollution impacts	Dying fish in Kuniningi canal Tk10
D141	3-Nov-15	D. Heinz, F. van Niekerk	Farm owners	Sf	On farm	Mining threat in area	Background re. abandoned mines and impacts in area.
D142	8-Jan-16	Farmers Association	Paulpietersburg farmers.	Sf	eDumbe Agri Center	Interviews	Interviews regarding mining/resource threats with Keith Schneider - Circle of Blue, USA.
D143	5-Feb-16	Farmers Association	Paulpietersburg farmers.	Sf	eDumbe Agri Center	Clarifying of uncertainties	Funding, membership, representation and purpose.
D144	24-Feb-16	K. Stock	Chairman, Pongola Sugar Cane Growers Association	Sf	Cane Growers	Mining threats in Pongola	Background re. Rhino Oil and Gas application for prospecting
D145	10-Mar-16	Farmers Association	Paulpietersburg farmers.	Sf	eDumbe Agri Center	Feedback meeting	Feedback on porgress of mining application - Tholie Logistics and EIA comments.

	Date	ORGANISATION/PERSON	DESIGNATION/ REPRESENTING	Category	Venue	Purpose of meeting	RESOLUTION / OUTCOME
D146	17-Mar-16	PROBA	IAP and public	Sf	Paulpiet library	Public consultation	Public Consultation meeting - Presentation Sabicento (Pty) Ltd
D147	4-Apr-16	Farmers Association	Commendale Farmers	Sf	Commondale	Feedback meeting	Report back Proba activities and role player participation in dealing with coal mining
D148	3-Jun-16	Impala	Farmer representatives	Sf	Impala office	Drought think tank	Review of drought forecasts and water management measures
D149	14-Jun-16	J. van Vuuren	Farm owner	Sf	On farm	Shongozela mining application	Information and consultation of the coal mining prospecting application of Shongozela.
D150	31-Aug-16	Farmers Association	Paulpietersburg farmers.	Sf	eDumbe Agri Centre	AGM Feedback mining applications	AGM Feedback mining applications in the catchment
D151	17-Sep-16	Impala	Pongola farmers	Sf	Cobus Horn	Focused group discussion	Focused group discussion with irrigation farmers. Reflection and forecasting
D152	20-Sep-16	MooiRivier Hlatikulu IB	V Koopman, Farmers	Sf	Mooi river	Information exchange	Mondi wetland program, WRM and WUA matters
D153	20-Sep-16	Farmers Hall Mooi River	V Koopman, Farmers	Sf	Mooi river	Information exchange	Mondi wetland program, WRM and WUA matters
D154	19-Oct-16	Impala	Nkambula pig farmers study group	Sf	Nkambula hall	Feedback meeting	Feedback on the Hoshoza Kariboo Colliery mining progress and solicit support
D155	8-Jun-17	Impala and role players	Role players and WWF	Sf	Country Lodge	Project GT 2140 Closure workshop	Project GT 2140 feedback workshop, closure address and future prospects.
D156	9-Dec-14	Materka Geraldine Foster	D Agric cattle disease control extension officer	Si	West area tour	Site tour and assessments	Site tour. Mining and Black Wattle investation in the Bivane River
D157	11-Jan-16	Impala with Keith Schneider	Journalist - Circle of Blue USA	Si	Impala office	Interviews	Background re. how SA manages its water resources, economic and ecological challenges in water scarcity and coal mining threats.
D158	11-Jan-16	Keith Schneider with farmers	Editor - Circle of Blue USA	Si	Impala office	Interviews	ZDM discussion. Water Provision and challenges and water threats
D159	4-Apr-16	Geraldine Foster	D Agric cattle disease control extension officer	Si	Paulpiet office DoAgric	Farming and land use practice	Discussion with Geraldine regarding Cattle Farming, grazing versus erosion.
D160	5-Apr-16	Me. G. Forster	D Agric cattle disease control extension officer	Si	Area visit central	Land use prax and erosion	Extent of communal cattle farming, land use and grazing practices and knowledge about the area.
D161	14-Jan-16	Pongola Farmers	Riparian farmers.	Si	Impala office	Drought and sharing low flow in the river	Little trust between riparian farmers, Agreed to a trial to share water.

	Date	ORGANISATION/PERSON	DESIGNATION/ REPRESENTING	Category	Venue	Purpose of meeting	RESOLUTION / OUTCOME
D162	16-Feb-16	Farmers	Riparian farmers.	Si	Impala office	Follow up on drought meeting	No special management changes. Continue status quo.
D163	30-May-16	uPhongola Municipal Full Council	Council members	Sl	Municipality office	Introduction and progress	Introducing Project GT708 and the EnvironChamps to the Council.
D164	26-Aug-14	K, Stock, K, Horn, L, Brecher	Irrigation study group	Ss	Cobus Horn	Intro to water use and management	Sound irrigation prax, water pollution and WC/WDM and WAR program.
D165	9-Sep-14	Wonderfontein Studiegroep	Riparian wonderfontein studiegroep.	Ss	Machiel Jacobsz	Project introduction, Best irrigation practices	Sound irrigation prax, water pollution and WC/WDM WAR program and alien invasives
D166	8-Apr-15	Farmer study group.	Irrigation study group	Ss	Machiel Radley	Water use and irrigation scheduling.	Efficient water use, WRM, development of infra structure adaptions and upgrades.
D167	20-May-15	E. Beneke	Chairman Cattle study group Paulpietersburg	Ss	eDumbe Agri Centre	Cattle practices	Background re. cattle farming practices, land practices and WRM. Solicit support and collaboration.
D168	11-Aug-15	Pig farmers study group	Nkambula pig farmers study group	Ss	Nkambule hall	WRM and pollution rehab	Background re. regulations ito NWA and NEMA. Discuss progress to upgrade and rehab water pollution because of practices.
D169	23-Sep-15	Pig farmers study group	Riparian pig farmers study group.	Ss	Nkambule hall	With officials from DWS. Legal compliance	Background re. regulations and penalties ito NWA and NEMA. Discuss progress to upgrade and rehab water pollution because of practices.
D170	11-Jan-16	Cobus Horn - study Group	Riparian cobus horn - study group.	Ss	Kobus Horn	Sound irrigation and healthy water/plant household	Optimum production and irrigation practices re soil/water balance.

WATER RESOURCE MANAGEMENT ACTIVITIES AND ACHIEVEMENTS IN THE PONGOLA RIVER CATCHMENT **APPENDIX E**

Final report on the status, focal points envisaged, achievements and challenges as from 1 August 2014 to 30 June 2017.

	PROJECT OBJECTIVES				ACHIEVEMENTS		CHALLENGES
	Focal points, threat identified and activities addressed.	Cases	Location/s	Network	Achievements and outcomes of activities	Indication of achievement of objective	Challenge/s and obstacles experienced/emerging
E1	**Water resource health assessment**						
E2	a **Formal river health assessment completed**	1	Western head waters	Me. P van Jaarsveld	Completion of intensive baseline study on assessment point in various rivers and tributaries.	100%	Low water status due to drought.
E3	b **Routine water quality analysis**	Multiple	31 routine sampling points over catchment and WWTW's	Impala, Integral laboratories	Monitoring water quality trends over the western and central catchment regions. Building up base line and reference data.	100%	Economics
E4	c **Specific water analysis**	Multiple	Points as per need	Impala, Integral laboratories	Monitoring and quantifying of specific problem areas and points sources of pollution for action and record.	100%	Economics
E5	d **Pongola river assessment - completed**	1	From Grootdraai weir up to Rietspruit confluence	Impala and Technikon students of PULA Engineering.	Monitoring and identification of points sources of pollution for action and record.	100%	Low flow because of drought and ever presence of crocodiles.
E6	**Sound water use control and supply security risks**						
E7	a **Potable water losses**	Multiple	Ncotshane town	War room wards 2 and 10, ZDM technicians as per 2.1d	Identified 64 leaks to a volume per 24 hours of 587 864 liters. Creating community awareness and exposure to losses. Attendance and rectifying of numerous points, identifying problems in infrastructure system and procurement problems in ZDM. Increased collaboration by ZDM technicians.	Decreased losses and ongoing monitoring.	Top down support, ZDM procurement porocess of equipment and tools. Uptake of personal responsibility of the home owners after the meter stays a problem.
E8	b **Water secuirty dimensions**	3	Pongola (central), Headwaters (west) and ZDM	Project team, irrigation engineer and consultants		100%	

		Focal points, threat identified and activities addressed.	Cases	Location/s	Network	Achievements and outcomes of activities	Indication of achievement of objective	Challenge/s and obstacles experienced/emerging
E9		**Effluent return threats to water quality**						
E10	a	**Effluent pollutions**	2	Pongola Sugar mill - north effluent and western waste control dams	Mr. K. Endres, GM; E Wentink - Act GM, Mr. T Koekemoer - Tech Manager	Awareness, self monitoring, major refurbishments and upgrading of waste and recycling facilities. Care on waste removal contractors.	100%	None. The Mill accepted as a continuing maintenance activity.
E11	b	**Crocodile farm effluent**	1	Meijershoek Pongola	Mr. C. Labuschagne	Awareness, Upgrading of waste control facilities, effluent control and waste management.	100%	Economics but in good progress
E12	c	**Pig farmers waste effluent**	3	Various - Penvaan river	Mr. V Schaeferman, B Hambrock, D Filter, D Rasiti and members of the study group	Awareness, self monitoring, major refurbishments and upgrading of breeding and waste facilities. Project was instrumental in closing down of one facility, Penvaan Feeds. Addressed CME through DWS	70%	Economics, specialised equipment, scale buy in.
E13	d	**Town sewer effluent**	Multiple	Ncotshane and Pongola towns	Mr. Ngobese - ZDM, Mr. Dlamini - ZDM, Mr. Marshall - ZDM, Mr. S. Landman - HOD Planning Wards and war room meetings	Attendance and rectifying of 23 points identified. Identifying problems in infrastructure system and procurement problems in ZDM	Awareness 100% at tech level	Top down support and procurement of equipment and tools are problematic. All HOD staff contracts expired and not replaced yet.
E14	e	**Township grey water effluent**	Multiple	Ncotshane town	Mr. Ngobese - ZDM, Mr. Dlamini - ZDM, Mr. Marshall - ZDM	Identification and awareness creation of the problem.	Reported to district and local authorities	As the community improves its living standards, the production of grey water increases dramatically. Town planning and infrastructure development does not take place at the same pace.
E15	f	**River salinisation**	Multiple	Pongola irrigation farming	Sugar Cane Growers Ass,Farmers study group, Sugar Cane Irrigation Working Group, Consultants.	Awareness of and improvement in cost effective practices.	Ongoing	Economics in upgrading systems and management on the farm. More farmers are upgrading because of drought and ESKOM cost.

