The concept of shared risk in public and private sector water security: a case study of Grabouw and the Elgin Valley, Western Cape, South Africa

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Abstract

This thesis investigates water risk in small- to medium-sized agro-processing companies and the public sector. Global interest in water management from the private sector has led to an increase in the development of water risk tools that are available to companies. Not only has the number of tools increased, but also the quality and form of these tools has been refined. Water risks are complex and extensive, and cannot be managed alone. Private sector interest in partnership and collaboration with other actors in managing water risk has increased as a result. The principal aim of this thesis is to investigate and explain the idea of shared water risk, using an adaptive theory process within a case study to investigate the understanding and knowledge of water risks among public and private actors. The study is informed by an assumption that if private and public interests are aware of the collective risks within a catchment, then sustainability of those business enterprises and public services, along with the protection and conservation of water resources may be possible. The case study is located in Grabouw and the Elgin Valley in the Theewaterskloof Local Municipality, Western Cape, South Africa. Private sector actors include agro-processing industries in the region, while the public sector includes local municipality officials and water resources management institutions such as the Catchment Management Agency and the Water Users Association. A conceptual framework of water risk and a sharing typology was developed from an analysis of interviews and the use of secondary sources of documents on the hydrology and socio-economic information on the catchment. The conceptual framework identifies the different water risks of the private and public sector, while the sharing typology indicates the progression of knowledge and understanding of private and public sector water risks, recognising that sharing does not take place in a single form. The framework and the typology together are intended to integrate an understanding of the theory and empirical data. Refinement of the framework and typology found that shared risk is especially pertinent in situations where systemic water risks affect the management of water and where that risk cannot be managed by individual companies or public sector authorities alone. The conceptual framework and typology identify the private and public sector exposure to risks, enabling actors to understand the scale and form of the respective risks in each sector. Where risks are not shared, the process of investigating the knowledge and understanding of risks helps to identify the complexity of the system. Contributions of this thesis include the use of risk as a common language to help bring together diverse sectors, especially when participatory decision-making is required. Not only the technical aspects of water supply and sanitation, but the wider social and environmental factors need to be considered as well. Understanding water security as a risk enables a wider and more diverse stakeholder group. The thesis concludes that collaboration and adaptive management need to be informed by knowledge and understanding of the complexity of risks within the catchment by multiple stakeholders.

Keywords: water risks, public and private sector, shared water risks, adaptive management

Contents

List of Figures

List of Tables

Abbreviations and Acronyms

2030 WRG	2030 Water Resources Group
AIRMIC	Association of Insurance and Risk Managers
ALARM	The Public Risk Management Association
AWS	Alliance for Water Stewardship
BEE	Black Economic Empowerment
BOCMA	Breede Overberg Catchment Management Area
CDP	Carbon Disclosure Project
CMA	Catchment Management Area
CMP	Catchment Management Plan
CMS	Catchment Management Strategy
CoCT	City of Cape Town
DBSA	Development Bank of Southern Africa
DEG	Deutsche Investitions und Entwicklungsgesellschaft mbH
DWA	Department of Water Affairs
DWA RO	Department of Water Affairs Regional Office
ERM	Enterprise Risk Management
EWR	Environmental Water Reserve
FP	Fruit Processor
GEMI	Global Environmental Management Initiative
GWP	Global Water Partnership
GWUA	Groenland Water Users Association
HACCP	Hazard and Critical Control Point Analysis
IDP	Integrated Development Plan
IFC	International Finance Corporation
IRGC	International Risk Governance Council
IRM	Institute of Risk Management
IWA	International Water Association
IWRM	Integrated Water Resources Management
KPA	Key Performance Areas

MAR	Mean Annual Runoff
MNC	Multi-national Corporations
NGO	Non-Governmental Organisation
NRM	Natural Resources Management
NWRS	National Water Resources Strategy
SANS	South African National Standards
SERM	Sustainable Enterprise Risk Management
SME	Small- to Medium-sized Enterprise
SWPN	Strategic Water Partners Network
TWK	Theewaterskloof Local Municipality
UN	United Nations
UN SEEAW	United Nations System for Environmental-Economic Accounts for Water
UNEP FI	United National Environment Programme Finance Initiative
WBCSD	World Business Council for Sustainable Development
WEF	World Economic Forum
WFN	Water Footprint Network
WFP	Water Futures Partnership
WHO	World Health Organisation
WMA	Water Management Area
WRG	Water Resources Group
WRM	Water Resources Management
WSA	Water Services Authority
WSP	Water Safety Plan
WTW	Water Treatment Works
WUA	Water Users Association
WWTW	Wastewater Treatment Works

Plagiarism Declaration

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There is no better way to know and understand the process of 'sharing' than going through the PhD process. A PhD is a collaborative process to say the least and this one in particular could not have been developed, researched or written without the support of many.

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Chapter 1: Introduction

In 2013, the World Economic Forum (WEF) Eighth Global Risks Report postulated that water security risk ranked among the top five global concerns (WEF, 2013). In the following year the Ninth Global Risks Report ranked water crises as the third highest risk globally (WEF, 2014). Water security is described broadly by some authors as a tolerable level of water risk at any scale and for any actor (Cook and Bakker, 2012; Grey and Garrick, 2012; Hope et al., 2012). It is also described more narrowly by the Global Water Partnership (GWP) as "access to enough safe water at affordable cost to lead a clean, healthy and productive life, while ensuring that the natural environment is protected and enhanced" (GWP, 2012: p.2). Nearly 80% of the world's population is impacted by the threat of water insecurity (Vörösmarty et al., 2010). In developed nations this threat is addressed through investment in water infrastructure, but less wealthy nations remain water insecure because of financial constraints (Smakhtin et al., 2004; Vörösmarty et al., 2010).

Water risks go well beyond the tap and water supply, affecting environmental health, social welfare, economic growth and development (Rayner et al., 2005; Pollard et al., 2007). The inter-connectedness and complexity of water risk, necessitates the integration of both technical and social concepts of risk. The measurement, and therefore management of risk is made further complex as risks vary in different situations and contexts (Giles et al., 2010). This thesis explores these complexities within and between the public and private sector. Private companies are often explicit in managing their water and associated risks (Orr et al., 2011), whereas the public sector (in certain instances) is reluctant to communicate the risks they face to the public (Pollard et al., 2004). Risk is a useful concept in this regard, as it is able to capture the attention of both the private and public sectors, albeit with a different focus. The different perceptions of risk make collaborative governance difficult.

South Africa is a semi-arid country with an average rainfall of 450 mm per annum, far below the global average of 860 mm per annum (CSIR, 2010). In 2005, more than 95% of the country's freshwater resources were already allocated to various land-uses and socio-economic activities (CSIR, 2010). In a report entitled "Charting Our Water Future", the Water Resources Group 2030 (2030 WRG) investigated the costs and trade-offs of different water augmentation solutions (WRG 2030, 2009). The report predicts that water supply in South Africa will need to increase from the current 15 billion m^3 to 17.7 billion m^3 in 2030 in order to meet the needs of an increasing population. Although the method of determining this figure has been challenged (Hepworth, 2012; Newborne and Mason, 2012; Mason, 2013), the message is clear: South Africa faces a water demand deficit which in the near future will be too expensive to close (WRG 2030, 2009; CDP South Africa, 2011).

Water insecurity in South Africa is recognised repeatedly in the White Paper on a National Water Policy for South Africa (DWA, 1997a). Furthermore, according to the National Water Resources Strategy (NWRS 2), there are concerns that the socio-economic growth of South Africa may be

"restricted if water security, resource quality and associated water management issues are not resolved in time" (DWA, 2013a: 1). Inadequate social and economic development due to water risk cannot be managed by government alone. However, Muller et al. (2009) are cautious about positioning South Africa in a "water crisis". They suggest there is sufficient water until 2025 to meet social and development needs, but recognise that some regions are constrained through insufficient water to meet developmental needs and aspirations in these affected parts. For example, in the Western Cape province of South Africa, three of the four Water Management Areas (WMAs) show a deficit between the average annual water demand and supply (Western Cape Government, 2011).

Some private sector companies in South Africa have begun to recognise the risks of an insecure water future, and are intervening accordingly at an operational and catchment scale. These risks may range from an insecure water supply to fears around water quality. Evidence of the business interest in water risks includes the Carbon Disclosure Project (CDP) Reports on South Africa (2011; 2012) and cases such as Sasol, Anglo American and SAB mitigating risks that they face at a catchment level (SABMiller et al., 2010; 2011; 2012 and Greenwood et al., 2012).

1.1.1 Integrated transdisciplinary water resources management

In order to mitigate the challenges and risks associated with water security, water resources need to be managed and governed appropriately. Water resources governance includes the range of political, social, economic and administrative systems which are in place to manage water resources. The management of water resources includes the development and delivery of water services and resources at different levels of society (Rogers and Hall, 2003). Water cannot be managed in isolation from other natural resources, and therefore necessitates an integrated, trans-disciplinary approach (Ganoulis, 2004; Mollinga, 2008; Pahl-Wostl et al., 2011).

Water management is complex because it is part of a larger socio-ecological system (Mollinga, 2008; Pollard and Du Toit, 2008; Ostrom, 2009; 2010; Pahl-Wostl et al., 2012). The multiple actors and sectors required to manage the resource add to the complexity of water resources management. This is supported by the recognition that "water management regimes are evolving in response to a growing emphasis on ecological values, meeting basic human needs, and re-evaluating the ties between economic growth and water use" (Taylor et al., 2012: 42). It is largely for these reasons that Orr et al. (2009) stress that with increasing water risks, it is necessary to improve the management of water, while other commentators take this further in suggesting that water scarcity is due to a "governance crisis, not a resource crisis" (Rogers, 2004; Pahl-Wostl et al., 2011). Therefore there is growing support for improved water resources governance to address a complex array of water risks (Mollinga, 2008; Ostrom, 2009; Pahl-Wostl et al., 2011) which involves technical solutions as well as social considerations that are critical to both sustainable and equitable water resource management (Ganoulis, 2004; Pahl-Wostl et al., 2011; Taylor et al., 2012).

Effective governance includes participation and involvement of multiple sectors of society (IRGC, 2007; Hardy, 2010; Pahl-Wostl et al., 2011; Van Asselt and Renn, 2011; WWAP, 2012). Moreover, and pertinent to this study, Pahl-Wostl (2009) claims that water resource management is optimised when "state and non-state actors" are involved. The inclusion of multiple actors in water management is assumed to be especially important in situations where data and knowledge are contested (Van Asselt and Renn, 2011).

1.1.2 The concept of risk in water resources management

In this thesis, "risk offers a unifying framework to link across multiple water security challenges" (Hope et al., 2012: 5) and is "central to our thinking about water security" Hall (2012: 1). Risk is a useful concept for considering a wide range of factors for specific responses in risk mitigation (IFC, 2011; Hope et al., 2012; Sarni, 2012). The discourse of risk gives critical insight into how water security and insecurity is managed within the interests of the public and private sector.