		Focal points, threat identified and activities addressed.	Cases	Location/s	Network	Achievements and outcomes of activities	Indication of achievement of objective	Challenge/s and obstacles experienced/emerging
E16		**Effluent return threats to water quality**						
E17	a	**Effluent pollutions**	2	Pongola Sugar mill - north effluent and western waste control dams	Mr. K. Endres, GM; E Wentink - Act GM, Mr. T Koekemoer - Tech Manager	Awareness, self monitoring, major refurbishments and upgrading of waste and recycling facilities. Care on waste removal contractors.	100%	None. The Mill accepted as a continuing maintenance activity.
E18	b	**Crocodile farm effluent**	1	Meijershoek Pongola	Mr. C. Labuschagne	Awareness, Upgrading of waste control facilities, effluent control and waste management.	100%	Economics but in good progress
E19	c	**Pig farmers waste effluent**	3	Various - Penvaan river	Mr. V Schaeferman, B Hambrock, D Filter, D Rasiti and members of the study group	Awareness, self monitoring, major refurbishments and upgrading of breeding and waste facilities. Project was instrumental in closing down of one facility, Penvaan Feeds. Addressed CME through DWS	70%	Economics, specialised equipment, scale buy in.
E20	d	**Town sewer effluent**	Multiple	Ncotshane and Pongola towns	Mr. Ngobese - ZDM, Mr. Dlamini - ZDM, Mr. Marshall - ZDM, Mr. S. Landman - HOD Planning Wards and war room meetings	Attendance and rectifying of 23 points identified. Identifying problems in infrastructure system and procurement problems in ZDM	Awareness 100% at tech level	Top down support and procurement of equipment and tools are problematic. All HOD staff contracts expired and not replaced yet.
E21	e	**Township grey water effluent**	Multiple	Ncotshane town	Mr. Ngobese - ZDM, Mr. Dlamini - ZDM, Mr. Marshall - ZDM	Identification and awareness creation of the problem.	Reported to district and local authorities	As the community improves its living standards, the production of grey water increases dramatically. Town planning and infrastructure development does not take place at the same pace.

		Focal points, threat identified and activities addressed.	Cases	Location/s	Network	Achievements and outcomes of activities	Indication of achievement of objective	Challenge/s and obstacles experienced/emerging
E22		**Effluent return threats to water quality**						
E23	a	**Effluent pollutions**	2	Pongola Sugar mill - north effluent and western waste control dams	Mr. K. Endres, GM; E Wentink - Act GM, Mr. T Koekemoer - Tech Manager	Awareness, self monitoring, major refurbishments and upgrading of waste and recycling facilities. Care on waste removal contractors.	100%	None. The Mill accepted as a continuing maintenance activity.
E24	b	**Crocodile farm effluent**	1	Meijershoek Pongola	Mr. C. Labuschagne	Awareness, Upgrading of waste control facilities, effluent control and waste management.	100%	Economics but in good progress
E25	c	**Pig farmers waste effluent**	3	Various - Penvaan river	Mr. V Schaeferman, B Hambrock, D Filter, D Rasiti and members of the study group	Awareness, self monitoring, major refurbishments and upgrading of breeding and waste facilities. Project was instrumental in closing down of one facility, Penvaan Feeds. Addressed CME through DWS	70%	Economics, specialised equipment, scale buy in.
E26	d	**Town sewer effluent**	Multiple	Ncotshane and Pongola towns	Mr. Ngobese - ZDM, Mr. Dlamini - ZDM, Mr. Marshall - ZDM, Mr. S. Landman - HOD Planning Wards and war room meetings	Attendance and rectifying of 23 points identified. Identifying problems in infrastructure system and procurement problems in ZDM	Awareness 100% at tech level	Top down support and procurement of equipment and tools are problematic. All HOD staff contracts expired and not replaced yet.
E27	e	**Township grey water effluent**	Multiple	Ncotshane town	Mr. Ngobese - ZDM, Mr. Dlamini - ZDM, Mr. Marshall - ZDM	Identification and awareness creation of the problem.	Reported to district and local authorities	As the community improves its living standards, the production of grey water increases dramatically. Town planning and infrastructure development does not take place at the same pace.
E28	f	**River salinisation**	Multiple	Pongola irrigation farming	Sugar Cane Growers Ass,Farmers study group, Sugar Cane Irrigation Working Group, Consultants.	Awareness of and improvement in cost effective practices.	Ongoing	Economics in upgrading systems and management on the farm. More farmers are upgrading because of drought and ESKOM cost.

		Focal points, threat identified and activities addressed.	Cases	Location/s	Network	Achievements and outcomes of activities	Indication of achievement of objective	Challenge/s and obstacles experienced/emerging
E29	a	**Mine impacts - abandoned coal mines over the head waters area of the catchment**	19	19 cases of new mining interest in the catchment head waters.	DEA officials, DWS Water Quality, DWS CMF workshops, Farmer Associations, IAP's and EAP's.	Dealt directly with the Applicants, EAP's and DMR. General awareness by IAP's (farmers, and communities), and created caution by applicants. More thorough EIA process. Deterring some Applicants.	100% awareness	DWS, DEA and DMR purports support. Beneficiation value of stockpiles appear very low. Integrity of DMR stays under suspicion.
E30	b	**Abandoned mine**	3	Makateeskop mine - 3 shafts.	Ralf Bohmer - owner and IAP's	Awareness amongst IAP's but no solution.	No solution	DWS, DEA and DMR purports support. Beneficiation value of stockpiles appear very low. Integrity of DMR stays under suspicion.
E31	c	**Abandoned mine**	1	Kempslust	Mr. J Kemp, DEA, Contractor and farmers of the area.	Awareness among IAP's, removal of most old abandoned stock piles, improved water runoff control from old working areas. Collaboration from DEA.	Stockpiles removed and run off controlled	DWS, DEA support. Beneficiation value of stockpiles exhausted.
E32	d	**Abandoned mine**	1	Longridge	Mr. Gerrie Beukes, H. Joubert and farmers in the area.	Awareness amongst IAP's but no solution.	No solution	DWS, DEA purports support. Beneficiation value of stockpiles appear very low. Integrity of DMR stays under suspicion.
E33	e	**Mining license applicant**	1	Farm Commissiekraal	PROBA members, DEA, DWS, EAP and other IAP's	Long and intensive monitoring, evaluation of documents and negotiation with Applicant and EAP. The awareness of IAP's (farmers and communities) and caution by Applicant. Exhausted RMDEC panel debates.	Successful high level negotiations	Awaiting Ministers approval or rejection. Applicant continues to pursue.
E34	f	**Illegal mining operation**	1	Farms Vryheid and Zoetmelksrivier	Applicant, EAP, DEA, DMR, Farmer Association	A new IAP awareness. Intensive monitoring, evaluation of documents and negotiation with Applicant. A claim of illegal mining was reported to DMR.	Monitoring ongoing	Reversal or review of an illegal activity by DMR. Integrity of DMR under suspicion. No feedback whatsoever.

		Focal points, threat identified and activities addressed.	Cases	Location/s	Network	Achievements and outcomes of activities	Indication of achievement of objective	Challenge/s and obstacles experienced/emerging
E35	**Land stability, land use practices and soil erosion**							
E36	a	**Land degradation - erosion**	Multiple	Manzaan river area, silting of the Bivane dam.	Local Dep Agric, DEA, Community	Direct liaison with KZN Dep Agric (Me T Naidoo and Engineer) and National DEA Chief Directorate National Resource Management (Mr. J Buckle).	Project application at Dep Agric.	Community education and buy in. Government support and funding application failed. Scale of rehabilitation.
E37	b	**Land degradation - indiscriminate dumping of rubbish and waste**	Multiple	Distribution over catchment but focused around rural area surrounding towns.	ZDM technicians, public, war rooms.	Awareness and sensitivity.	Reported and ongoing monitoring.	No support at all from Pongola loal Municipality, economics, contractor obligations, monitoring and enforcements.
E38	c	**Land degradation - Poor land use practices**	Multiple	Extensive over central region of catchment	Dep Agric, DEA, Community.	Direct liaison with KZN Dep Agric.	Reported	Community education and buy in, Government support and funding, economics, scale of work. To get the 37 Dep Agric officials to perform their duties.
E39	a	**Injudicious township expansions**	3	Mnjini area (Tvl siphon), Izimvubu area Ncotshane tributary and Pongola along N2.	City planners (Mare, Taljaard and Cronje), ZDM Water Use manager, SALGA.	Awareness of city planners about environmental and water resource impacts. Inputs via City Planners into IDP's.	Reported	Cognisance of traditional leaders and communities of the impacts and problematics in injudicious hand out of land lots and settlement without infrastructure planning and provisions.
E40	**River bank vegetation and alien invasive plants**							
E41	a	**Alien invasive plants**	Multiple	All over catchment	DWS-CMF's, Mr. Shabalala of DEA, Work for Fire - Mr. J Maritz, farmers and private business owner.	Awareness but no solution yet.	No implementation plan	Convincing farmers to buy in, farm safety, maintaining maintenance and follow up, procurement, economics. Revisiting of a holistic approach needed. Scale.

		Focal points, threat identified and activities addressed.	Cases	Location/s	Network	Achievements and outcomes of activities	Indication of achievement of objective	Challenge/s and obstacles experienced/emerging
E42		**Education and awareness creation**						
E43	a	**Farmers Associations**	5	Pongola	Pongola Cane Growers Ass	Mutual understandings and awareness. Contextualising scientific background.	100% awareness Signs of improvement and care but slow.	Buy in on larger scale. Capital required by farmers for improvement of infra structure appears challenging. Drought and ESKOM pressure force farmers to change prax.
E44	b		3	Pongola	Phumelela farmers Ass			
E45	c		4	Commondale	Commondale Farmers Association			
E46	d		6	Paulpietersburg	eDumbe Agric Centre			
E47	e		4	Nkambule	Pig Farmers			
E48	f		2	Nkambule	Nkambule Farmers Association			
E49	g		2	Pongola	Horn study group and Wonderfontein study group.			
E50	h		1	Paulpietersburg	eDumbe Cattle Study group			
E51	i		Multiple	Catchment	IAP's			
E52	a	**Catchment Management Forum**	Multiple	Pongola	CMF participants	Awareness regarding environmental care and its role in water security.	100%	Role player participation and interest stay poor. Comprehension of purpose low.
E53	b	**Catchment Management Forum**	Multiple	Paulpietersburg	CMF participants			

		Focal points, threat identified and activities addressed.	Cases	Location/s	Network	Achievements and outcomes of activities	Indication of achievement of objective	Challenge/s and obstacles experienced/emerging
E54		**Zululand District Municipality**	2	Pongola to Paulpietersburg area - west and central catchment region.	Speaker of ZDM, Operations Manager, Technical Manager, Water Use Manager, Pongola Super intendent and technicians.	Cognisance regarding of the role of the environment in water security. Top management minuted support. Healthy collaboration of technicians. EnviroChamp project keeps pressure on the system.	100% cognisance but poor internal support	All HOD's expired. No replacements yet. The impact of the inefficiency of the ZDM in detecting of problems and diligent following up on the work load of other external IAP's.
E55	a	**Community Schools**	1	Golela Combined School	Me E Roux	Education on general environmental and water resource care. Planting of trees.	Require continuous follow up.	Care in presenting the correct nuanced message for children. Keeping children interested. Continued support from teachers through children activities restricted. Need a mind change amongs teachers and inputs and focus on curriculum content level.
E56	b		1	Magut Private School	Me T Rautenbach	Education on general environmental and water resource care. Planting of trees.		
E57	c		1	Sakhumuzi	Me H Klopper	Education on general environmental and water resource care. Planting of trees.		
E58	d		1	Pongola Akademie	Me S Senekal	Education on general environmental and water resource care. Planting of trees.		
E59	e		2	Sinothile Primary	Me G Buthelezi	Education on general environmental and water resource care. Planting of trees. Organising a school rubbish pick up.		
E60	f		1	Lelieshoek Primary	Me Sibiya	Education on general environmental and water resource care. Planting of trees.		
E61	g		1	Ophongolo High School	Mr. JP Ngema	Education on general environmental and water resource care.		
E62	h		1	Dwaleni High School	Mr PM Zulu	Education on general environmental and water resource care.		
E63	i		2	Masiphula High School	Me ND Khumalo	Education on general environmental and water resource care. Organising a school rubbish pick up.		