Risks incorporate technical as well as social aspects of knowledge that are derived from a range of actors (Renn, 2008b). Public and private actor participation in risk identification achieves a multi-sector perspective by combining different value judgements and technical information relevant to the context. The combination of technical risk information, in addiempirtion to socially framed risk perspectives, gives insight and understanding of the collective nature of the risks in the public and private sector (McDaniels et al., 1999; Holford, 2009). In this thesis, water risk is understood broadly as any negative impact of water insecurity, whether quantity or quality, affecting private or public actors within a catchment through physical, regulatory or reputational impacts. The integration of technical and social concepts of water risk are considered, while at the same time acknowledging that water risks vary in different situations and contexts, and therefore are difficult to measure and manage, and to find solutions (Giles et al., 2010). For example, an engineer will present technical solutions such as improving technology efficiency in water stressed conditions. A social scientist however, will consider the "problem as rooted within the perceptions of individuals and perhaps a lack of awareness or concern resulting from declining water resources" (Pahl-Wostl et al., 2011: 853).

1.1.3 The private sector response to water risks

Recent reports highlight the growing interest of the private sector in seeking collective solutions to managing water risks, whether in supplying water or in dealing with pollution (Orr et al., 2009; Morrison et al., 2010; SAB, GTZ and WWF, 2010; Greenwood et al., 2013). Large Multi-National Companies (MNCs) (particularly in the northern hemisphere) are taking note and are responding to compelling humanitarian and business reasons to address water issues (Wharton, 2011; Sojamo and Larson, 2012). In some instances, this means working together with government in formulating new water policies (Barton et al., 2011; CDP, 2011; Hepworth, 2012; Orr et al., 2009). In other initiatives, such as in the Carbon Disclosure Project (CDP), the Global 500 companies list "assessment,

management and mitigation of water-related risks as the main drivers for collective action" (CDP, 2012: 5). In 2012, 53% of the CDP respondents reported that water-related issues had financially impacted their businesses over the past five years (CDP, 2012).

This brings the discussion to the idea of 'shared risk' which is central to this thesis. The idea has been used by a growing number of authors in business, such as Pegram et al. (2009); Morrison et al. (2010); Pegram, (2010); Hepworth et al. (2011); WWF (2011) and Hepworth, (2012). These and other authors suggest that the idea could be extended to develop opportunities for the private and public sector to cooperate effectively and manage water resources sustainably (Pegram et al., 2009; Morrison et al., 2010), yet the concept of 'shared' in water resource management remains ill-defined. Hepworth (2012: 544) explains that shared water risk is about a "common pool resource dilemma," whereby "degraded and depleted water resources and inadequate supply have impacts across society". In other words, sharing the risks also means sharing the impacts caused by the deterioration of a resource.

Awareness of resource deterioration without any effort to address the problem is unacceptable. This is one reason why it is in the interest of the public and private sector to work together to address the many and varied 'wicked' problems that are associated with water (Pegram et al., 2009; Orr et al., 2009; Morrison et al., 2010; Hepworth, 2012). Issues are characterised by Carley and Christie (2000:156) as 'wicked' by: a) uncertainty; b) inconsistency of needs, preferences and values; c) "an unclear sense of all consequences and/or cumulative impact of collective action"; and d) "fluid, heterogeneous, pluralistic participation in problem definition and solving". In order to address wicked issues, Turnpenny et al. (2009) acknowledge the value of multi-stakeholder participation in decision-making, knowledge review and feedback.

1.1.4 Perceptions of water risks

Water risks in the public and private sectors are experienced or perceived differently (Slovic, 1987; Larson et al., 2009). Private companies, for example, are often explicit in managing their water and associated risks (Orr et al., 2011) because risk management is an integral part of the corporate business culture. In contrast, the public sector in certain instances is more risk averse and reluctant to communicate the risk to the public (Pollard et al., 2004). Dobbie and Brown (2014: 294) claim that "there has been very little examination of the role of these risk perceptions in advancing more sustainable water supply management through the adoption of alternative sources". As a result, empirical analyses of these differences or similarities, particularly between the public and private sector, are not well known (Orr et al., 2009; Pegram et al., 2009; Morrison et al., 2010; and Hepworth, 2012). Understanding of the different perception of risk associated with diverse actors is an important step towards better understanding the problems being faced, and the potential solutions to solve them (Slovic, 1987).

1.2 Rationale for the research

Recent interest by the private sector in 'engaging outside the factory fence' to manage their water risks has led to the development of the idea of shared water risk which is now widely used by large corporates and consultancies (Daniel and Sojamo, 2012; Sojamo and Larson, 2012; Gardiner, 2014), however it has not been interrogated sufficiently. Empirically based research is required to develop the concept further by examining and comparing private and public sector perspectives of water risk and to establish support for the idea in an academic discourse (Sartori, 1991).

Research and publications on private sector water risk have mainly considered cases of MNCs with large reputational concerns (CDP, 2009; 2010; Pegram and Eaglin, 2011; Greenwood et al., 2012; Sojamo and Larson, 2012). However, the risks of water scarcity in Small to Medium-sized Enterprises (SMEs) are less well known or publicised in comparison to MNCs (Sojamo and Larson, 2012; Hepworth, 2012). This research focuses on small to medium-sized agro-processing industries within the private sector that are confronted with distinctive risks relating to their scale, operations and dependence on water. This study examines agro-processing companies as the unit of study within a drainage basin (Sojamo and Larson, 2012). Agro-processing companies are heavily dependent on adequate quantity and quality of water resources (WEF, 2009; SAB, GIZ and WWF, 2011; Sojamo and Larson, 2012). The rationale for selecting small to medium-sized agro-processing industries is also because they are situated within a single catchment and therefore share water risks within a single catchment. The public sector interests in the case study are represented by three forms of organisation, namely the Catchment Management Agency (CMA), Water Users Association (WUA) and local municipality.

The principal aim of this study is to investigate and explain the idea of shared water risk. The study is informed by an assumption that if private and public interest are collectively informed by risks that confront their business and operations within a catchment, then it might also be possible to ensure the sustainability of those business enterprises and public services, along with the protection and conservation of water resources. Therefore, research is required to examine the knowledge and understanding of risk within the public and private sectors to develop an empirically based understanding of shared water risk. In so doing, the study will use an adaptive theory approach to gather evidence through interviews and contextual analysis to formulate a deductive understanding of shared water risk.

1.3 Research questions

The research questions are based on the premise that water insecurity is a risk experienced by both the private and public sectors at different orders of magnitude. The research questions are separated into three distinct elements which coincide with the three core contributions of the thesis. The research questions are:

1. *What is the knowledge and understanding of water risks within and between the public and private sectors within a single catchment?*

2. How does the knowledge and understanding of public and private sector water risks help to map and understand shared water risks in a catchment?

3. How do the public and private sectors respond to shared water risk?

Aim and Objectives

The aim of this thesis is to understand, identify and characterise the different and similar water risks within and between the private and public sector actors. A framework communicating the different risks is developed in addition to a typology that describes the progression of knowledge and understanding in the sharing of risks. A further aim of the thesis is to refine the framework and shared risk typology. These aims are achieved through the following six objectives:

- To examine current literature on water risk and water resources governance in addition to private and public sector perceptions of risk and risk sharing and collaboration to inform the adaptive theory process.
- To understand the hydrological and socio-economic context of the case study.
- To identify and analyse water risks confronting the private and public sector in the study area.
- To develop a conceptual understanding of: 1) the private and public sector water risk, 2) the relationship between the water risks and the scale at which these risks are observed.
- To develop a classification scheme to expand the idea of shared water risk, and to place the knowledge and understanding of risk within a topology of shared water risk.
- To review and refine the conceptual framework from interviews with stakeholders.

1.4 Demarcation of the study area

The case study region for this research is the town of Grabouw and the surrounding Elgin Valley. This is situated in the Palmiet River Catchment found within the Theewaterskloof Local Municipality (TWK), Western Cape, as shown in Figure 1 below. The region is part of the Breede Water Management Area, which is managed by the Breede–Overberg Catchment Management Agency (BOCMA). The catchment is one of the only in the country with a functioning Catchment

Management Agency (CMA) and Water Users Association (WUA). The region was also chosen due to the large number of agro-processing companies situated within the area.

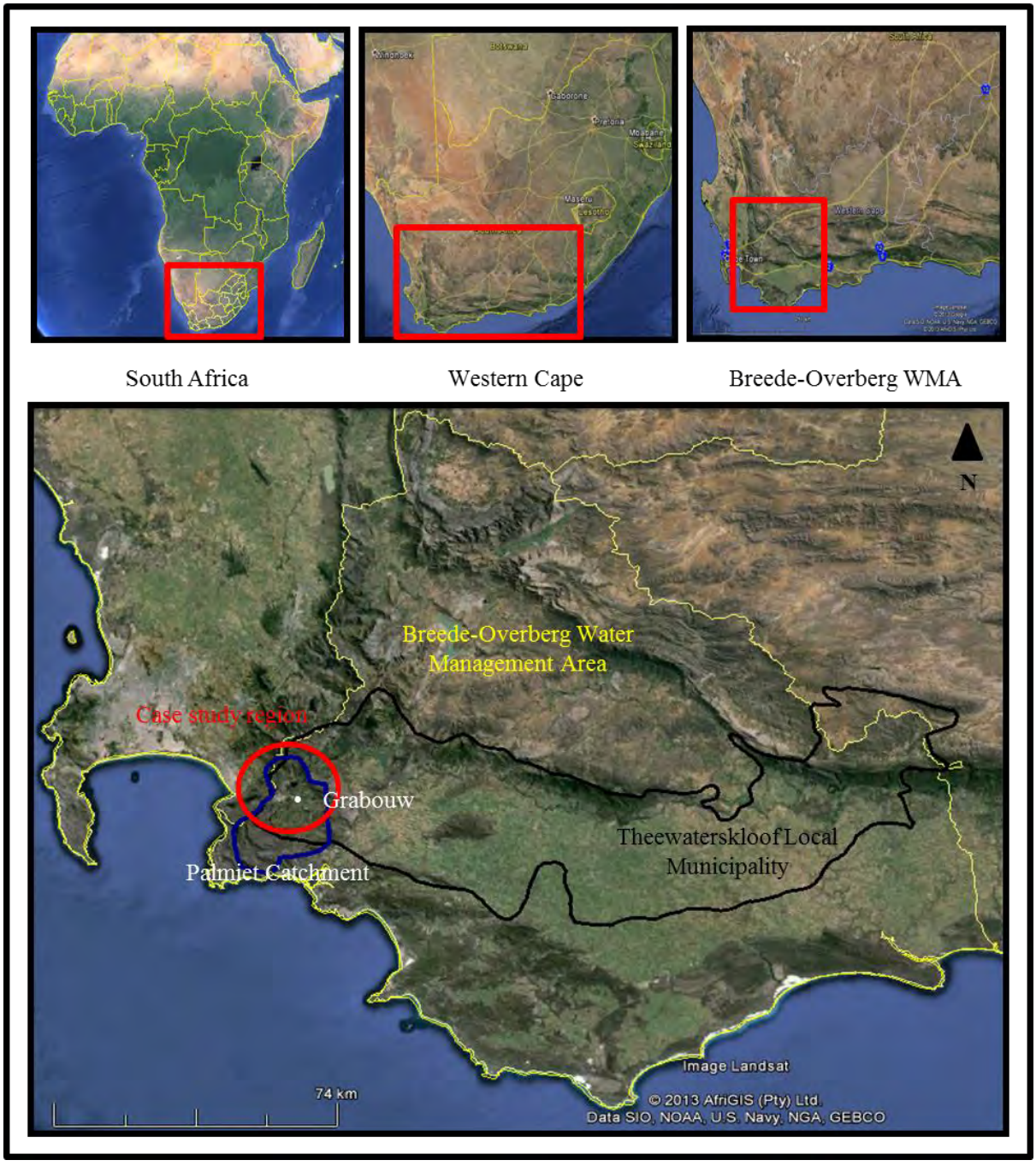

Figure 1: Case study region with relevant administrative and hydrological boundaries indicated (Adapted from AfriGIS, 2013)

The economy of the Theewaterskloof region is almost 50% agrarian, which includes the agro-processing activities in the region. The focus of the research is centred on the town of Grabouw and

the surrounding Elgin Valley, the largest economic centre of the Theewaterskloof Municipality (TWK, 2011b). The area is not theoretically water-stressed as it has a relatively high annual rainfall between 1000 and 1500 mm/annum (Paxton and Ractliffe, 2010). However, water resources are in high demand, including competition for water which supplies the Greater Cape Town municipality, and strict environmental requirements for the Kogelberg Biosphere and the Palmiet estuary reserves. These competing water users increase the complexity of risks facing public and private sector water supply in the region, especially in considering the impact of future population, economic development and climate change in the region.