		Focal points, threat identified and activities addressed.	Cases	Location/s	Network	Achievements and outcomes of activities	Indication of achievement of objective	Challenge/s and obstacles experienced/emerging
E64		**Zululand District Municipality**	2	Pongola to Paulpietersburg area - west and central catchment region.	Speaker of ZDM, Operations Manager, Technical Manager, Water Use Manager, Pongola Super intendent and	Cognisance regarding of the role of the environment in water security. Top management minuted support. Healthy collaboration of technicians. EnviroChamp project keeps pressure on the system.	100% cognisance but poor internal support	All HOD's expired. No replacements yet. The impact of the inefficiency of the ZDM in detecting of problems and diligent following up on the work load of other external
E65	a	**Community Schools**	1	Golela Combined School	Me E Roux	Education on general environmental and water resource care. Planting of trees.	Require continuous follow up.	Care in presenting the correct nuanced message for children. Keeping children interested. Continued support from teachers through children activities restricted. Need a mind change amongs teachers and inputs and focus on curriculum content level.
E66	b		1	Magut Private School	Me T Rautenbach	Education on general environmental and water resource care. Planting of trees.		
E67	c		1	Sakhumuzi	Me H Klopper	Education on general environmental and water resource care. Planting of trees.		
E68	d		1	Pongola Akademie	Me S Senekal	Education on general environmental and water resource care. Planting of trees.		
E69	e		2	Sinothile Primary	Me G Buthelezi	Education on general environmental and water resource care. Planting of trees. Organising a school rubbish pick up.		
E70	f		1	Lelieshoek Primary	Me Sibiya	Education on general environmental and water resource care. Planting of trees.		
E71	g		1	Ophongolo High School	Mr. JP Ngema	Education on general environmental and water resource care.		
E72	h		1	Dwaleni High School	Mr PM Zulu	Education on general environmental and water resource care.		
E73	i		2	Masiphula High School	Me ND Khumalo	Education on general environmental and water resource care. Organising a school rubbish pick up.		
E74		**SALGA**	2	Pongola/Ncotshane	Mr. Bright Nkotwana Me Bathandwa Vazi, Me J. Taljaardt	Cognisance of problematics via Me. J Taljaardt.	Reported	SALGA and buy in to constructively motivate/improve District and Local municipalities lacks.

		Focal points, threat identified and activities addressed.	Cases	Location/s	Network	Achievements and outcomes of activities	Indication of achievement of objective	Challenge/s and obstacles experienced/emerging
E75	a	**Internal participation and learning**	1	Wetland Indaba	DEA and DWS officials and Scientists in the field.	Exposure to wetland dynamics, care and rehabilitation.	Ongoing Excellent EnviroChamp roll out and progress	The lack of alternative/continued funding at the expiry of Projects has negative effect on project and motivation momentum.
E76	b		3	Liz Taylor DUCT and Kirsten Mahood GroundTruth	DUCT and GroundTruth	Exposure to EnviroChamps project		
E77	c		3	WESSA basic environmental courses for EnviroChamps	GroundTruth	Learning curve and education for EnviroChamps for application in the community.		
E78	d		2	Citizen Science training	GroundTruth	Exposure to basic citizen science approaches working with communities.		
E79	e		1	Visit with Vaughan Koopman	WWF Mondi Wetlands program and Mooi River and Hlatikulu Irrigation Boards.	Exposure to the WWF official's work and experience in group communication, activities and wetland identification and rehab.		
E80		**Mobilisation of existing Resources**						
E81	a	**Impala water Users Association**		Pongola	Impala Board	Board support. IWRM on catchment scale.	100%	Economics, time, man power but very willing to proceed.
E82	b	**Department of Environmental Affairs**		Ulundi	Mr. D.Ndlovu Mr. L. Mpongose Mr C Ngubu	Collaboration of officials. Involvement and action in various environmental issues; (abandoned mines, removal of stockpiles, dumping of rubbish, mobilsing local municipality).	Good collaboration	Keeping commitment alive and working through cumbersome governmental procedures.
E83	c	**Department of Water and Sanitation**		Durban	Mr. J Reddy, Me. Z. Makwabasa	Involvement and action in various environmental issues; abandoned and new mines impacts) Mobilisation of CMF's	Concerning	
E84	d	**Zululand District Municipality**		Ulundi	Mr. D. Marshall, Mr D. Ngobese, Mr A Dlamini Mr Z Dladla HOD Tech, Mr. S. Landman HOD Planning	Involvement and action in various environmental issues; (losses of purified water, problematic sewer systems dumping of rubbish). Collaboration with Technicians.	Poor internal support, good local support	Keeping top down support, commitment and cumbersome procurement procedures. The acceptance and taking up of responsibilities between ZDM, local municipality and house owners.

	Cases	Focal points, threat identified and activities addressed.	Location/s	Network	Achievements and outcomes of activities	Indication of achievement of objective	Challenge/s and obstacles experienced/emerging
E85	e	**Pongola Sugar Mill**	Pongola	Mr. K. Endres, E Wentink, T. Koekemoer		Good internal support, good local support	Continued monitoring and very expensive maintenance.
E86	f	**Various agricultural and irrigation consultants**	Nkambule, cattle districts, eDumbe, Commondale, Pongola.	Piggery system upgrades, irrigation consultants, crop production consultants			
E87	g	**Ncotshane Community**	Ncotshane	Wards 2 and 10	Cognisance, buy in and support of activities that impacts on the environment. Motivate to raise issues and personal concerns regarding conditions of sewer and freshwater systems. Visible rerouting of rubbish dumping. Detecting reporting of leaks and sewer blockages.	Progressing well	Keeping politics out. Up keep of motivation and interest.
E88	h	**Nkambula Pig farmers Study Group**	Paulpietersburg	Study Group	Cognisance, buy in and action in sensitive environmental issues; breeders waste, and stock dam waste capacity and effluent control.	Good interest and good buy in.	Keeping commitment alive and keeping good relationships. Economics. Very expensive to upgrade and proceed with expansion.
E89	i	**Cattle study Group**	Paulpietersburg	E Beneke and Study group	Cognisance, buy in and action in sensitive environmental role in water security.	Good interest	Keeping commitment alive and keeping good relationships. Masintenance of buy in.
E90	j	**African Conservation Trust**	Pongola	Paul Cryer and Sihle Madonsela	Support and discussions about "eco partnerships"	Discussions	Trust has a low profile in this area.
E91	k	**AfriForum**	Pongola and Paulpietersburg	E van Aswegen.	Cognisance, buy in and action in sensitive environmental role in water security. Effective as a pressure forum.	Good interest good buy in and active in support.	Keeping commitment alive and keeping good relationships. Maintenance of buy in and commitments.
E92	l	**Pongola Chamber of Commerce**	Pongola	S Weich, Me. M. Jacobsz			
E93	m	**PROBA - The Pongola River Catchment Protection Association**	Catchment	IAP's and associations in the catchment			
E94	n	**Public through their institutional structures**	Catchment	All mentioned above	Cognisance in sensitive environmental role in water security.	Though cognisance, poor active contributions	

APPENDIX F

ACTIVITIES RELATING TO EVALUATION AND CONSULTATION REGARDING MINING IN THE PONGOLA RIVER CATCHMENT

	ORGANISATION and ACTIVITY	DATE	INTEREST	APPLICATION	DMR register number OR activity	PROPERTIES TARGETED / ACTIVITIES
F1	**Come What May Properties 35 (Pty) Ltd**	2009	Coal	Prospecting	KZN 30/5/1/1/2/577PR	Farm Paris 750HU on Bivane River down stream of Bivane Dam.
F2	Discover prospecting activities of Tholie Logistics and Commissikraal Coal	15 Nov '10	Coal	Prospecting application		Commissiekraal 90HT, Klipplaatdrift 120HT, Pivaans Waterval 267HT
F3	**Establishment of PROBA at eDumbe Agricentre**	7 Dec '10	Establishment			Establish PROBA, accepting Constitution and first members
F4	PAIA applications at DMR and appeals to the Minister of DMR	Feb/Mrch '10	Appeal to the minister of DMR			Objection and opposing of the prospecting activities of Tholie, Commissikraal Coal and Bright Resources.
F5	**Tholie Logistics (Pty Ltd)**	2010	Coal	Prospecting granted. Proceeded with mining right application	KZN 30/5/1/2/2/10061MR	Commissiekraal 90HT, Klipplaatdrift 120HT, Pivaans Waterval 267HT
F6	**BSC Resources**	2010	Coal	Area inquiries	NOT AVAILABLE	Commissiekraal 90HT, Klipplaatdrift 120HT, Pivaans Waterval 267HT
F7	**Variswave Investments (Pty) Ltd**	2010	Coal	Area inquiries	NOT AVAILABLE	Commissiekraal 90HT, Klipplaatdrift 120HT, Pivaans Waterval 267HT
F8	AGM of PROBA members	28 Apr '11	AGM meeting			First PROBA AGM at Kempslust and update members
F9	AGM with Pongola farmers	30 May '11	AGM meeting			First PROBA AGM in Pongola and update members
F10	Rumours of the construction of a seaport harbour for coal export north of Ponta D'Ouro	15 Nov '11	Coal	Media and NGO speculation		Participated in opposition through NGO in Ponta D'Ouro and TV program of the late Johann Botha.
F11	**Kebrastyle (Pty) Ltd**	2012	Coal	Prospecting unlawfully granted	KZN 30/1/1/2/624PR	Pivaanspoort 10HT. Contributed to opposition through attorney Christo Rheeders.
F12	**Umsobomvu via Geoff Silk as EAP.**	10 Jan 12	Fe	Prospecting	KZN 50/5/1/2/10169 PR KZN 30/5/1/1/2/10141 PR KZN 30/5/1/1/2/10181 PR	Prospecting application of Umsobomvu Holdings on the farm Ontevreden 203HT. Public meeting 25 Jan 2012.
F13	Opposing Umsobomvu in RMDEC debate Durban		RMDEC panel debate			Opposing application at RMDEC Durban
F14	**Impala Platinum Ltd - African Exploration Mining and Finance Corporation (Pty) Ltd**	2012	Fe, Mn, Au, Al, Pn, Co, Pb	Prospecting application	MP 35/5/1/1/2/5633PR / MP 30/5/1/1/2/5547PR	Sulphurspring 14 HU and 13 HU
F15	**Mashinini Trading CC**	2013	Coal	Prospecting application	MP 30/5/1/1/2/10861PR	Imelkaar 102HT, Talaga 183HT, Nederland 202HT, Wetteren 176HT