In this research, small to medium-sized agro-processing companies were selected as the private sector representatives. The food and beverage sector is especially vulnerable to water stress because of its dependency on agricultural produce in the supply chain (Levinson et al., 2008; Pegram et al., 2009; WEF, 2009; Sojamo and Larson, 2012). The public sector includes the local Theewaterskloof Municipality (TWK), the Breede-Overberg Catchment Management Agency (BOCMA) and Groenland Water Users Association (GWUA). These institutions have different levels of multi-sector representation, and are therefore not uniform, but all serve towards a collective public good (Hardy, 2010).

1.5 Methodology

An adaptive theory and case study approach are used to guide the study design which is discussed in more detail in Chapter 3. The phrase 'adaptive theory' refers to theory developed from empirical data (i.e. case study) research and literature (Layder, 1998). It is a form of inductive reasoning where evidence is gathered from interviews and literature to build theory. Adaptive theory acknowledges that prior research and understanding of some concepts and literature is done prior to collecting empirical data (Straus and Corbin, 1990; Layder, 1998; Charmaz, 2002; Goulding, 2005; Lingard et al., 2008).

The case study methodology is used to investigate water risks within a single catchment. Multiple units of analysis are embedded within the case study region (Yin, 2009: 46). The embedded units of analysis include interviews with a range of public and private sector representatives (inside and outside of the case study region), contextual analysis of the case study region (including institutions and hydrology) and literature analysis of the public and/or private sector water risks. The sub-units enhance insights into the single case, enabling opportunity for extensive investigation and triangulation (Yin, 2009). Public and private sector perspectives of water risk are compared and contrasted to understand how risks may be shared with the aim of developing a theoretical construct of 'shared water risk'.

Using adaptive theory, re-occurring phrases and words collected from the interviews were clustered into key themes. These were compared and contrasted to identify the differences and similarities of risks for the construction of a shared water risk conceptual framework. Interviews were carried out in person using open-ended questions within a semi-structured format. The interview data, literature analysis, and contextual analysis were used to design and inform a conceptual framework. This thesis also introduces a public and private sector sharing typology which was developed to show how knowledge and understanding of shared risk vary according to the manner in which the risks are understood and communicated. A second phase of interviews was used to refine and review the framework and typology (Sartori, 1991).

1.5.1 Limitations and assumptions

The willingness of interviewees to communicate sensitive information during interviews was always going to be limitation of a qualitative study. Consent forms were signed from each respondent prior to these interviews (Appendix A). In order to protect the identities of the interviewee, all companies and institutions were assigned a coding instead of names. These precautions and practices were undertaken in an effort to achieve as full as disclosure as possible. Information was attributed to the companies in the catchment, only where available publically.

Using only one case study may be deemed a limitation (Yin, 2009). However, due to the depth and breadth of information required to investigate water risks, it was felt that a single case study would be more useful precisely because it could identify the unit of analysis clearly and to work towards gathering increasing depth of information. To bolster the case study findings, accounts of other forms of collective action in South Africa between the public and private sector were investigated to identify common attributes of cooperation between sectors.

The International Finance Corporation (IFC, 2011) highlights the difficulty to "quantify and meaningfully analyse water risks and impacts due to a lack of systematic measurement and data". This is especially true in the case of water risks. Data shortages are a drawback in quality-related water risk investigations, whereas differing and changing regulatory and reputational risks limits quantification. Furthermore, the availability of water data may be difficult to trace. Hydrological data may be incomplete or may not include the information required. Alternative data sources, including that of the Department of Water Affairs (DWA), municipalities and the selected industries usually present an incomplete or highly fragmented dataset. This thesis used a mixed methods approach as a result of difficulties in collecting water data and the social and technical nature of water risk. It draws on technical as well as social information to determine water resources and risks within the public and private sector. The triangulation of empirical data and literature collected through interviews and text analysis is used to expand the idea of shared water risk.

1.6 Thesis structure

Figure 2 below indicates the structure of this thesis.

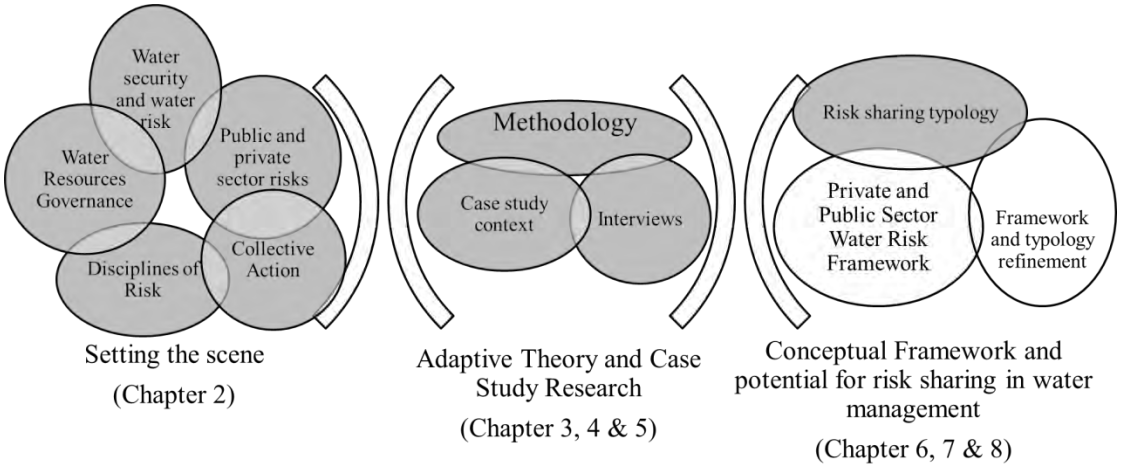

Figure 2: Structure of this thesis

Chapter Two, the literature review, sets the scene. The literature review investigates water resources governance and the different disciplines of risk. Different risk frameworks and tools used by the public and private sector respectively are examined to understand how each sector understands their risks of water insecurity. This is followed by a discussion on collective action and the sharing of water risks.

Chapter Three presents the methodology. The rationale for the research methods is followed by the research design and procedure. A case study method uses adaptive theory as the analytical framework. Interviews are used as the empirical data to expand the concept of shared water risks, while additional literature and data are used to support the findings. Institutional information and data on the socio-economic profile of the case study as well as the hydrology of the region form embedded analyses of the case study.

Chapter Four introduces the hydrological and administrative nature of the Palmiet Catchment. Secondary literature on the catchment area regarding the hydrology and socio-economic context formed the basis of this chapter.

Chapter Five introduces the results from the interviews with public and private sector representatives of the case study region. The case study includes an examination of the socio-economic profile of the region as well as water availability and administration, giving understanding and context to some of the interview responses.

Chapter Six explains the development of the conceptual framework. The case study interview data supported by the context and literature is used to formulate the conceptual understanding of water risks in the private and public sector. The conceptual framework attempts to indicate the differences

and similarities of water risks between the public and private sector. True to adaptive theory, a large number of frameworks and literature are relied upon as a basis for the conceptual framework. The conceptual framework distils the complexity of water risks within each sector in order to identify the similarities and differences. The framework is then refined through further comments from Phase II interviews.

Chapter Seven discusses the concept of water risk sharing supported by empirical interview evidence and literature. The mechanism of how risk sharing can take place is introduced through the risk sharing typology, which is furthermore refined through literature and empirical data.

Chapter Eight, the concluding chapter of the thesis, highlights the contributions made to expanding the idea of shared water risk, and how this is experienced in private and public sectors. Contributions not only to theory, but also the policy and water resources management in general are highlighted.

Chapter 2: Literature Review

2.1 Water Resources Governance and Management

Governance is a concept which is used loosely and hence has an elusive definition (Robichau, 2011). It involves the processes of ruling and decision-making by multiple actors, with a range of flexible boundaries between them, from formal to informal (Ferreyra, 2006; Huitema et al., 2009). Governance may occur along a state-centric to society-centric continuum where the state either retains the power as chief actor or becomes decentralised, relying on non-state actors to fulfil responsibilities and specific duties. Even when decentralised, the role of government is to keep ethical values in place (Ward, 2004; Jackson, 2009; Robichau, 2011). Water resources governance theory is used in this thesis to inform how collaboration may take place among multi-stakeholders. Collaborative governance may take place in a number of ways. The focus in this thesis is to explore how an understanding of public and private sector water risks may inform water governance.

Selected theories on governance are used in this thesis, to provide a language with which to discuss general theoretical questions about the nature of risk within the private and public sector in water resources management. This pertains especially to how the private and public sector make decisions about the water-related risks they face. The processes and interactions through which highly diverse social interests and actors produce their policies and practises affects the 'governing' of a system (Cleaver and Franks, 2008; Newig and Fritsch, 2010). The range and plurality of stakeholders add to the complex processes and interactions required of governing water resources (Burris et al., 2005; Huitema et al., 2009; Pahl-Wostl et al., 2007).

Governance paradigms for WRM are shifting from 'command and control' to collaborative partnerships between a range of stakeholders within a catchment (Ferreyra, 2006; Carr et al., 2012; Diaz-Kope and Miller-Stevens, 2014) as participation in water management and governance becomes increasingly common (Huitema et al., 2009; Berry and Mollard, 2010). Collaborative partnerships typically have a number of stakeholders which are coordinated collectively in order to address complex water issues that cannot be solved by any single institution alone (Agranoff, 2006; Carr et al., 2012). One of the fundamental reasons for collaboration is "that the complexity within the problem domain exceeds the resource capabilities of traditional institutional structures" (Diaz-Kope and Miller-Stevens, 2014: 7). Thus the role of government and private actors within a collaborative partnership is influenced by the nature of the problem requiring governance (Diaz-Kope and Miller-Stevens, 2014).

The failure of 'command and control' regulation in addressing environmental and economic interests, at local and regional scales, is a major reason for the increasing emphasis on collaborative partnerships in water resources management and governance (Diaz-Kope and Miller-Stevens, 2014).

Evidence of this change is seen through the development of frameworks such as Integrated Water Resources Management (IWRM), where increased participation from a broad range of stakeholders is promoted (Ferreyra, 2008; Pollard and Du Toit, 2008; Hardy, 2010). Increased multi-stakeholder participation brings together many interests, leading to a deeper understanding of the issues being faced in addition to bringing legitimacy through transparent and democratic processes such as consensus building (Pahl-Wostl, 2002; Burris et al., 2005; Carr et al., 2012).

Governance through collaborative partnerships may take place through a range of forms (Mandell and Steelman, 2003). Agranoff (2007) characterises collaboration between government and other stakeholders as: informal, developmental, outreach and action networks. Partnerships may also be categorised according to the member composition such as: government-directed (or agency-based), citizen-based and hybrid (or mixed) partnerships (Diaz-Kope and Miller-Stevens, 2014). These typologies highlight the range of stakeholder composition, organisation affiliation, scale, institution and operational activities involved in collaborative partnerships. In this thesis, a continuum between public sector representatives from a local municipality to private sector companies is considered to capture these different perspectives.

Collaborative governance requires a level of cooperation between public and private stakeholders that can be challenging considering the differences between them. High stakeholder diversity results in higher potential for conflicting interests (Bryson et al., 2006; Ansell and Gash, 2007). To build collaboration between diverse groups, participatory deliberation and consensus building are suggested (Diaz-Kope and Miller-Stevens, 2014). This is especially the case between the private and public sector, where perceptions of the challenge being faced may be different (Larson et al., 2008). Cleaver and Franks (2008) suggest that different knowledge and understanding of the risks being faced by the actors may be a contributing factor to the challenge of multi-stakeholder collaborative governance. Furthermore, empirical evidence of improved "collaborative and multi-level forms of governance in terms of policy effectiveness" remains scarce (Newig and Fritsch, 2010: 2).

Bressers and Lulofs (2010) introduce the concept of boundaries within water management. For example, temporal boundaries influence the propensity for groups to collaborate within water resources governance. Bressers and Lulofs' (2010) findings show that people who do not discount future outcomes are less willing to cooperate, while those who do discount the future are more inclined to cooperate. Therefore the wider the horizon, the more likely the actors are to cooperate for adaptive action. In order for actors to span their normal boundaries, it is critical to understand boundary judgements and make integrated plans (Bressers and Lulofs, 2010). Due to the different time perspectives of government and private sector actors it is not inconceivable that their time horizons differ to such an extent that adaptive governance, sharing or collaborative participation are not automatic responses to the challenges faced within a catchment. Not only do perceptions of risk

differ among a range of actors, but because of their perspectives of time, the sharing of risks and collaborative participation in water resources management can be difficult.

Collaborative partnerships tend to tackle environmental issues which rely on both governmental and non-governmental actors to reach an outcome. In addition to the challenges associated with the actors within collaborative governance is the instability and uncertainty associated with water resources management. Ansell and Gash (2007) identify variables which support the success of collaborative governance. These include "face-to-face dialogue, trust building, and the development of commitment and shared understanding," that need to overcome potential differences between "incentives for stakeholders to participate, power and resources imbalances, leadership, and institutional design" between the actors (Ansell and Gash, 2007: 543). Continuous and systematic data sharing is seen as crucial to iterative and collaborative governance of natural resources (Rogers and Weber, 2010; Carr et al., 2012; Green et al., 2012).

Disadvantages and limitations associated with participation in natural resource management are numerous. Aside from the difficulties in multi-stakeholder perceptions and time frames, it is time consuming, leading to higher financial costs (Carr et al., 2012). The rhetoric of participation can also be used for manipulation of powerful interests or reduce government responsibility (Cooke and Kothari, 2001; Carr et al., 2012). The challenge of collaborative governance is to bring together the private and public sector with different mandates and risk concerns in order to share knowledge and understanding of their water risks collectively. The tensions of increased participation in water resources management and governance need to be understood in the context of the common or shared water risks being faced within the catchment.

Although there are potentially numerous advantages to social participation (McDaniels et al., 1999), there are a number of drawbacks as suggested by Berry and Mollard (2010). Firstly, there is little evidence that social participation leads directly to improved water governance. The balance of control between administrative control and social participation has yet to be established so that all parties are adequately involved where necessary. For example, Berry and Mollard (2010) found that there are trade-offs between the efficiency of management and the equity of participation. Power relations within social groups and how they participate also require attention to improve understanding (Cooke and Kothari, 2001).

There have been major reforms in the water sector in South Africa since 1994 through the National Water Act (NWA; DWA, 1998) and Water Services Act (WSA, DWA,1997b). These ambitious pieces of legislation that promote equity, sustainability, representation and efficiency are designed to address the poverty and inequality through water management decentralisation, and improved access to services (Pollard and Du Toit, 2008; Berry and Mollard; 2010). Participation in the form of civil society consultation and feedback has been cornerstone in the implementation of the legislation, while

user involvement takes place during the development and management of decentralised water resource entities including catchment management agencies and water user associations (Berry and Mollard; 2010; Schreiner, 2013). The Policy White Paper for South Africa supports the approach of including actors from a range of disciplines in water resources management (DWA, 1997a).

There have been challenges in formulating partnerships between state and non-state actors in water resources management. These challenges are not unique to South Africa, as observed in Australia. Misalignment of values between different actors has been one of the major barriers of multi-stakeholder participation in Natural Resource Management (NRM) (Taylor et al., 2012). Additional challenges include the perception from the South African government that water resource management is not effectively institutionalised in business management, resulting in industry not giving water the priority deserving of it (Morrison and Gleick, 2008; DWA, 2013a). In a water scarce country such as South Africa, government needs to work collectively with the private sector to manage water resources effectively.

Limited capacity in the public sector is one of the challenges with the formation of public and private sector partnerships (Appelgren and Klohn, 1999). This is especially the case in the developing world where human resource capacity in public sector natural resource management is constrained (Kranz, 2011; Methner, 2012; Schreiner, 2013). Limited capacity in many local municipalities across South Africa has resulted in slow progress in the decentralisation of water management (Muller et al., 2009; Berry and Mollard, 2010). The lack of public sector capacity in South Africa is one of the many challenges facing water resources management (Schreiner, 2013). Limited human capacity is indicated in the Water for Growth and Development Framework (DWA, 2009), which shows the status of civil engineering professionals within local municipalities in South Africa (CSIR, 2010**Error! Reference source not found.**). The red colouring represents municipalities where zero civil engineering professionals are working for the local municipality. The lack of technical capacity needed to manage the local municipality's results in underperformance.

The shifting nature of water resources governance and management towards the inclusion of multi-stakeholder actors has contributed towards improved inclusivity in water resources governance (Lankford and Hepworth, 2010). The bringing together of multiple interests has led to an increase in understanding the complexity of WRM in addition to broadening the transparency of the process. Yet, there are difficulties associated with the inclusion of multiple stakeholders in WRM. This is particularly true regarding collaborative governance between the public and private sector. For instance, public and private actors have different perceptions of water risk, and historically manage these risks in different ways (Cleaver and Franks, 2008; Larson et al., 2008). Power imbalances between the private and public sector may also put sustainable water management at risk (Berry and Mollard, 2010). In countries such as South Africa, human resource capacity is constrained in addition

to financial and physical water stress, further compounding the challenge. Nevertheless, efficient and effective water resource management cannot be carried out by one sector alone, and therefore the participation of private actors is necessary.

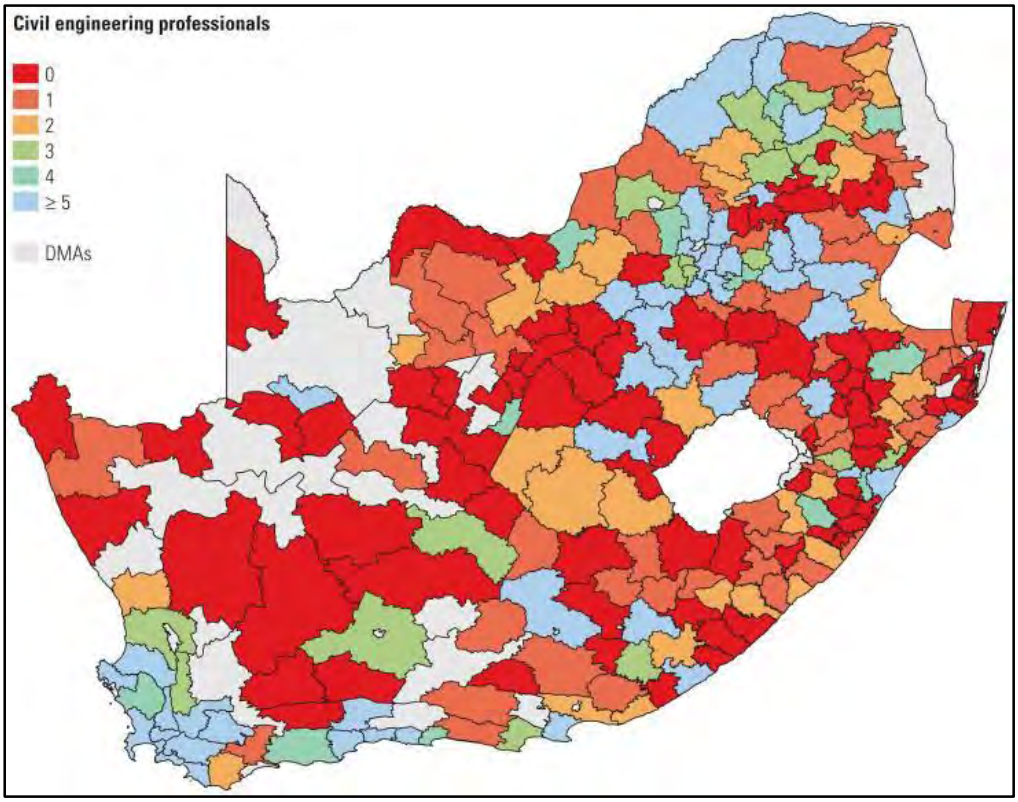

Figure 3: Status of civil engineering professionals in local municipalities and District Management Areas (DMA) (DWA, 2009)

2.2 Risk

There appears to be no single accepted definition of risk found in the academic literature (Bernstein, 1996; Flint and Luloff, 2006; Thywissen, 2006), and there are numerous concepts of risk found in various disciplines which are often distinctly different from each other (Dey, 2010). Holford (2009) reviewed and identified how the concept of risk varies across a range of disciplines. For example, "economists see risk as uncertainty of financial gains and losses, using statistical probability models to measure this uncertainty" (Holford, 2009: 465). By contrast, risk management in health, safety and environment considers risk as "the probability of an event occurring times [*multiplied by*] the impact of that same event (e.g. nuclear plants in regards to potential nuclear accidents)" (Holford, 2009: 465). It is not surprising therefore, that risk assessments depend on how risks are conceptualised along with the purpose of the assessment. Renn (2008c) suggests that risks are technically or socially constructed. A technical risk is defined as the probability of the occurrence of an undesirable event (Renn, 1998; Jooste, 2000; Sebastian, 2000; Flint and Luloff, 2006; Thywissen, 2006).