	ORGANISATION and ACTIVITY	DATE	INTEREST	APPLICATION	DMR register number OR activity	PROPERTIES TARGETED / ACTIVITIES
F16	**Conceit Investment (Pty) Ltd**	2013	Coal	Prospecting application	MP 30/5/1/1/2/10876PR	Talaga 183HT, Nederland 202HT, Tafelberg 188HT, Normandie 178HT
F17	Opposing Coal Bed Methane	25 Oct '13	Coal gas	Prospecting application		Afro Energy application in Wakkerstroom
F18	Lanodex Trade and Investments 4 (Pty) Ltd	5 March 2014	Coal/Fe/Mn	Prospecting meeting		Consultation meeting with Applicant, EAP and Impala Management.
F19	Commondale Farmers meeting	18 Feb '14	Meeting			Farmers meeting - information and update
F20	**Gwazela Hlabamaduna Trading CC**	2014	Coal, Fe, Mn	Prospecting application	MP 30/5/1/1/2/11597PR	Neederland 202HT
F21	RMDEC debate against Umsobomvu in Durban	8 Apr '14	RMDEC panel debate			Opposing Umsobomvu application at RMDEC in Durban
F22	RMDEC debate against Conceit Investments in Witbank	27 March '14	RMDEC panel debate			Opposing Conceit Inv application at RMDEC in Witbank
F23	RMDEC debate against Conceit Investments and Hlabamaduna in Witbank	16 Apr '14	RMDEC panel debate			Opposing Conceit Inv and Hlabamaduna application at RMDEC in Witbank
F24	Tholie Logistics and Commissiekraal Coal in Utrecht	12 Aug 2014	Coal	Coal mining right application	KZN 30/5/1/2/2/10061 MR DC25/0010/2014: KZN/EIA/00001763/2014	Public consultation meeting with IAP's on the Tholie Logistics and Commissikraal coal projects on the farm of Nico Lens.
F25	eDumbe AgriCenter meeting	20 Aug '14	Meeting			Farmers meeting - information and update
F26	**Lanodex Trade and Investments 4 (Pty) Ltd**	2014	Mn, Fe	Prospecting application	KZN 10426PR	Farm Dwaalhoek 105HU
F27	Investigation meeting - Materka	9 Des 2014	Coal	Investigation re. mining plans on M Barnard farm		Investigating alleged plans of coal mining in Elandsberg on the farm of M. Barnard.
F28	**Yzermyn - Atha Africa Ventures (Pty) Ltd**	2015	Coal	Mining right granted DWS 16/2/7/W51 Wtr License application	Authorisation - 17/2/3/GS - 131	Mpumalanga/KZN Wakkerstroom
F29	Paul Farrel - Kemptonpark	24 Feb 2015	Meeting			Investigation of wetlands to rehabilitate coal mine effluent.
F30	Kempslust Tholie Logistics and Bright ResourcesPublic consultation meeting	26 March 2015	Coal	Coal mining right application		Two public consultation meetings (English) and (Zulu regarding application for coal mining.

	ORGANISATION and ACTIVITY	DATE	INTEREST	APPLICATION	DMR register number OR activity	PROPERTIES TARGETED / ACTIVITIES
F31	CMF meeting presentation	12 May '15	Meeting			Information and update meetin in Paulpietersburg
F32	**Delf Silica (Pty) Ltd**	2015	Silica	Prospecting application	KZN 30/5/1/1/2/10541PR	Rondspring 137HU Vryheid
F33	Address eDumbe AgriCenter meeting	12 March 2015	Meeting			Members meeting regarding the Tholie Logistics scoping report.
F34	Address eDumbe AgriCenter meeting	20 May 2015	Meeting			Feedback meeting to members regarding Tholie Logistics application
F35	Address meeting at Impala in Pongola	9 June 2015	Meeting			Meeting with Water Quality Division DWS regarding abandoned coal mines effect on water resources.
F36	Address eDumbe AgriCenter meeting	11 June 2015	Meeting			Request for identification and effects of abandoned coal mines
F37	Address eDumbe AgriCenter AGM meeting	12 Aug 2015	Meeting			Feedback to members regarding addressing mining activities.
F38	Address eDumbe AgriCenter AGM meeting	17 Sep 2015	Meeting			Preparations and information regarding the EIA of Tholie Logistics application
F39	Address role players at Kempslust	3 Nov 2015	Meeting			Information and update meeting to members at Kempslust
F40	Appeal for extension for EIA and EMP objections of Tholie Logistics	12 Nov '15	Coal	Coal mining right application	KZN 30/5/1/2/2/10061 MR DC25/0010/2014: KZN/EIA/00001763/2014	Commissiekraal 90HT
F41	Appoint 12 experts to evaluate Tholie EIA and EMP	12 Nov '15	Coal	Coal mining right application	KZN 30/5/1/2/2/10061 MR DC25/0010/2014: KZN/EIA/00001763/2014	Commissiekraal 90HT
F42	Newcastle - Tholie Logistics focused meeting	13 Nov 2015	Coal	Coal mining right application	KZN 30/5/1/2/2/10061 MR DC25/0010/2014: KZN/EIA/00001763/2014	Focused workshop with IAP's with Tholie Logistics caol mine application.
F43	**Sabicento (Pty) Ltd**	2016	Coal	Prospecting application	KZN 35/5/1/1/2/10602PR	Farm Pivaanspoort 80 HT
F44	Address eDumbe AgriCenter meeting	8 Jan 2016	Meeting			Meeting with members and Keith Schneider from USA regarding impacts of coal mining.
F45	Address eDumbe AgriCenter meeting	5 Feb 2016	Meeting			Soliciting funding for the scientific evaluation of the Tholie EIA and EMP.

	ORGANISATION and ACTIVITY	DATE	INTEREST	APPLICATION	DMR register number OR activity	PROPERTIES TARGETED / ACTIVITIES
F46	Rhino Oil and Gas Exploration South Africa (Pty) Ltd	2016	Oil and gas	Prospecting application	KZN 108 TCP	2 million ha - north, central and east KZN
F47	Address eDumbe AgriCenter meeting	10Mrch'16	Meeting			Farmers meeting - information and update on Tholie and Sabicento applications.
F48	Palpietersburg Library - Sabicento	17 March 2016	Meeting	Prospecting application	KZN 35/5/1/1/2/10602PR	Public consultation meeting for an exploration application on the Farm Pivaanspoort 80 HT
F49	Address Commondale Farmers meeting	4 April 2016	Meeting			Farmers meeting - information and update on Tholie and Sabicento applications.
F50	Kempslust - Rehabilitation of Mine Residu Dumps	6 May 2016	Coal	Removal and rehabilitation of MRD		Inspection of MRD removal activities with DEA.
F51	Kempslust - Rehabilitation of Mine Residu Dumps	23 May '16	Coal	Removal and rehabilitation of MRD		Meeting with land owner and contractor regarding removal and rehabilitation of Mine Residu Dumps
F52	Kempslust - Rehabilitation of Mine Residu Dumps	14 June 2016	Coal	Removal and rehabilitation of MRD		Follow up meeting regarding the removal and rehab of MRD
F53	**Shongozela Mining Eploration (Pty) Ltd**	2016	Coal	Prospecting application	KZN 38/5/1/1/2/10618PR	Holkrans 210HT, Bloemendal 538HT
F54	Frisbee Track & Investment 1171 cc	2016	Coal	Reneval/ proposed development	KZN 30/5/1/1/2/10074MR	Kaffersdrift 17072, eDumbe 436, Kempslust 81.
F55	AGM of eDumbe Agri Center	9 Aug 2016	Meeting			Farmers meeting - information and update
F56	RMDEC debate against Tholie Logistics application in Durban	13 Sep '16	RMDEC panel debate		KZN 30/5/1/2/2/10061 MR DC25/0010/2014: KZN/EIA/00001763/2014	Opposing mining right application at RMDEC Durban
F57	**Hoshoza Resources / Kariboo Colliery**	Sep '16	Coal	Plant set-up and started to mine- MR 18 Jan '12 and WUL 11 Jun '15	KZN 30/5/1/2/2/233MR WUL 06/V32G/ABCGIJ/2865	Port 0 rem Farm Vryheid 159HT, Port 4 rem Vryheid 159 HT, Port 1 Zoetmelksrivier 86 HT
F58	Karibo Colliery Zoetmelksrivier	28 Sep 2016	Coal	Site inspection	KZN 30/5/1/2/2/233MR WUL 06/V32G/ABCGIJ/2865	Site inspection of the extent of mining activities.
F59	Address Nkambula Farmers meeting	28 Sep 2016	Meeting		KZN 30/5/1/2/2/233MR WUL 06/V32G/ABCGIJ/2865	Farmers information meeting to inform farmers about Hoshoza mining activities and PROBA activities.
F60	Address Nkambula Farmers meeting	19 Oct '16	Meeting		KZN 30/5/1/2/2/233MR WUL 06/V32G/ABCGIJ/2865	Farmers information meeting to inform farmers about Hoshoza mining activities and PROBA activities.

	ORGANISATION and ACTIVITY	DATE	INTEREST	APPLICATION	DMR register number OR activity	PROPERTIES TARGETED / ACTIVITIES
F61	Liaison and collaboration with 8 scientists regarding the EIA and EMP, Tholie Logistics	19-Nov-16	Coal	Research to address EIA and EMP	KZN 30/5/1/2/2/10061 MR DC25/0010/2014: KZN/EIA/00001763/2014	Require scientific expertise in the opposition of mining right application for submssion to DMR and debate at RMDEC Durban
F62	Appeal to DMR regarding Hoshoza mining activities	21 Nov 16	Coal	Coal Mining activities		Appeal and report illegal mining activities to DMR Complaints Directorate.
F63	**Frisbee Track & Investment 1171 cc**	2016	Coal	Reneval/ proposed development at Kempslust	KZN 30/5/1/1/2/10074MR	Kaffersdrift 17072, eDumbe 436, Kempslust 81.
F64	**Bombo Group (Pty) Ltd**	2016	Rhyolite	Mining permit application	KZN 30/5/1/3/2/10481MP	Portion 1 of the Farm west no 16637, Jozini.
F65	Holkrans community meeting	4 Feb 2017	Meeting			Information and educational meeting with the Holkrans/Bloemendal community
F66	Shongozhela public meeting	18 Feb 2017	Meeting	Prospecting application	KZN 30/5/1/1/2/10654 PR	Public consultation meeting by Shongozhela for coal prospecting.
F67	Formal comments on Shongozhela application and BAR and EMP	15 May 2017	Coal	Prospecting application	KZN 30/5/1/1/2/10654 PR	Evaluation of the BAR and EMP and comments in opposition to DMR.
F68	Second round of investigations against Tholie Logistic application	4 May 2017	Objections	Coal mining right application	KZN 30/5/1/2/2/10061 MR DC25/0010/2014: KZN/EIA/00001763/2014	Review and evaluation of additional work by Tholie Logistics and comments to RMDEC - Durban
F69	Liaison and collaboration with 4 scientists regarding the EIA and EMP, Tholie Logistics	22-May-16	Coal	Research to address EIA and EMP	KZN 30/5/1/2/2/10061 MR DC25/0010/2014: KZN/EIA/00001763/2014	Require scientific expertise in the opposition of mining right application for submssion to DMR and debate at RMDEC Durban
F70	RMDEC debate 2 against Tholie Logistics application in Durban	13-Jul-17	RMDEC panel debate 2		KZN 30/5/1/2/2/10061 MR DC25/0010/2014: KZN/EIA/00001763/2014	Opposing mining right application at RMDEC Durban
F71	Shongozela Mining Eploration (Pty) Ltd	Sep/Oct 2017	Coal	Persue rights to enter private land for site investigations.	KZN 30/5/1/1/2/10654 PR	Negotiation - availability of a reconnaisance right to get legally onto private land to execute data gathering for EIA.