Socially constructed risks cannot be measured using statistical probabilities because they are largely a condition of the mind and are therefore subjective (Douglas and Wildavsky, 1982; Kasperson et al., 2003; Flint and Luloff, 2006). As such, what people think about a risk is what makes the risks real (Douglas and Wildavsky 1982; Flint and Luloff, 2006). Social concepts of risk share the notion that "humans do not perceive the world through pristine eyes, but through perceptual lenses filtered by social and cultural meaning, transmitted via primary influences such as family, friends, subordinates and fellow workers" (Dietz et al, 1996: 46). This explains why social theorists have gone beyond strictly mathematical and technical analyses of risk and have entered into studies that consider risk practices and implications of risk for society (Kasperson et al., 2003; Pidgeon and Butler, 2009).

While socially constructed risks are not always accurate, and may be swayed by anecdotal evidence or false assumptions, technical risks are also open to criticism (Renn, 1998; Pidgeon, 1998; Pahl-Wostl et al., 2009; Henwood et al., 2010). The world is often not as simple as the narrow framework required in a technical risk analysis (Flint and Luloff, 2006; Thywissen, 2006; Renn, 2008b). A frequently cited criticism of technically-based risk assessments suggests that these measures are reductionist by nature, and unable to consider social concerns such as "rational and meaningful perception characteristics" (Renn and Klinke, 2004: 411). A numerical value assigned to a risk indicator does not "appropriately consider the interactions between human activities and consequences" which are believed to be "more complex and unique than the average probabilities used in technical risk analyses are able to capture" (Renn, 1998: 65; 2008a).

Renn (2008b) and Walker et al. (2010), suggest that an integrated understanding of risk is necessary to ensure that technical and social elements of risk are incorporated into risk governance. The integration of technical and social contexts "has not yet received sufficient attention since often technical systems have been studied and developed in isolation from their social context" (Pahl-Wostl, 2007b: 50). Recent developments have shown an integration of risk disciplines in which both technical and social science risk concepts are integrated (Allan, 1999; Flint and Luloff, 2006; Thywissen, 2006; Renn, 2008b). Meigh and Sullivan (2007), whilst acknowledging the difficulty in integrating technical and social knowledge, stress the importance of integration to ensure that environmental resources are managed effectively. Pidgeon (1998) proposes that decisions are made through the incorporation of risk perceptions. This allows for as a much richer framework through the introduction of social science research on risks and risk perceptions. This is especially useful in water risk management because of the systemic nature and complexity of the risks: water is neither purely technical nor purely social. The concept of risk is increasingly being used to capture the inter-disciplinary characteristics of water resources management and governance (Hepworth et al., 2010; Hall 2012; Hepworth, 2012; Hope et al., 2012; Shiroyama et al., 2012).

Water risks are broadly understood in this thesis to be water as any negative impact of water insecurity. Water insecurity may stem as a result of inadequate quality or quantity of water, whether flood, drought or inadequate management of infrastructure or governance. The impacts of water risk may be felt by any actors within a catchment, including the private or public sector within a catchment. Some of the negative outcomes of water risk may be physical, while others may manifest through regulation or reputation. The broadness of this understanding of water risk provides scope for expansion through empirical interviews.

2.3 Risk Perceptions

Risk perceptions, as indicated in the differences between technical and social aspects of risk, may differ widely. It is believed that the inclusion of a range of risk perspectives is important in considering all stakeholder concerns (Cross, 2001; Bickerstaff et al., 2006). However, participation of actors outside of expert risk managers is also highly contested. Although policy for risk management impacts a range of actors, whose contributions and perceptions of the risk should be considered, risk management decisions are also particularly complex with technical uncertainty and value trade-offs. Decisions about risk management are complex and difficult for experts, hence no-one expects lay persons to understand and contribute meaningfully to risk management decisions alone (McDaniels et al., 1999). Although drawbacks to multi-stakeholder participation exist, due to the multifaceted, complex and public nature of water, it is unacceptable not to consider a range of stakeholder perceptions (Klinke and Renn, 2002; Florig et al., 2009; Larson et al., 2009).

Larson et al. (2009) examined multi-dimensional perspectives on water scarcity in an attempt to understand how and why perspectives about water scarcity and resource management vary across the public, policy, and science arenas. In their research, surveys were used to answer 'how' perspectives differed, while literature across a number of disciplines was used to explain 'why' water management perspectives vary (Larson et al., 2009). They identified the many "diverging perspectives toward environmental problems, their causes, and [how] solutions can exacerbate controversy in participatory decision making" (Larson et al., 2009: 1012). Simple calculations of damage and cost are insufficient to measure risk alone because psychological, political, economic, social and cultural forces interact with technical feasibility to drive the behaviour of both individuals and stakeholders (Slovic et al., 1982; Bickerstaff et al., 2006; Florig et al., 2013). Child and Armour (1995) suggest the inclusion of multiple professions and perspectives as a core tenet within IWRM, as no one perspective alone can be adequate or has priority over others (Child and Armour, 1995). The foregoing discussion presents an understanding of how the experience and management of risk varies between different actors and agencies (Hampel, 2006), and that expert assessment, even if seemingly rational, should not be the only input in a risk assessment approach or tool (Klinke and Renn, 2002; Renn and Klinke, 2004).

This is particularly true in water resources management, where inclusion of multiple sectors is suggested to ensure integration of a number of perspectives (Child and Armour, 1995).

In the water sector Larson et al. (2009) found that although water scarcity and resource management are major concerns among their interviewees, there have been few studies which have investigated how and why these perspectives varied. Through surveys with a range of respondents and a multidisciplinary literature review, Larson et al. (2009) identified the similarities and differences among groups. Bellante and Link (1981) attempt to understand whether or not public sector employees (in general) are more risk averse than those in the private sector. Their results confirm that more risk adverse personalities will be drawn towards public sector employment as a result of the increased employment and financial stability, in turn, impacting the risk aversion of the sector. Organisational culture is claimed to impact resource managers and policy professionals through their views, norms and expectations (Pidgeon, 1998; Siegrist et al., 2000; Rayner, 2007; Larson et al., 2009; Summerhill et al., 2010). Water resource professionals in the public sector in particular tend to be conservative, and aim to maintain the status quo using established norms, such as large, centralised systems to meet growing water demand (Larson et al., 2009; Gleick, 2002). The reduction of risk however is targeted towards the consumers' experience; therefore managers strive to supply water to their customers, regardless of demand and calls for efficiency (Larson et al., 2009; Gleick, 2002). An example of this is the water managers in the Western U.S. who believe that delivery of inexpensive water is their foremost priority as they perceive their customers as unwilling to change their water use behaviour (Larson et al., 2009). The organisational and political context of decision making in the water sector causes policy makers to attempt to minimise the blame placed on residential customers as demand-side alternatives and other publically opposed alternatives are downplayed (Rayner, 2007; Larson et al., 2009). These results highlight the challenges collaborative research and policy-making face in trying to incorporate different knowledge systems into a single management strategy (Cleaver and Franks, 2008; Larson et al., 2009).

2.4 Private Sector Water Risk

2.4.1 Water as a business risk

Water-dependent businesses cannot take water for granted (Morrison and Gleick, 2008). A range of factors from "operational crises, supply chain failures and brand management" (Pegram and Eaglin, 2011: 3) are examples of water-related risks typically found within the private sector (Morrison and Gleick, 2008; Orr and Cartwright, 2009; WEF, 2009; Pegram and Eaglin, 2011). The roles and responsibilities of the private sector have shifted with changing paradigms of water management in an environment where public policy is being challenged and redefined (Gleick, 2000). In addition, as social awareness of water risk grows, pressures mount on private companies to display and market their efforts to achieve water use efficiency (WEF, 2009; Amis and Nel, 2011; CDP, 2011). Phills et

al. (2008) and Newborne and Mason (2012) believe that the growing pressure on the private sector to consider the social impact on business has led companies to embrace this new role in society.

One result of the public pressure is the emergence of a 'private global water governance regime,' led by large MNCs, using reporting tools with an emphasis on water risk accounting, disclosure and management principles (Daniel and Sojamo, 2012: 636). Although there is no single methodology or framework for managing water risks, the UN CEO Water Mandate Guide to Responsible Engagement (Morrison et al., 2010: 5) has formulated five principles to foster "effective, sustainable, and equitable" external engagements related to water (See Appendix B). The assumption is that an awareness and understanding of the water challenges in the private sector could raise expectations for sharing information with stakeholders outside the direct sphere of influence of the private company, thus resulting in an improved understanding and management of risk (SAB and WWF, 2009; Holford, 2009).

The private sector, especially large multi-nationals, are well versed in the implications of water insecurity in business (2030 WRG, 2009; CDP 2009; SAB and WWF, 2009; Morrison and Schulte, 2009; Pegram, 2010; Kranz, 2011). Water is a central component of risk analysis in the private sector (WBCSD, 2006; IFC, 2011). Without the assurance of clean, reliable and inexpensive water, all sectors, including agricultural, electricity generation, industrial manufacturing, and tourism sectors, are at risk (Jensen and Namazie, 2007; Levinson et al., 2008; WEF, 2008; Barton, 2010; DEG and WWF, 2011). Increasing water security is a concern that forces private businesses to address water risks regardless of whether this is a traditional area of business expertise or not. Water scarcity, quality and climate-related risk pose "potentially a greater threat than fossil fuel shortages due to the lack of alternatives to water as a critical resource for human survival on earth" (Morrison et al., 2009: 11). Yet despite the dependency on water resources, water risks are difficult to assess. There is limited information regarding supply conditions as well as irregular private sector reporting and disclosure practises (WEF, 2009). Furthermore, water risks extend across the entire product value chain in varying degrees of intensity and not just to the primary industry or business (SAB and WWF, 2009).

2.4.2 Water risk tools for information generation

New and innovative tools are being developed to identify and assess water risks, and to generate data to quantify risks (IFC, 2011). In addition to water risk tools, there are a number of organisations and institutions worldwide that are involved in identifying, categorising or supporting the investigation of water risks. The UN CEO Water Mandate, for example, recognises the role of the private sector in addressing water challenges (CEO Water Mandate, 2011). The CEO Mandate is designed to assist companies in the development, implementation and disclosure of water sustainability policies and practices (Barton 2010; Morrison et al., 2010). Other institutions include the World Business Council for Sustainable Development (WBCSD), Carbon Disclosure Project (CDP), and the 2030 Water

Resources Group (2030 WRG) (Jensen and Namazie, 2007; Morrison et al., 2009; SAB and WWF, 2009; Pegram, 2010; CEO Water Mandate, 2011). Risk awareness in the NGO sector, for example, the World Wide Fund for Nature (WWF), the Nature Conservancy and Pacific Institute, partner with companies to address risks which include consideration of impacts on communities and the environment (Pegram, 2010).

A range of water risk tools have been developed for companies to understand their water–related risks. The tools identify information or data which are useful in informing knowledge and understanding of the risks. Pegram and Eaglin (2011: 10) suggest that risk tools are useful for "companies to identify supply chain or production water risks, and to disclose a suite of risk factors which may be useful to investors," as well as to indicate catchment level risks affecting others in the catchment too. Identification of these risks may help promote participation with other stakeholders within the catchment. A list of these tools is shown in Appendix C. Two specific tools of relevance to this thesis are explored further, namely the WWF Water Risk Filter and WRI Aqueduct Water Tool.

2.4.2.1 WWF Water Risk Filter

The WWF Water Risk Filter helps companies understand and analyse their exposure to water-related business risks according to the basin they are situated in and the nature of their company (Figure 4) (Orr et al., 2011). The tool includes an online water risk questionnaire with questions on water use, monitoring, governance and regulation. The World Business Council for Sustainable Development Global Water Tool is then overlaid to give a catchment-level water scarcity lens to highlight specific regions of higher risk. Business risk is closely linked to a specific location and context of the local water conditions because the effects of water are felt locally (IFC, 2011). The catchment level, instead of larger scale (large basin or national), is used because it is difficult to quantify water risk in a larger unit area (Norman et al., 2012). A catchment level analysis is able to capture the important and unique local context that influences water risk (Morrison et al., 2010; Cohen and Davidson, 2011). As shown in Figure 4, the risk evaluation is divided into both basin-specific and company-specific risk since both impact the relevant mitigation opportunities available to each company (Orr et al., 2011). This is a useful framework because it recognises that risks may be experienced at different scales.

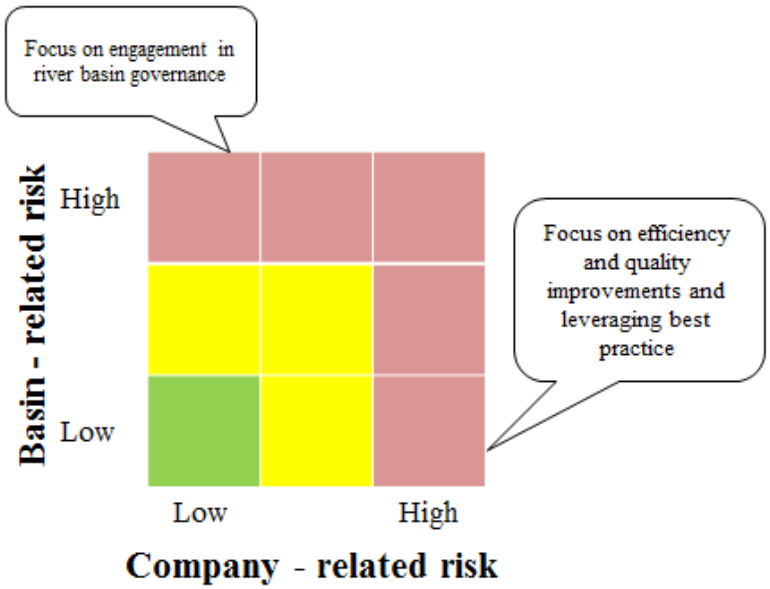

Figure 4: Conceptual Framework of the WWF Water Risk Filter (Orr et al., 2011)

However, there are additional layers that are required in investigating the catchment. For the purposes of this research, the areas of risk are examined at two scales: context (supply chain and catchment) and company level, as illustrated in Figure 5. Risks that are relevant to the business itself may be distinct from those affecting the wider catchment and both are important. Within the wider catchment, risks to business are embedded within the specific context of the company and its processes (throughout the value chain) as well as the location of the company within a particular catchment (Orr et al., 2009; Cohen and Davidson, 2011; IFC, 2011; Greenwood et al., 2012). Therefore, there is a distinction between the catchment where the company is situated, and the supply chain from which inputs are sourced (from the same or a different catchment). This is useful as water security may be at risk within the supply chain of the product, or within the actual catchment where the production facility is situated. Both are water risks that a company should consider outside of their own production facility.

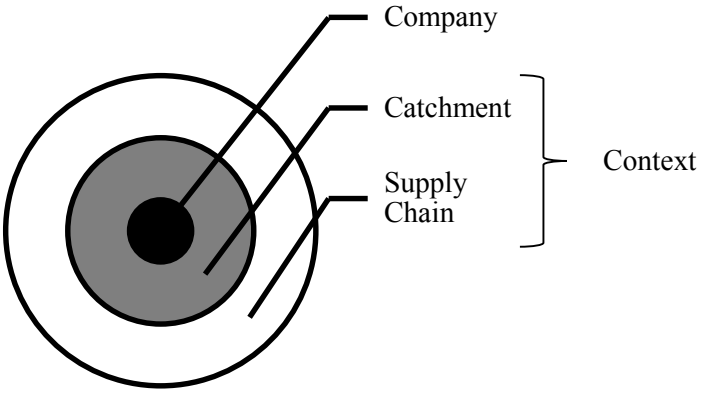

Figure 5: Company, catchment and supply chain scales of the risk context (Modified from WWF and DEG, n.d.)

Risks associated with the catchment include factors such as, water availability and quality, and the regulatory and political environment, the economic development of the catchment, demographic shifts, climate variability or social norms and expectations (Greenwood et al., 2012). Risks related to the company itself are linked to the nature of the business and the role that water plays in the company. Among other factors, the discharge of pollution from production processes and the nature of water-related impact of the company on other users and ecosystems influences risk within the catchment (IFC, 2011).

The WWF Water Risk Filter questionnaire is designed and applied at company scale to assess physical, regulatory and reputational risk at the drainage basin scale. The value of considering physical, regulatory and reputational risks in a conceptual framework is the ability of the tool to identify a range of indicators and factors affecting the water security for a company (WWF and DEG, n.d.). This is relevant to this thesis because it examines both technical (mostly physical) and social (regulatory and reputational) elements of water risk. Each individual company completes the questionnaire and analyses the risk based on an aggregate score. This information can be shared among other users in the catchment, or entered onto the 'Water Action Hub' to identify other companies or organisations in similar situations (WAH, 2013). The output of the questionnaire is shown in Figure 6. According to a scale developed by WWF, green indicates low risk, orange medium risk and red indicates a high risk level. The distinct risk indicators are weighted to give a final catchment and company risk score.

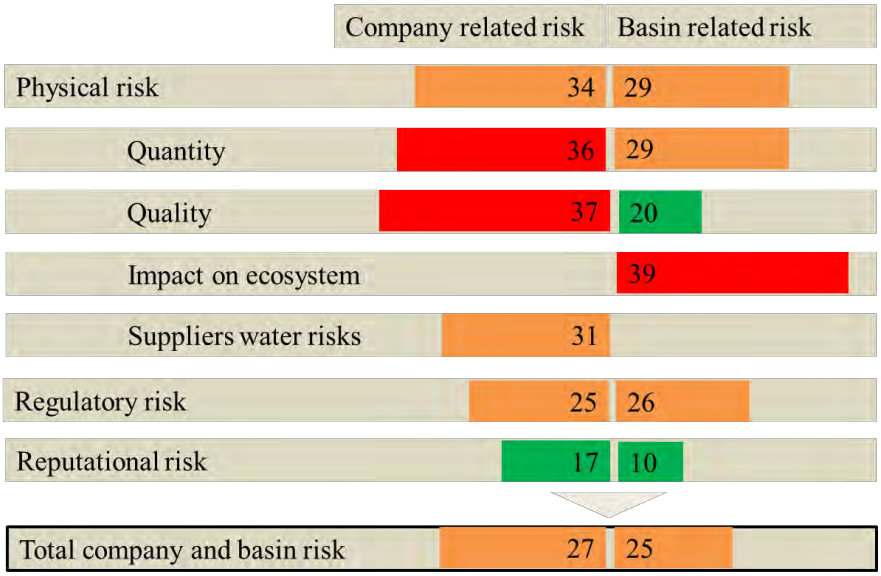

Figure 6: WWF Water Risk Filter aggregate risk output from water risk questionnaire (WWF and DEG, n.d.)

Physical risk is when the actual water quality or quantity does not meet the requirements of the company. Physical disruption or deterioration in the quality of water supply may directly impact on production (i.e. brewing, bottling or crop cultivation). Physical risks include flooding (Grey and Sadoff, 2004). In the WWF Water Risk Filter physical risks are further categorised into quantity, quality, and impact on ecosystem and suppliers water risks. Quantity risk questions include the proportion of water withdrawn by the company relative to what is available. Quality risk questions investigate the level of pollution discharged by the company into the catchment. Suppliers' risks are explored by identifying where their respective water quality or quantity risks may lie. The impact on the ecosystem then takes the questionnaire results overlain with general quantity and quality information regarding the catchment. These risk categories reflect the scales of risk context introduced previously in Figure 5 of company (quantity and quality), catchment (impact on ecosystem) and supply chain (suppliers' water risk). The four impacts through which physical water risks may manifest have different company or basin level responses. Aside from the risk of not having the physical water available, physical water resource constraints make companies susceptible to reputational and regulatory risks (Pegram, 2010).

Regulatory risk may arise from increasing stress on the resources. When water resources become stressed in a catchment, the response from the public sector is often to impose further legislation, with potential consequences for future water supply to the company (Pegram et al., 2009). For example, regulatory restrictions on legal licences for water supply or waste discharge may directly impact on production. The policy itself may be the source of concern, for example, in the allocation of water during times of scarcity. Regulatory risk may also arise from the reallocation of water to other users.

Licences are required which allow abstraction or discharge within certain parameters. These are issued and monitored by regulatory agencies (Lambooy, 2011). However, the management and implementation of policy is the main source of concern. If incorrectly implemented, regulatory risk may exacerbate social, environmental, economic or business risks (Morrison et al., 2010). Although most literature mentions the risk of poorly regulated or implemented public policy to the private sector, the same applies to the public sector which is at risk if companies do not abide by the law (Hepworth, 2012; Mason, 2013). In addition, and apart from meeting the legal requirements, the public and private sector need to abide by the law as this provides stability and predictability that are necessary for innovation and investment (Hecht et al., 2012).

As mentioned earlier, companies are under increasing scrutiny, especially with increasing public interest in what companies do in production, operations and business (Lambooy, 2011; Orr et al., 2011; Sarni, 2011). This is reputational risk. The King III report claims that stakeholder perceptions of companies result in the formation of corporate reputations; and that reputation is an important contributor of the economic value of the company (King III, 2009). One of the methods for gauging reputational response to risk is the number of times businesses have appeared in the media in connection with water. The media exposure could be positive or negative. Other ways of identifying the potential for reputational risk include an examination of the socio-economic profile of the surrounding population. This is most noticeable in regions where universal access to sufficient clean water is not available. Therefore information regarding the socio-economic profile may better understand the propensity for reputational concerns. For example, in times of crisis, companies, particularly high-profiled corporations, become vulnerable to consumer rejection (Orr et al., 2009; Morrison et al., 2009). This is often regardless of their actual contribution to the water problem (Hepworth 2012). In water-scarce regions, tensions arise between businesses and local populations, particularly in developing countries where people lack access to safe and reliable drinking water. Media coverage may damage brand reputation, in turn reducing product sales (Orr et al., 2009; Morrison et al., 2009). Evidence of this is in the beverage industry where potable water is the primary and most important ingredient. Consequently, the operations within beverage companies are vulnerable to water availability and quality concerns. Beverage manufacturing requires high-quality source water, putting the water use of this industry in direct competition with supplies to local populations. In cases of severe shortages or contamination of drinking sources, bottling and manufacturing facilities risk shutdowns, as found in the case of PepsiCo and Coca-Cola bottlers in Kerala, India in 2004 (Morrison et al., 2009; Hepworth et al., 2011).