Chronological actions on sewer and potable water system problems in Pongola and Ncotshane Towns

NOTES: Sewer leaks were arbitrarily described as follows:

A: Volume leak appearance small
B: Volume leak appearance moderate
C: Volume leak appearance severe

1: Potential impact on human activity small
2: Potential impact on human activity - slight
3: Potential impact on human activity - high

NOTES: All leaks action codes description:

A: Leak assessed
B: Volume loss determind
C: Reported to relevant authority/owner

F: Attended to and fixed
O: Problem unattended and ongoing
D: Delayed response to attend or fix

Issue No is the reference number from ZDM for problems reported to "Customer Care"

Date	House Number	Description of leak	ZDM / Owner	Location coordinates		Sewer leaks		Potable Water	
						Discription Code	Action code	Loss L/24Hr	Action Code
29/08/14	B2360 Theo Uitbr	ZDM Design Problem	ZDM	S27 20'49.83"	E31 35'32.98"	C2	ACO	Jet Chem Attended 17/05/17	
06/06/14	B1164	ZDM Main Line	ZDM	S27 21'22.87"	E31 34'36.0"			4608	ABCO
06/06/16	B2542	Pipe before meter	ZDM	S27 21'15.34"	E31 35'8.51"			3456	ABCO
06/06/16	B2543	Sewer. Design problem. Refer to Engineers		S27 21'17.78"	E31 35'7.97"	B2	ACF		
06/06/16	B2543 44	3 Houses connected to 1 meter		S27 21'15.52"	E31 35'7.97"			not measured	ACO
07/06/16	B1095	ZDM Sewer problem	ZDM Owner	S27 21'21.40"	E31 34'53.72"	B3	ACO		
07/06/16	B874	Grey water.Drain spill into street.	Planning	S27 21'4.50"	E31 34'42.33"	A1	ACO		
13/06/16	B1798	Main line close 17h00 Water shedding.		S27 20'54.45"	E31 34'34.55"			Big spill	ACF
21/06/16	B2095	ZDM Fixed	ZDM	S27 20'46.93"	E31 35'13.69"			3240	ABCF
21/06/16	B3291	Owner fixed	OWNER	S27 20'58.4"	E31 35'16.6"			3240	ABCF
23/06/16	Jaji Store		OWNER	S27 20'58.35"	E31 34'56.22"			1368	ABC(DI)
26/06/16	Wimpy	ZDM said it was a Contractor who did not attend to the problem. Coordinator followed up regurlarly ZDM took more than a month to fix.	ZDM	S27 22'41.41"	E31 36'57.92"	B3	ACO		
28/06/16	Golf coarse	3 different m/holes	ZDM	S27 22'06.66"	E31 37'01.57"	3 x C3	ACO		
30/06/16	B1686		ZDM	S27 20'52.54"	E31 34'31.40"			648	ABCF
30/06/16	B454	No water meter	ZDM	S27 20'56.22"	E31 34'52.36"			not measured	ACO
30/06/16	B541		ZDM	S27 20'58.35"	E31 34'56.22"			1008	ABCF
30/06/16	B547		ZDM	S27 20'56.94"	E31 34'52.33"			864	ABCF
30/06/16	B554	& leaking Tap	ZDM/Owne	S27 20'55.92"	E31 34'49.33"			10800	ABCO
09/07/16	B762	ZDM Main line	could not measu	S27 21'10.47"	E31 35'6.30"			To big to measure	ACF
15/07/16	B2591	Jabu neighbour	ZDM	S27 21'13.27"	E31 35'3.57"			4896	ABCF
15/07/16	B913	Connection to house Unattended over weekend	ZDM	S27 21'11.71"	E31 34'57.97"			13824	ABC(DI)
26/07/16	B2682	Fixed	ZDM	S27 21'25.96"	E31 34'54.75"			not measured	ACF
26/07/16	B3284	Water after meter. Owner fixed	ZDM	S27 20'57.72"	E31 35'14.45"			6912	ACC(DI)
28/07/16	B2684		ZDM	S27 21'28.20"	E31 34'53.50"			7488	ABC(DI)

Date	House Number	Description of leak	ZDM / Owner	Location coordinates		Sewer leaks		Potable Water	
						Discription Code	Action code	Loss L/24Hr	Action Code
28/07/16	Reservoir Disconnected	Illegal Connection Reconnected	ZDM/Pollc	S27 21'27.88"	E31 34'41.12"			63mm pipe	ACO
29/07/16	B2408	Sewer near Neli	ZDM	S27 21'12.94"	E31 35'11.79"	B2	ACF		
29/07/16	B2420	Sewer	ZDM	S27 21'14.5"	E31 35'11.8"	C2	ACF		
01/08/16	B2387		ZDM	S27 21'6.14"	E31 35'19.02"			1944	ABC(Dl)
01/08/16	B2423	Main line. To much to measure		S27 21'14.54"	E31 35'9.87"			To big to measure	ACF
01/08/16	B2564		ZDM	S27 21'17.78"	E31 35'5.25"			2160	ABC(Dl)
01/08/16	B2566	Owner	OWNER	S27 21'18.50"	E31 35'4.59"			See 19/11/16	ABC(Dl)
07/08/16	B2546	water meter leak	ZDM	S27 21'16.44"	E31 35'6.85"			2448	ABC(Dl)
07/08/16	B2548		OWNER	S27 21'18.31"	E31 35'5.22"			fixed	ACF
08/08/16	B2405	Owner must fix.	OWNER	S27 21'12.50"	E31 35'11.91"			not measured	AC(Dl)
11/08/16	B1046	Owner Tap leaking	OWNER	S27 21'19.55"	E31 34'43.93"			fixed	ACF
11/08/16	B1145		ZDM	S27 21'21.40"	E31 34'48.90"			5760	ABC(Dl)
11/08/16	B1148		ZDM	S27 21'20.98"	E31 34'45.48"			3027	ABCF
12/08/16	B2393	75mm main line	ZDM	S27 21'7.90"	E31 35'17.11"			not measured	ACF
12/08/16	Suikerbekkie 383		OWNER	S27 22'53.91"	E31 37'05.45"			13680	ABCF
16/08/16	Maria's Man hole	sewer	ZDM	S27 22'39.24"	E31 36'48.07"	B3	ACF		
19/08/16	B762	ZDM Main line	ZDM	S27 21'10.47"	E31 35'6.30"			To big to measure	ACF
22/08/16	Matash	Rev. Sipho reported. Weekend	ZDM	S27 22'38.61"	E31 36'50.60"	B1	ACF		
29/08/16	B1784		ZDM	S27 20'53.43"	E31 34'40.54"			3096	ABCF
29/08/16	Car wash		Opservation	S27 20'54.20"	E31 34'43.40"		@War Room	13478	
01/09/16	B1197	Fixed sling Temp. solution	ZDM	S27 21'7.81"	E31 34'35.56"			not measured	ACF
05/09/16	Pamper Valley	Serious pollution	Munisipali	S27 20'32.57"	E31 34'52.79"			Pollution	ACO
05/09/16	Sewer Pamper Valley.	Serious spill. Main Sewer line		S27 20'36.04"	E31 24'53.50"	C3	ACF		
06/09/16	B150	Septic Tank	OWNER	S27 20'30.18"	E31 34'52.70"	A1	ACO		
06/09/16	B156		ZDM	S27 20'32.08"	E31 34'49.59			216	ABCF
06/09/16	B2553	Owner fixed	OWNER	S27 21'14.24"	E31 35'5.72"			8640	ABCF
06/09/16	Thebene Store	Sewer/ Owner	OWNER	S27 20'18.54"	E31 34'58.23"	C3	ACF		
30/09/16	B2522		ZDM	S27 21'10.43"	E31 35'13.68"			1728	ABCF
30/09/16	B471 Across		ZDM	S27 20'57.69"	E31 35'7.54"			25920	ABCF
30/09/16	Man hole Dr v Aardt		ZDM	S27 22'37.17"	E31 36'41.65"	C3	ACF		
03/10/16	B1808		ZDM	S27 21'4.10"	E31 35'0.82'			360	ABC(Dl)F
03/10/16	B698		ZDM	S27 21'1.36"	E31 34'58.89"			288	ABC(Dl)
03/10/16	B726		ZDM	S27 21'4.24"	E31 35'1.99"			3071	ABCF
05/10/16	Sewer Police Station		ZDM	S27 22'37.62"	E31 36'59.18"	A1	ACF		
12/10/16	B2158	Meter reverse	ZDM					not measured	ACO
17/10/16	B421	Leak in road	ZDM	S27 20'56.45"	E31 35'3.68"			2304	ABCO
17/10/16	B421	No w.meter	fixed/ZDM	S27 20'56.45"	E31 35'3.68"			432	ABC(Dl)

Date	House Number	Description of leak	ZDM / Owner	Location coordinates		Sewer leaks		Potable Water	
						Discription Code	Action code	Loss L/24Hr	Action Code
17/10/16	Ncotshane Reservoir	Gland packing	ZDM	S27 21'27.61"	E31 34'42.49"			7776	ABCO
21/10/16	B2403	Neli	ZDM	S27 21'11.51"	E31 35'13.11"			1224	ABCO
21/10/16	Jaji Dwaleni School	75mm main line burst	ZDM	S27 21'00.10"	E31 34'55.69"			259200	ABCF
22/10/16	Matash	Sewer leak	ZDM	S27 22'38.61"	E31 34'50.60"	B1	ACF		
22/10/16	Sewer line at crossing before oPhongolo High School.		ZDM	S27 20'27,54"	E31 35'04.17"	C3	ACF		
09/11/16	B2542		ZDM	S27 21'15.22"	E31 35'08.58			Leak increased to 12672	ABCO
09/11/16	B912	stop cock faulty	ZDM	S27 21'11.08"	E31 34'56.37"			5472	ABCO
09/11/16	Ncotshane Reservoir	Gland packing	ZDM	S27 21'27.88"	E31 34'41.12"			3168	ABCO
09/11/16	Nhlabiti Butchery		ZDM	S27 21'03.1"	E31 34'38,6"			2448	ABCO
11/11/16	Marias	Sewer	ZDM	S27 22'39.24"	E31 36'48.07"	C3	ACF		
13/11/16	A266	Owner pipe	owner	S27 19'50.89"	E31 34'39.06"			5328	ABCF
13/11/16	A277	middle of road	ZDM	S27 19'59.0"	E31 34'45.0"			2736	ABCO
13/11/16	Rehobot Supermark	Across B762	ZDM	S27 21'10.94"	E31 35'06.28	C3	ACF		
17/11/16	B2533	Drein blocked	ZDM	S27 21'11.20"	E31 35'8.18"	B2	ACF		
18/11/16	B1298	Pipe after meter	Owner	S27 21'22.85"	E31 34'22.04"			28800	ABCF
19/11/16	B1183		Owner/ZDI	S27 21'02.25"	E31 34'31.11"			28800	ABC(DI)
19/11/16	B2403		ZDM	S27 21'11,51"	E31 35'13.11"			Decreased to 6336	ABCO
19/11/16	B2535		owner	S27 21'11.10"	E31 35'8.48"			10080	ABC(DI)
19/11/16	B2566		owner	S27 21'18.27"	E31 35'04.60"			2304	ABC(DI)
19/11/16	B421		ZDM	S27 20'56.45"	E31 35'3.68"			See 17/10/16	ABC(DI)
21/11/16	A277	middle of road	ZDM	S27 19'59.0"	E31 34'45.0			See 13/11	ABCO
21/11/16	B1301	Siyabonga spoke to office for response	Owner	S27 21'21.0"	E31 34'21.7"			not measured	AC(DI)
22/11/16	Kings Centre	Supply Fix Private Contractor 2/12/16	ZDM	S27 22'42,56"	E31 36'46.09"			25920	ABC(DI)
26/11/16	Red bric Centre	Main line 160mm	ZDM	S27 21'2,47"	E31 35'12,83"			To much t.m	AC(DI)
29/11/16	Ncotshane Reservoir	Illegal Connection	ZDM/Polic	S27 21'27.88"	E31 34'41.12"			63mm pipe	ACO
29/11/16	Ncotshane Reservoir	Gland packing	ZDM	S27 21'27.61"	E31 34'42.49"			Increased to 6912	ABCO
30/11/13	Dr v Aardt	2 Man holes overflow	ZDM	S27 22'37.27"	E31 36'41.64"	C3	ACF		
02/12/16	Hans Strydom St 71	Sewer. Line from Businesses	ZDM	S27 22'29.57"	E31 37'12.47"	C3	ACF		
03/12/16	Hans Strydom St 61		ZDM	S27 22'34.35"	E31 37'04.72"	C3	ACF		
04/12/16	Naude Str. Dr v Aardt	Manholes blocked since 30/11/16	ZDM	S27 22'37.07"	E31 36'41.54"	C3	ACF		
05/12/16	B421	Leak still unattended increased in Volume	ZDM	S27 20'56.45"	E31 35'3.68"			2304 to 11232lt /24 Hrs	ABCO
05/12/16	Dirkie Uys Str 145	Water leak. First attemp could not measure	ZDM	S27 22'33.86"	E31 37'30.63"			504	ABCO
05/12/16	Edmond Hess 115	Blocked Sewer	ZDM	S27 22'30.94"	E31 37'39.24"	B2	ACF	Attended 28/05/2017	
05/12/16	Hans Strydom Street 64	Blocked Sewer	ZDM	S27 22'34.41"	E31 37'04.44"	B2	ACF		
05/12/16	Naude Str. Dr v Aardt	Blocked Sewer 2 Manholes	ZDM	S27 22'37.27"	E31 36'41.64"	B2	ACF		
05/12/16	Impala Water Tower	2 Stop Valves Gland packing	ZDM	S27 22'49.92"	E31 36'28.72"			not measured	ACO
07/12/16	B697	EC's could not measure	ZDM					not measured	AC(DI)
07/12/16	B1677	EC's could not measure	ZDM					not measured	AC(DI)
07/12/16	B870	Grey water.Drain spill into street.	ZDM/Owne	S27 21'03.8"	E31 34'39.9"			not measured	ACO

Date	House Number	Description of leak	ZDM / Owner	Location coordinates		Sewer leaks		Potable Water	
						Discription Code	Action code	Loss L/24Hr	Action Code
07/12/16	B872	Grey water.Drain spill into street.	ZDM/Owne	S27 21'04.2"	E31 34'41.4"			not measured	ACO
07/12/16	B421	Old leak reported again	ZDM	S27 20'56.45"	E31 35'3.68"			See 17/10/17	ABC(Dl)
08/12/16	B1696	Babsy and Siyabonga measured	ZDM	S27 20'55.00"	E31 34'27.00"			25920	ABC(Dl)
08/12/16	B1776	Leak at water meter	ZDM/Owne	S27 20'52.5"	E31 34'35.77"			27280	ABCF
08/12/16	B554	Waterleak owner fixed	ZDM					not measured	ACF
12/12/16	B774	EC's could not measure	ZDM					not measured	AC(Dl)
12/12/16	B2592		ZDM					not measured	AC(Dl)
15/12/16	B1776	Still leaking	ZDM/Owne	S27 20'52.5"	E31 34'35.77"			27280	ABCO
20/12/16	B1808		ZDM	S27 21'4.10"	E31 35'0.82'			260	ABCO
21/12/16	Wimpy Pongola	Fixed same day.	ZDM	S27 22'41.41"	E31 36'57.92"	▼	ACF		
03/01/17	B2360 Theo Uitbr	Sump full	ZDM	S27 20'49.83"	E31 35'32.98"	B2	ACF		
03/01/17	B2372	Sewer line blocked	ZDM	S27 20'45.97"	E31 35'29.52"	B2	ACF		
03/01/17	Sewer Blue pipe uPhongolo	High School Sewer Blocked		S27 20'27.36	E31 35'04.27"	B2	ACF		
10/01/17	Junk DIY	Leak already 2 Weeks		S27 22'31.82"	E31 36'47.55"			12950	ABC(Dl)
10/01/17	Edmond Hess 115	First reported 05/12/16	ZDM	S27 22'30.94"	E31 37'39.24"	B2	ACF		
10/01/17	Dirkie Uys Str 145	New leak Left corner of erf	ZDM	S27 22'33.86"	E31 37'30.63"			11880	AC(Dl)
13/01/17	Tortelduif 346/347	Fixed 20/01/2017	ZDM	S27 23'09.41"	E31 37'08.41"			720	**ABC(Dl)**
16/01/17	Tortelduif 346/347	Report. Leaking again	ZDM	S27 23'09.41"	E31 37'08.41"			720	ABC(Dl)
19/01/17	Buzi Store	Sodwana Corridor	ZDM	S27 22'42.26"	E31 36'49.72"	B3	ACF		
19/01/17	Past New Garage	Severe Sewer leak	ZDM	S27 22'42.26"	E31 36'49.72"	C3	ACF		
19/01/17	Buzi Store	Sodwana Corridor Unattended	ZDM	S27 22'42.26"	E31 36'49.72"	B3	ACF		
20/01/17	Sewer Blue pipe uPhongolo	High School Sewer Blocked		S27 20'27.36	E31 35'04.27"	B2	ACF		
20/01/17	A176	Storm water blocked Manhole	ZDM	S27 20'08.63"	E31 34'40.66"	B3	ACF		
20/01/17	Edmond Hess 115	No Progress	ZDM	S27 22'30.94"	E31 37'39.24"	B2	ACF		
20/01/17	Tortelduif 346/347	Fixed	ZDM	S27 23'09.41"	E31 37'08.41"			*	ABC(Dl)
24/01/17	Sewer Blue pipe uPhongolo	Took long to respond	ZDM	S27 20'27.36	E31 35'04.27"	B2	ACF		
30/01/17	Pga City Kwa-Lala	Severe Sewer leak	ZDM	S27 22'41.29"	E31 36'37.02"	C3	ACF		
30/01/17	Klasie Havenga St	Lebombo printers	ZDM	S27 22'32.32"	E31 36'49.67"	C3	ACF		
02/02/17	25/26		ZDM	S27 21'26.11"	E31 34'51.44"			15696	ABCO
02/02/17	B769		ZDM	S27 21'12.68"	E31 35'04.19"			10941	ABC(Dl)
02/02/17	Klasie Havenga St	Lebombo printers Still Overflowing	ZDM	S27 22'32.32"	E31 36'49.67"	C3	ACF		
02/02/17	Pga City Kwa-Lala	Severe Sewer leak Still overflowing	ZDM	S27 22'41.29"	E31 36'37.02"	C3	ACF		
03/02/17	MEETING HEAD OF ZDM PLANNING AND OTHER ZDM OFFICIALS. CONTACTED ENGINEERS ASKED FOR ASBUILD PLANS. URGENT UPGRADE NECESSARY								
03/02/17	Mohammed Trust	Housing Complex vere spilling	Owner Pur	S27 22'34.71"	E31 38'00.01"	C3	ACF		
03/02/17	Entrance Ncotshane	Contractor broke manhole	Municipali	S27 20'55.83"	E31 35'33.66"	C3	ACF fixed 28/02/17		
03/02/17	B1784	Water not from car wash	ZDM	S27 20'53.43"	E31 34'40.54"			720	ABC(Dl)
04/02/17	John's House	Saterday big water leak ZDM Fixed	ZDM	S27 21'06.7"	E31 35'08.5"				
	Manhole Discussed problem with Municipal Technical Director. He got involved. Problem solved the next day								
07/02/17	B755	ZDM fixed big water leak same day	ZDM	S27 21'06.8"	E31 35'01.2"			43200	ABC(Dl)

Date	House Number	Description of leak	ZDM / Owner	Location coordinates		Sewer leaks		Potable Water	
						Discription Code	Action code	Loss L/24Hr	Action Code
07/02/17	25/26 B2691	Reported a few times already	ZDM	S27 21'26.11"	E31 34'51.44"			*	ABCO
07/02/17	B1808	Leaking again	zdm	S27 21'4.10"	E31 35'0.82'			6912	ACO
07/02/17	Mohammed Trust	Spoke to Owner and Agent	Owner	S27 22'34.71"	E31 38'00.01"	C3	ACF		
21/02/17	Edmond Hess 115	Sewer	ZDM	S27 22'30.94"	E31 37'39.24"	B2	ACF		
23/02/17	NG Church Hall	Water pipe leak We fixed with sling	ZDM	S27 22'42.34"	E31 37'35.70"			not measured	ACF
27/02/17	B761	In Street. Johnson phoned. Fix 9/3/17	ZDM	S27 21'9.48"	E31 35'7.79"			48960	ABC(Dl)
01/03/17	25/26 B2691	Report to ZDM Ref. Issue 27015	ZDM	S27 21'26.11"	E31 34'51.44"			*	ABCO
03/03/17	Post Office	Leak again ZDM fixed about 2 weeks ago.	ZDM	S27 22'39.31"	E31 36'56.35"			1440	ABC(Dl)
03/03/17	Telkom Tower	ZDM don't know where stop cock is	ZDM/Owne	S27 22'39.37"	E31 36'55.43"			18000	ABCF(Dl)
08/03/17	Rehobot Shop	Sewer Blocked	ZDM	S27 21'10.94"	E31 35'06.28	B2	ACF		
08/03/17	B1776	Leak after meter	Owner	S27 20'52.50"	E31 34'35.77"			27280	ABC(Dl)
13/03/17	PnP Pongola	Grey water dump into stormwater pipe.	Owner	S27 22'32.30"	E31 36'44.11"	B2	ACF		
14/03/17	B2372	Sewer Blocked	ZDM	S27 20'45.97"	E31 35'29.52"	B1	ACF		
20/03/17	DWS Sump Mnyma Rd	Sump full and overflowing	ZDM	S27 23'11.11"	E31 37'02.71"	C2	ACF		
22/03/17	DWS Sump Mnyma Rd	Sump full and overflowing	ZDM	S27 23'11.11"	E31 37'02.71"	C2	ACF		
27/03/17	B2590	Water pipe leak in street	ZDM	S27 21'13.36"	E31 35'03.09"			14688	ABC(DL
28/03/17	Wimpy	Sewer. Pipe to mainline damaged. Dries sorted out	Owner/Wim	S27 22'41.60"	E31 36'57.11"	B3	ACF		
29/03/17	Gezina Kruger Street 158	Line Blocked Plumbers short drain rods	ZDM	S27 22'36.75"	E31 37'23.59"	A2	ACF		
29/03/17	Rietass	Leak under pavement or paving	ZDM	S27 22'39.24"	E31 36'54.99			not measured	AC(Dl)
31/03/17	A229	Waterleak EC not measured	ZDM					not measured	AC(Dl)
31/03/17	A264	Water leak EC's reported	ZDM					not measured	AC(Dl)
31/03/17	A230	Water leak EC's reported	ZDM					not measured	AC(Dl)
31/03/17	B2354	Water leak EC's reported	ZDM					not measured	AC(Dl)
03/04/17	Sewer Pass Rusta	Sewer directed to stormwater pipe	ZDM	S27 20'47.98"	E31 35'26.60"	C3	ACF		
03/04/17	A300	EC's helped to replace S/Pipe & Tap	Owner					not measured	ACF
03/04/17	A290	Waterleak reported to ZDM	ZDM					not measured	AC(Dl)
03/04/17	A292	Waterleak reported to ZDM	ZDM					not measured	AC(Dl)
03/04/17	A261	Waterleak EC not measured	ZDM					not measured	AC(Dl)
03/04/17	B2403	Waterleak fixed by EC's	Owner					not measured	ACF
12/04/17	B2360 Theo Uitbr	Contractor. Workmanship. Jet Chem 17/5/17	ZDM	S27 20'49.83"	E31 35'32.98"	B3	ACF		
12/04/17	B2362	This line caused a problem from the beginnig	ZDM	S27 20'48.96"	E31 35'32.67"	B3	ACF		
12/04/17	B2363	Despute between ZDM & Munisipality. Mr	ZDM	S27 20'48.04"	E31 35'31.61"	B3	ACF		
12/04/17	B2364	Beukes reported issue to DWS. ZDM on site	ZDM	S27 20'47.64"	E31 35'31.15"	B3	ACF		
12/04/17	B2365	17/05/17	ZDM	S27 20'46.91"	E31 35'30.38"	B3	ACF		
19/04/17	Golf coarse	ZDM Fixed same day	ZDM	S27 22'05.92"	E31 37'01.12"	C3	ACF		
21/04/17	Sewer Pass Rasta	See 3/4/17	ZDM	S27 20'47.98"	E31 35'26.60"	C3	ACO Manhole still to be build		
04/05/17	Honey Sucker out of order since 20/03/2017 Report to ZDM Customer Care Issue 27716						CO		
11/05/17	PGA RCL Ncotshane	Met with delegation from DWS to highlight problems not able to solve							
15/05/17	DWS Sump Mnyma Rd	ZDM Customer care Issue 27838	ZDM	S27 23'11.11"	E31 37'02.71"	C2	ACF		