Table 1 (below) illustrates the use of the three risk categories in the WWF Water Risk Filter, where potential responses to risks range from water awareness to governance. Risks are delineated between those that relate to the company itself and those that relate to the wider basin. Water risk is understood in the broadest sense, including not only primary (quantity and quality) physical water risk, but the

secondary effects of physical risk, such as reputational and regulatory risk (Orr and Cartwright, 2009; Orr et al., 2009; Morrison et al., 2010; SAB, GTZ and WWF, 2010). Consideration of the physical, regulatory and reputational risks within a company as well as a catchment will help to ensure that technical elements of water supply and the social or political aspects of water risk are considered. In Table 1 there are five forms of response which a company might consider in order to mitigate the risks they are facing. Those listed under 'basin-related risk' feature actions that communicate or collaborate with stakeholders outside of the boundary of the company itself.

Table 1: WWF water risk tool framework (Adapted from WWF and DEG, n.d.)

	Company Related Risk			**Basin Related Risk**	
Physical Risk	***Water awareness***	***Knowledge of impact***	***Internal action***	***Stakeholder engagement***	***Influence governance***
Regulatory Risk					
Reputational Risk					

The WWF Water risk tool framework identifies the importance of knowledge and understanding of internal company risks through the collection of data and information that support knowledge about water risks. This is a process which needs to be followed before companies are able to begin mitigating basin related risks. 'Stakeholder engagement' is the step whereby the risks of the company may be shared among the risks of other users in order to identify where risks may be best mitigated in a collective response.

2.4.2.2 WRI Aqueduct Tool

The World Resources Institute (WRI) Aqueduct tool (WRI, n.d.) uses detailed water risk maps indicating water stress data at a local level. A major portion of the data is the source vulnerability assessments of Coca-Cola (Jenkinson, 2011; CDP, 2012; Reig et al., 2013). Similar to the WWF Water Filter Risk tool, the WRI Aqueduct Risk tool divides water risks into three categories: physical, regulatory and reputational. The framework combines twelve water risk indicators to calculate an overall risk score as shown in Figure 7.

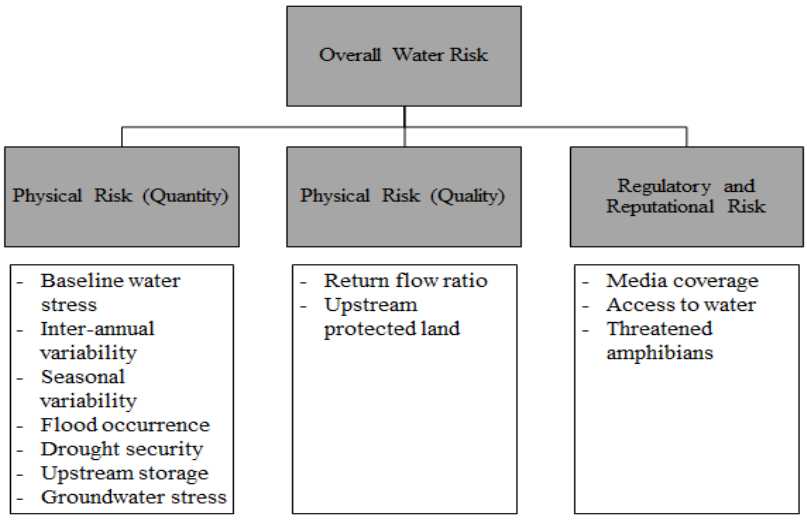

Figure 7: WRI Aqueduct Water Risk Framework (Reig et al., 2013)

The WRI framework indicates which sources of information or data inform the respective risks. Specific indicators of each risk are aggregated together in order to form an overall water risk score. Unlike the WWF Water Risk Filter, the WRI Aqueduct tool is purely a mapping tool which indicates the level of water risk within a geographic location. There is no link between a specific company or institution and the catchment level water risk.

2.4.3 Private sector water risk

Private water risk is commonly characterised as physical, reputation and regulatory water risks (Orr et al., 2009; Orr and Cartwright, 2009; Morrison et al., 2010). The value of using the risk categories used by the WWF Water Risk Filter and WRI Aqueduct is that both technical and social risk factors are considered, as suggested by Renn (2008b). Technical risks are represented by the identification of physical water risks to business. Quality and quantity of water resources are the two primary physical risks for business. However, other factors also impact and influence water risks. These may manifest as reputational impacts or regulatory changes affecting the bottom line of business through costs (SAB and WWF, 2009). Regulatory and reputational risks are more closely represented by social than technical risks, and are often related to the catchment where the particular company is situated (Orr et al., 2009). Data and information supporting the knowledge and understanding of these different risk categories needs to include both technical as well as social aspects of water to ensure water resources are managed holistically (Pahl-Wostl et al., 2007).

Traditionally for private business it is essential to ensure profit, although this is also moving away from money and towards creating shared value for shareholders and customers alike. This includes ensuring positive value creation within the community in which the product is produced. The private sector is able to identify water as an input which needs to be protected. However, as indicated with the

risk frameworks being used by the private sector, wider considerations outside of purely physical water quality and quantity are also being considered. These include the regulatory and reputational risks associated with water.

2.5 Public Sector Water Risk

A risk-free environment does not exist for any organisation. Every organisation needs to devise its own framework through which to manage its own unique risks (Hamilton et al., 2006; Coetzee and Lubbe, 2013). This includes both the private and public sector. For public institutions the challenge lies in meeting mandates in an environment beset by constraints that include "inadequate capacity, excessive bureaucracy and silo mentality, limited resources, competing priorities and infrastructure backlogs" (RSA National Treasury, 2010: 3). These constraints together with the overwhelming demands on the public sector in South Africa increase the risk profile of the public sector and place an 'extra duty of care' on managers to contain the risks within an acceptable limit.

Globally, the public sector is often described as conservative and averse to risk (Hoff et al., 2003). Moreover, studies in the United States of America (USA) showed that risk-averse personalities are drawn to the public sector as opposed to private sector employment as a result of the increased employment certainty and financial stability (Bellante and Link, 1981). In the water sector specifically, professionals are conservative, and tend to focus on maintaining the status quo of established norms (Gleick, 2002; Larson et al., 2009). Thus, while public water utilities are responsible for public health (through drinking water quality), they are often not in the position to be as creative or seize opportunities in the same manner as the private sector (Hamilton et al., 2006; Pollard, 2008).

Water insecurity affects the ability of government to meet water-related policy goals (Orr et al, 2011). In most cases, the primary purpose of water and wastewater treatment is the protection of public and environmental health (Hamilton et al., 2006). The central goal of a water utility sector is to "provide wholesome, affordable and safe drinking water which has the trust of customers" (Pollard, 2004: 453). Therefore, without a secure source of water, it becomes difficult for the public sector to meet particular policy objectives.

2.5.1 Water risk management frameworks in the public water sector

A number of risk management frameworks exist in the water sector, which differ according to the scope and/or discipline of analysis (Hoop et al., 2003; Pollard, 2008; Jack et al., 2011). These include assessing risks in catchments (catchment-to-tap framework), drinking water guidelines (drinking water safety plans) and The Driver-Pressure-State-Impact-Response (DPSIR) framework (used in Europe for the Water Framework Directive (WFD)) (Armacost and Pet-Edwards, 1999; Pollard et al., 2004). There are also risk assessment frameworks used in asset management and wastewater

treatment regulations (Jack et al., 2011). Therefore, there is no single risk framework that holistically identifies public sector water risks as each country, province or even department within the public sector uses different risk management frameworks (Hoop et al., 2003).

The first introduction of risk, as a concept in the water industry, was initiated by the International Water Association (IWA) in the Bonn Charter for Drinking Water (IWA, 2004) which outlined the institutional, managerial and operational requirements for the effective provision of safe drinking water (Pollard, 2008). The Drinking Water Charter introduces the concept of integration of the technical risk of water treatment within a utility, together with risk factors including the catchment where water is sourced and discharged. The social elements of risk and water resources management were not considered.

Literature on water risks in the public sector that considers physical, regulatory and reputational risk as discussed under the private sector is limited in comparison, with primarily technical concepts of water risk. Pegram et al. (2009) and Orr et al. (2011) are two of the few resources which consider the risks of the public and private sector to water in parallel. Pegram et al. (2009) and Orr et al. (2011) suggest that there is a potential shortcoming of government in terms of understanding the social and economic context of public water-related risks. Pegram et al. (2009) identify the primary (physical) risk of water security to the public sector arising from water scarcity, flooding or pollution. "This is usually because water allocation, water use by different sectors, and water resources infrastructure are not adequately managed at a policy, strategy and/or implementation level" (Pegram et al., 2009: 15). The resulting risks are government public health, environmental health, food security, energy security and industrial development (Pegram et al., 2009; Orr et al., 2011) and may compromise the achievement of environmental sustainability, poverty alleviation, social development and economic growth objectives (Pegram et al., 2009; Orr et al., 2011). Pegram et al. (2009: 15) also suggest that secondary water risks in the public sector are "due to inadequate institutional capacity, financial viability and infrastructure operations." Secondary risks impact the credibility of government, especially in urban areas (Pegram et al., 2009).

Reputation is increasingly important in the United Kingdom (UK) public sector as decisions regarding the management of public health and safety are under regular scrutiny (Pollard, 2008). "Managing the risk of reputational damage or the opportunity for reputational enhancement is a growing feature of utility management" (Pollard, 2008: 25). The reputation of the public sector from the perspective of the regulator issuing licenses to operate, investors and funders, as well as customers is important (Pollard, 2008).

Regardless of how the risk is framed (between countries or between sectors), risk management is an effective tool in assisting management with their responsibilities (Coetzee and Lubbe, 2013). In South Africa, risk management is included in the leading corporate governance codes and legislation

including the PFMA (1999) and King Report on Governance (2009). These regulatory requirements are a form of control by government in an effort to reduce risks to society (Hood et al., 2003; Wixley and Everingham, 2010). Some changes have been suggested as a shift in policy towards greater sustainability (Hamann and O'Riordan, 2000).

2.5.2 Public Sector Risk Framework in South Africa

According to the South African National Treasury Risk Management Framework, risk is defined as "an unwanted outcome, actual or potential, to the institution's service delivery and other performance objectives caused by the presence of risk factors" (RSA National Treasury; 2010: 1). The framework acknowledges that some risk factors are positive, presenting opportunities which management must be prepared to act upon (RSA National Treasury, 2010).