Date	House Number	Description of leak	ZDM / Owner	Location coordinates		Sewer leaks		Potable Water	
						Discription Code	Action code	Loss L/24Hr	Action Code
15/05/17	B2407	Leaking before meter Issue 27850						not measured	ACO
15/05/17	B2524	Pan handle before meter Issue 27852		S27 21'11.39"	E31 35'12.04"			not measured	ACO
15/05/15	B2523	Meter is leaking Issue 27853		S27 21'11.83"	E31 35'11.45"			not measured	ACO
15/05/17	B2445	Leak after meter owner not at home	Owner	S27 21'12.16"	E31 35'09.35"			57600	ABC(Dl)
16/05/17	to 29/05/17 Jet Chem	Different sewer problem line were pointed out to them and opened up because of our interaction with DWS							
26/05/17	Gezina Kruger Str 160	Serious Blockaged Opened by Jet Chem	**ZDM**	**S27 22'35.32"**	**E31 37'19.91"**	**B2**	**ACF**		
31/05/17	DWS Sump Mnyma Rd	Sump full and overflowing Issue28027	ZDM	S27 23'11.11"	E31 37'02.71"	C2	**ACF**		
31/05/17	Water Police Station	Visited with Mr Dlamini and Marshall Origan unknow will investigate to determine Sewer or Potable Water.						ACO	Test show not
01/06/15	House 750/751	Water leaking at meter Issue 28039	ZDM	S27 21'00.75"	E31 34' 58.49"			not measured	ACO
01/06/17	House B236	Water leaking at meter Issue 28040	ZDM	S27 24'8.20"	E31 38'54.30"			not measured	ACO
02/06/17	C/O Hedmund Hess/Hans Strydom Issue 28047		ZDM	S27 22'23.27"	E31 37'15.39"	C3	ACF	Same day unblocked.	
			Measured potable water loss in liter per 24 hour cycle					887111	Liters

CONGRUENCE THROUGH TRIANGULATION OF THE DEDUCTIVE PROPOSITIONS AND EMPIRICAL EVIDENCE TO ASSESS SUITABILITY OF THE CONCEPTUAL MODEL

APPENDIX H

		Deductive propositions about the conceptual model		What evidence is associated that had been executed	Triangulation for improved congruance: Evidence1 (lit/docs)	Evidence 2 (ext activities)	Evidence 2 (Internal supp)	Concluding congruence confirmation	Challenges/deviation
CONTENT	**Knowledge**	Understands water **system knowledge** base in its variety of forms	H1	Staff qualifications, experience and exposure in various activity disciplines.	Staff qualifications, experience, exposure, using of literature research (weather, w quality, erosion, rivr health).	Sensible liaison and contracting with scientists (R/health, Tholie, D/Agric engin) workshops (wetlands, DUCT, WESSA, NB Stystems).	Board comprehension and support (Imp, Edum, Commdale, Nkamb, Phumel, SCGA)	Yes the agent does understand water systems in its variety of forms. 7 main knowledge domains and 20 disciplines	Reqruitment, freedom to train/grow.
		Different **science disciplines** are being integrated	H2	Different disciplines of work activities; engineering, biological, crop sci, cattle prod, social educat.	Tholie studies, R/health, weather forecasts, irrigation, erosion.	Attract engineering, river health, educators, crop science, CMF	CMF, Dagric, DEA, Irigation, Education.	Yes the agent does intergrate various knowledge diciplines	None
	Knowledge education and awareness	Knowledge is efficiently **transferred** horisontally and vertically	H3	Info dissemination/debate and inhouse training, workshops and community education.	Send snr staff appropriate training, workshop address, farmer association addres	Workshops with role players	Formal board and members meetings	Transfer of relevant knowledge within local role players structures takes place	Determination of level relevance and depth.
		Impacts and risks on humans and natural sytems can be **mitigated** through WRM by a local agent.	H4	Water security octagram, soil erosion focus, flood monitoring, water quality monitoring.	Octagram, water planning, pollution data, erosion data, land use data, community distribution	Drought mitigated prax, workshops and support, PROBA, erosion project.	Enquiries from role players to the agent for knowledge and support	The agent can mitigate impacts and risks	The mitigation does not include agent financed infrastructure development.
	Founding reasoning and insight	A proper process of **reasoning** and insight are exposed in decision-making.	H5	Management Committee debates, workshops, responding to inquiries.	Minuted meeting debates in the Management Committee meetings of Impala	Use and study of literature	Workshops with various stake holders on various MSP	The agent allow and participate in reasoning. Agent is conditioned to "apply" his mind due to high court cases.	Within a functional context and principle of care for future sustainability.
		Freedom for **debate** on values and policy discourse exists.	H6	MC and member meetings, workshops, socio education, SAAFWUA.	Ditto	Ditto	Ditto	The agent allow and participate in reasoning. Agent is conditioned to "apply" his mind due to high court cases.	Within a functional context and principle of care for future sustainability.
		The shift in **interest based water use** against old rights-based use is supported and balanced.	H7	Acceptance of water allocations, support small scale farmers project, mentorships.	Establishment of the small scale farmers project	Promoted the education and mentor support to famers	Selling of commercial famers to workers or communities.	The agent promoted and supported adaption from rights-based water use to interest.	Productive water use and water use and -supply economics
	Change in paradigms	Trade offs for achieving **social objectives** are made.	H8	Small scale farmers project, mentorships for communal farms.	Ditto	Ditto	Sustainable provision from Bivane Dam	The agent promoted and implemented trade-offs to achieve social objectives.	
		Proper depth and width of **stakeholders** are engaged.	H9	Management Committee compilation, CMF participation, IAP workshops, community liaisons.	Constitution of the agent.	Community schools education	IAP and relevant role players regarding water security risks.	The agent engage with an significant range of role players.	Bridging gaps that exist in other institutions. Hindered by cumbersom decision authorisation in gov departments.

		Deductive propositions about the conceptual model		What evidence is associated that had been executed	Triangulation for improved congruance			Concluding congruence confirmation	Challenges/deviation
					Evidence1 (lit/docs)	Evidence 2 (ext activities)	Evidence 2 (Internal supp)		
ORGANISATION	**Infrastructure care**	Appropriate engineering works development and maintenance are done.	H10	Bivane Dam, canal network.	Construction and upkeep of civil canal and weir infrastructure.	Upgrading and care of monitoring instrumentatation and exuipment	Construction of Bivane Dam of 115 mill cub m capacity at a cost of R 150 miil.	Proper applicable engineering development and care takes place.	At this point this excludes devlopment on the catchment scale due to authority jurisdictions and finances.
	Acceptance of responsibilty	Responsibility and authority are accepted, implemented and monitored?	H11	Business plan, Water security project, EC project.	Business plan, meeting minutes.	Physical involvement in catchment WRM activities	Liaison with role players	The agent accepts responsibility and implements more than its primary functions	Staff and leadership dependent
	Authority	Proper legitimate regulations and agreements for WRM are in place?	H12	Litigation cases, Due diligence investigation, annual audit.	Business plan Impala, Business Plan WRM project.	Constitution of Impala WUA and delegations.	Minutes of Board meetings.	The agent has legitemate authority. Proper regulations and guiding planning documents in place	Uncertainty through actions by DWS and DMR
	Financial viability	Revenue is raised, properly controlled and used for its purpose?	H13	Water use charges, machine hire, Nedbank Green Trust funding.	Pricing strategy of DWS	Water use charges, internal and external auditing.	Project funding through suitable donors	The agent has acces to funding and is properly controled	The NWA does provide for WRM funding. However aimed for CMA's. Reimbursement or direct funding not tested.
IMPLEMENTATION	**Water security risks**	The likelihood and impacts of risks on the humans and systems in the catchment are interpreted and mitigated.	H14	Drought mitigation, water quality	Water management in the irrigation system, water quality monitoring.	Bivane Dam water supply management	Liaison with ZDM, the polluting and concerned role players in the catchment.	The agent execute monitoring and interpretation of impacts and risks.	Wider WRM action funding needed (staff, erosion, measuring weirs, weather stations)
	Infrastructure care	Engineered infrastructure development, maintenance and monitoring is efficiently done.	H15	Bivane Dam, canal network, monitoring equipment.	Bivane Dam	Internal infrastructure development and maintenance	Monitor system investment, maintenance and upgrades	The agent invests in civil and electronic infra structure for water system management and monitoring.	Wider WRM action funding needed (staff, erosion, measuring weirs, weather stations)
	CME	Efficient monitoring, compliance and enforcement take place in the catchment.	H16	Water use, land use, erosion, pollution, infrastructure.	Board meeting minutes	Legal actions against water theft (Pgla) and pollution (Rasiti, RCL)	DWS (plantations, crocs) and DEA (bottle and mining) actions	Efficient CME is executed and relevant role playersare involved.	Agent has authority. Being undermined by slow hesitant action from Gov Dep.
	Dispute resolution	Proper conflict prevention and dispute resolution are executed.	H17	Workshops, councilling.	Board councilling with concerned role players	Workshops and specific meetings (Nkambule, eDumbe, DEA Ward meetings)	Legal support and mediation (Water theft Pgla, Hoshoza, Pen		Exhausting process to prevent court cases

APPENDIX I

SPECIFIC SEMI STRUCTURED INTERVIEWS AND WORKSHOP DISCUSSIONS CARRIED OUT

INDIVIDUALS

	Name	Designation	Date	Venue / Location
I1	Dr A. Turton	Scientist	15-Apr-2015	Office in Krugersdorp
I2	Prof M. Muller	Former DG of DWS and scientist	23-Jul-2015	Office at WITS
I3	Dr M. du Plessis	CEO of WWF-SA	23-Nov-2015	Office in Cape Town
I4	Me T. Frantz	Manager Environmental - WWF	24-Nov-2015	Office Cape Town
I5	Dr. M. Graham	GroundTruth	21-Oct-2015	Telephonic conversation.
I6	Me. . Taylor	DUCT	5-7 May 2015	DUCT offices in Howick.
I7	Me. K. Mahood	GroundTRuth and i4Water	3-4 March 2017	Impala offices in Pongola
I8	Mr. V. Koopman	WWF-SA	19-20 Sep 2016	Information tour Midlands KZN.
I9	Mr. J. Reddy	Act CEO Pongola Umzimkulu CMA	14-Nov-2016	Office DWS Durban
I10	Mr. W. Enright	Former DWS Engineer, Water Consultant	24-Nov-2015	Office Cape Town
I11	Mr. L. Bruwer	CEO Central Breede WUA	23-Nov-2015	Office Robertson
I12	Mr. A. Labushagne	CEO Sandvet WUA, Chairman SAAFWUA	27-Mar-2017	EuroPrime Hotel, Boksburg
I13	Mr. H. du Toit	CEO OranjeRiet WUA	22-Sep-2017	New National Lodge, Cape Town
I14	Mr. B. Dhulwayo	CEO Vaalharts	27-Mar-2017	EuroPrime Hotel, Boksburg
I15	Mr. N. Fourie	CEO Hartbeespoortdam WUA	7-Dec-2017	Outlook Lodge, ORTambo.
I16	Mr. J. van Stryp	CEO Loskop Irrigation Board	22-Sep-2017	New National Lodge, Cape Town
I17	Mr. N. Knoetze	CEO SAAFWUA	21-Jul-2015	Office Jacobsdal
I18	Mr. B. Hambrock	Chairman - Nkambule Farmers Association	7-Apr-2017	Office Pine Cone Piggeries
I19	Mr. R. Niebuhr	Chairman - eDumbe Agri Centre	8-Jan-2016	eDumbe AgriCenter Paulpietersburg
I20	Mr. K. Hinze	Secretary - Commondale Farmers Association	4-Apr-2016	Augsburg Church Hall, Commondale

WORKSHOPS AND GROUP DISCUSSIONS

I21	SAAFWUA	Roadmap Task team	21-22 Jul 2015	SAAFWUA office Jacobsdal
I22		Strategic Task Team session	6-7 Feb 2017	EuroPrime Hotel, Boksburg
I23		Strategic Task Team session	22-Mar-17	Greenside Nursery, Bloemfontein
I24		Strategic Task Team session	27-Mar-17	EuroPrime Hotel, Boksburg
I25		Strategic Task Team session	19-Apr-17	EuroPrime Hotel, Boksburg
I26	SAAFWUA	Management Committee meeting	21-May-2014	Ons Tuiste, Belville Cape Town.
I27		Management Committee meeting	18-Aug-2015	City Lodge OR Tambo.
I28		Management Committee meeting	5-Oct-2016	Damas Guesthouse, Worcester.
I29		Management Committee meeting	22-Sep-2016	Ons Tuiste, Belville Cape Town.
I30		Management Committee meeting	4-Oct-2017	New National Lodge, Cape Town.
I31		Management Committee meeting	7-Dec-2017	Outlook Lodge, ORTambo.

APPENDIX J

Photos and graphic illustrations of various WRM activities executed during the project.

Water resources and river health assessment.

Photo 1: Me Petro van Jaarsveld (aquatic and ecological scientist) and colleague Mattie Beukes in process with the river health and ecosystem assessments.

Photo 2: The author and colleague Mattie Beukes with three Technikon students executing a river assessment.

Photo 3: The difficulty in some areas of taking water samples in the river systems

Pongola River through the irrigation scheme: water salinity hazard classification in terms of the Sodium Absorption Ratio and the electrical conductivity (mS/m)

	SAR		EC mS/m		Salinity Classification	
	Sep '10	Sep '16	Sep '10	Sep '16	Sep '10	Sep '16
P1:- Grootdraai weir	0.52	0.47	13	14.54	C1S1	C1S1
P2:- Rouillard bridge	2.1	3.83	42.3	115.5	C2S1	C3S1
P3:- ZDM Pump station	4.1	4.45	99.4	130.2	C3S1	C3S1
P4:- Mill pump station	2.1	4.01	42.6	114.9	C2S1	C3S1
P5:- Nqumile bridge	2.3	3.63	51	113.2	C2S1	C3S1
P6:- Rietspruit inflow	2.6	3.94	46.6	86.3	C2S1	C3S1
P8:- Mhlati weir	2.5	4.35	47.7	116.3	C2S1	C3S1

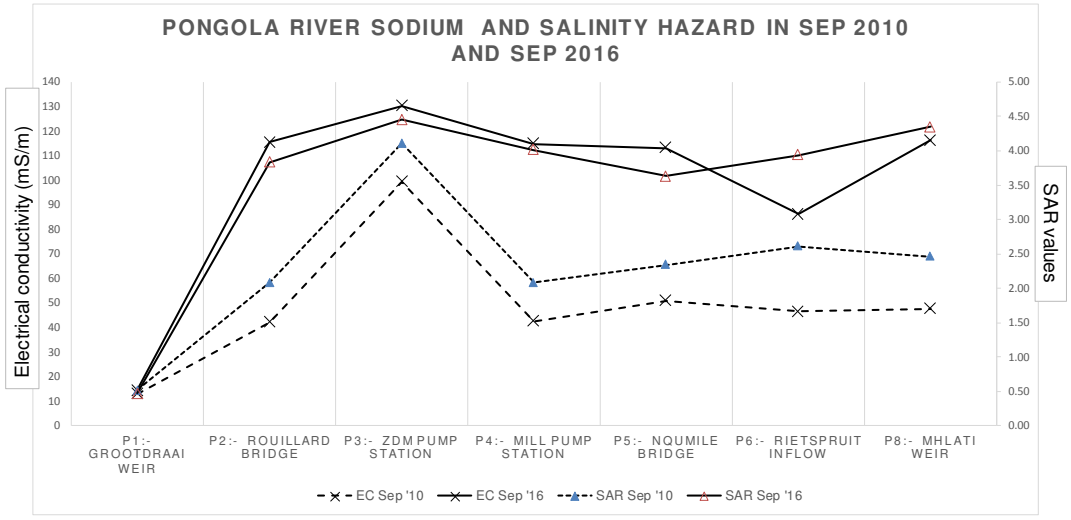

Figure 1: A graph indicating the variation in the river salinity and sodium content at various sampling points over the river course through the Pongola irrigation scheme.

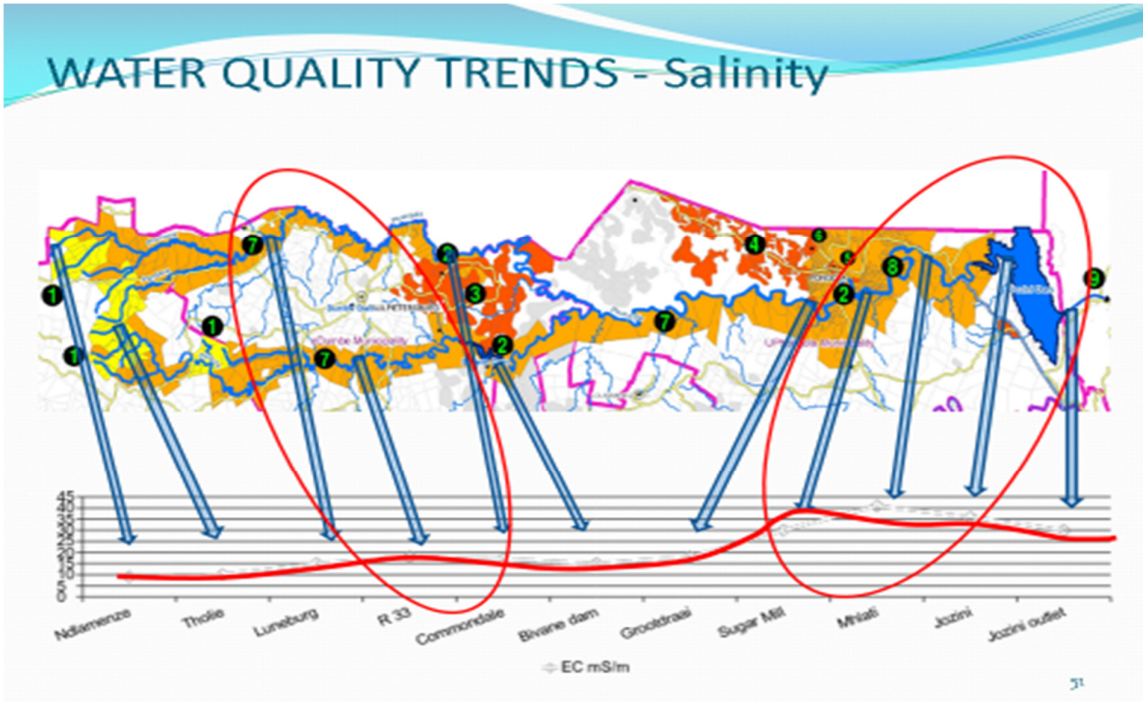

Figure 2: An indication of different water sampling points across the catchment, showing the increasing salinity trend through the river course from the headwaters (left) to the outflow of the Pongolapoort dam (right).

Effluent and waste threatening the water resource.

Photo 4: Heavy pollution of the Pandaan River because of poor waste management of high intensive piggeries.

Photo 5: Effluent from the sugar mill factory running in the Rietspruit at Pongola.

Photos 6a and 6b: Domestic waste dumping on the banks of the river and into a natural water course.

Mining activities in the headwaters.

Photo 7: Mining sediment flowing from the Makateeskop abandoned mine into a small river that cannot be used for either domestic water or cattle drinking.

Photo 8: Clearing up of abandoned coal stockpiles at the Kempslust abandoned mine which were found to be of suitable quality for sale.

Photos 9a and 9b: Participation in public consultation meetings of coal mining applicants for prospecting on the farm Pivaanspoort, affecting the Bivane River and the farm Holkrans affecting the Bivane and Manzaan Rivers.

Photo 10: Open cast excavation of a coal mine that obtained a mining permit without a proper procedure and without the knowledge of interested and affected people in the area.

Land use and practices.

Photos 11a and 11b: The author during an area visit with senior personnel of the KZN Department of Agriculture for an application for funding of a project to address large scale soil erosion.

Table 68: Photographs of other features at REMP site 025 [W4PAND-COMDS]

Other features	
	
Wattle infestation (Photo 052)	Recent fire in riparian zone (Photo 067)
	
Erosion of banks (Photo 081)	Erosion of banks due to wattle (Photo 075)

Photos 12a to d: Wide spread distribution of wattle along water courses in the headwaters is very common (Van Jaarsveld, 2016:73)

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Photo 13: A presentation during the 2017 bi-annual "Journey of Water" tour of WWF-SA at a site of extreme erosion.

Photo 14: Large silt volumes excavated annually from the canal systems due to increasing erosion in the upstream catchment.

Photo 15: Large scale eradication of naturally occurring acacia trees by local population contracted by the KZN Department of Agriculture.

Education and awareness.

Photos 16a and 16b: Awareness education and tree planting projects at local schools.

Photo 17: Assistance to a local resident in his efforts to run a recycling business in the town of Ncotshane.

Photos 18a and 18b: Potable water leak measuring and sewer leak detection by the EnviroChamps in the towns of Pongola and Ncotshane; these leaks affect the natural water courses.

Photo 19: An EnviroChamp during an interview with a local radio station regarding environmental and water awareness and care.

Photo 20: Training on soil types and susceptibility to soil erosion.

Photo 21: An indication of poor management at the potable Water Treatment Plant in Pongola. During the severe 2015 drought, the plant manager decided to dig trenches alongside the water reservoirs to release excess water from the holding reservoir instead of closing the inlet sluices.

Photo 22: An indication of poor management at sewer system infrastructures in Pongola. Children are playing around an open sewer mainline manhole.