There are a number of pieces of legislation in South Africa which require the use of risk management frameworks in the public sector. For example, the National Treasury risk framework (RSA, 2010), the Public Finance Management Act (PFMA, Act no. 29 of 1999), Municipal Systems Act (MSA, Act no. 32 of 2000) and Municipal Finance Management Act (MFMA; Act no. 56 of 2003) all require the use of an integrated risk management framework (TWK Risk Policy; 2011). The King III Corporate Governance code (2009) also expects risks to be managed through an integrated plan aligned with the principles of good corporate governance (Wixley and Everingham, 2010). In response to these regulatory requirements, the Department of Water Affairs Annual Report (DWA, 2011) indicates that a risk management framework based on the Public Sector Risk Management Framework is in place. It recognises that risk management is an integral component of effective corporate governance (DWA, 2011). These risk management framework requirements are for national or provincial government to ensure that public sector governance is carried out with the best interests of society (Hoop et al., 2003).

Since 2010, National Treasury has provided a risk management framework available to all local municipalities helping them to use Enterprise Risk Management (ERM) in their risk management policies (RSA, 2010). The risk management framework was developed to include corporate governance and operational risk management functions under the wider umbrella of enterprise risk management. The development of the risk framework is also in response to the PFMA (RSA, 1999) and MFMA (RSA, 2003) requirements of "effective, efficient and transparent systems of risk management and control". Good governance is one of the central requirements of the risk management strategy (DWA, 2013a: 15). The National Treasury Risk Management Framework "recognises that institutions are not homogenous hence it is not possible to produce a blueprint that can be generically replicated across all institutions" (RSA, 2010: 30). Therefore, the framework is not prescriptive, but instead suggests principles which support effective risk management (RSA, 2010).

Enterprise Risk Management (ERM) is a concept gaining popularity (for example through the National Risk Management Framework) in the public sector, allowing risk managers to think more broadly than purely financial risks (Hoffman, 2008). Aside from stating explicitly in the National Risk Management Framework that it is based on Enterprise Risk Management (ERM) (RSA, 2010: 5), there are elements of the framework which are indicative of ERM. Like ERM, the National Risk Management Framework recognises that risks and opportunities are often dynamic and interdependent. Not only is the institution expected to consider internally generated risks, but also external risks (Hoffman, 2008). The consideration of internal as well as external risks is also a part of ERM. The National Treasury Risk Management Framework stipulates that in order to understand external risks, clear and timely communication with all relevant stakeholders is necessary. It is critical to ensure close interaction between internal and external stakeholders (RSA, 2010), indicating public sector support for wanting to liaise with the private sector. National Treasury anticipates that by using a risk management framework, institutions should be able to achieve sustainable and reliable delivery of services as decisions will be informed by innovation, rigour and analysis (RSA, 2010). Therefore the value of carrying out the risk management framework is through a better understanding and knowledge of the factors causing the risk. As seen in the National Risk Framework, this needs to be in an integrated manner which considers the internal (company) and external (basin) risks.

2.5.3 Water risk concerns in South Africa

According to the Department of Water Affairs (DWA) 2013/2014 Annual Performance Plan, the 10 most critical strategic risks confronting the DWA are: ageing water infrastructure, no strategy to curb unlawful water use, no strategy to prevent pollution of water resources by mining activities or sewerage from municipalities, inadequate capital for infrastructure projects, failure to meet regulatory requirements, non-compliance to meet with legislation, internal controls and code of conduct, possible failure or delay of major projects or contracts, irregular expenditure, under spending of the budget and poor performance management (DWA, 2013b). The DWA 2013 Strategic Plan further investigates the strategic risks, indicating that a gap in human capacity skills and negative reputation are among the most critical risks that need to be managed. The skills capacity gap is a result of inadequate technical skills, an ageing workforce and large number of resignations. Negative media resulting from a poor reputation causes a lowering of public sector staff morale and a lack of trust and interest from civil society (DWA, 2013c). Other strategic risks indicated in the report include poor service delivery, failure to meet regulatory requirements, pollution of water resources, insufficient budget, supply chain management, human resources capacity, communication and reputational risk (DWA, 2013c). These risks listed in the DWA reports indicate an awareness of the importance of water resources management beyond the physical water itself, acknowledging the risk of not meeting their regulatory requirements as well as the risks of a poor public image.

Water in South Africa is a national resource held in custodianship by the State (National Water Act (NWA) (RSA, 1998). The State controls the utilisation of the resources, and is responsible for investing and implementing water management functions to account for the entire water cycle holistically and ecologically (Mazibuko and Pegram, 2006). In South Africa the use of the IWRM policy and framework (Schreiner, 2013), is aimed at managing water resources protection together with social and economic development. There are only two guaranteed entitlements to water: the ecological reserve, and meeting basic human needs (CDE, 2010). The ecological reserve includes both quantity and quality concerns (Jooste and Claassen, 2001). The inclusion of an environmental reserve is widely acknowledged by water resource managers globally; however, implementation thereof has been lacking (Schreiner, 2013).

Challenges in the water sector are significant (DBSA, 2012). These include weak and/or poor institutional frameworks that have led to inadequate funding and asset management, and inadequate skills in the sector (Atkinson, 2007; DBSA, 2012). Inappropriate regulation of domestic, industrial and agricultural practises has resulted in pollution especially from poorly operated wastewater treatment works and industrial effluent (DBSA, 2012). These and other challenges are listed by the Development Bank of Southern Africa (DBSA) as critical challenges that need to be addressed in order to secure water resources in South Africa (DBSA, 2012). A study done on the state of municipal infrastructure in South Africa, including its operation and maintenance found that "for a significant proportion of the municipal infrastructure, the sustained provision of services is under threat" (SAICE, 2011: 4). Water treatment, water reticulation, wastewater treatment and sanitation services were all investigated. Two systemic issues were identified as the underlying causes for inadequate service provision. These are, "inadequate budgets (either because of the municipality being in a distressed financial state and thus unable to fund infrastructure maintenance or, even if the municipality is not distressed, infrastructure maintenance is not allocated sufficient budget)" and "inadequate skills (especially technical skills) and experience to plan and implement appropriate maintenance" (SAICE, 2011: 6).

There are challenges implementing catchment management agencies (CMAs) as custodians of water resources in South Africa, which Du Toit and Pollard (2008) identify as a lack of holistic IWRM planning and a lack of clarification regarding the different levels of engagement and procedures which are too elaborate and sophisticated for initial public engagement stages of a CMA. In order to overcome these challenges, Du Toit and Pollard (2008: 708) suggest the breakdown of the Catchment Management Strategy (CMS), the "locus of decentralised, democratised, participatory water management," into associated tasks with appropriate levels of participation. The International Association for Public Participation (IAP2P) (2000), highlights particular phases and stages within the CMS process which are aligned with different forms of public participation through a Public Participation Spectrum. The spectrum ranges through inform, consult, involve and collaborate

following a "general trend from provision of information to collaboration decision making" (Du Toit and Pollard, 2008: 709). Though the sharing of information between stakeholders within the catchment, Pollard et al. (2011) have identified adaptive learning processes taking place. An adaptive approach in this regard allows for reconsideration should new data or linkages arise.

The Department of Water Affairs (DWA) implemented the Blue and Green drop certification programme as a tool with which to monitor and benchmark the functioning of water and wastewater treatment facilities across the country. The programme gives an indication of water or wastewater quality compliance as well as an indication of the asset and operations management of each facility. In the 2012 Blue Drop Report the Western Cape scored the highest (94%) while Mpumalanga scored the lowest (60%) (DWA, 2012b). In the 2011 Green Drop Report the average score of facilities investigated in the Western Cape was highest in the country at 83%, while the Northern Cape had the lowest score of 23% (DWA, 2011). These findings indicate an uneven performance of municipalities nationally. In many cases this is as a result of lack of human resources capacity in smaller municipalities. For these smaller municipalities, the inability to meet regulatory requirements is a risk. For businesses in these regions, this too, may translate into a regulatory risk.

Inadequate access to water has led to protest action regarding service delivery (DBSA, 2012). The challenges of the public sector, in particular "municipal ineffectiveness in service delivery, the poor responsiveness of municipalities to citizens' grievances and the conspicuous consumption entailed by a culture of self-enrichment on the part of municipal councillors and staff" are the underlying causes of protest action in South Africa (Atkinson, 2007: 53). According to government, the protests are often a result of "inadequate communication between the three spheres of government and affected communities" (Atkinson, 2007: 56). The experiences are comparable to the negative media received by corporate companies translating into reputational risk. Although the effects of a poor reputation are not the same, as corporates may experience a decrease in brand value while government may experience a decrease in political support, the basic concerns are the same.

Public sector risks are therefore far-reaching because water is a public good. The risks of not having secure access to water include poverty, inequality, poor health, conflict and low economic growth and trade. Also, there are significant negative repercussions outside of the water sector which may stem from some of the mitigation strategies government may put in place (e.g. the energy requirements of desalination). Therefore, for the public sector, water risks occur at two distinct levels: the strategic wider level which includes the wide public scope of government, and then the technical and operational risks identified through the water utility.

In summary, public and private sector risk frameworks are not structured in exactly the same manner. However, both are underpinned by ERM, whereby not only internal, but external risks are considered. This is important in water management as the systemic nature of water results in risks which are

caused by internal as well as external factors. For example, internal factors of water risk may include an inability to store sufficient water on site for a company; however external factors of risk may include the polluting activity of an industry upstream in a catchment. Private sector risk frameworks, by including physical, regulatory and reputational categories of risk, consider this range of risks. Public sector risk frameworks are not as clear regarding physical, regulatory or reputational risks. However, as indicated, their concerns are comparable to the structuring of physical, reputational and regulatory risks. The public sector may be concerned about meeting the PFMA or MSA, for example. Failure to meet these regulatory requirements is a regulatory risk to the public sector. Service delivery protests are an example of reputational risks. Therefore, although the risks themselves are not identical, water security is a common concern, and in some cases there are similar responses to the risks.

2.6 Sharing risks

As risks rise in importance and frequency in the modern world, Minow (2012) identifies the primary problem as the divisions between public and private sector responsibility. A sense of mutual duty, rather than individual self-reliance is needed to change the distribution of risk (Minow, 2012). In order to deal with complex risks such as water insecurity, we need a sufficient shared sense of 'we,' which is founded upon, "a greater sense of shared risks and responsibility" (Minow, 2012: 257). Both the technical complexities of risk, in addition to the lack of social understanding and communication of the problem, are to blame. Hacker and O'Leary (2012) propose finding the right mix between public and private sector participation and 'sharing' to ensure risks are adequately managed.

In the water sector, the term 'shared risk' has been used to indicate the common concerns the private and public sector may have with respect to water (Pegram, 2010). The risks which each sector face are distinct and are not identical. Prior to "the extraordinary consolidation of central state authority", private engagement in governmental mandates was neither new nor rare historically (Donahue and Zeckhauser, 2006: 500; Pollard, 2008). Throughout history, the private and public sector have carried out a range collective action arrangements, from Roman tax administration to the history of the British East India Company (Bernstein, 1996; Donahue and Zeckhauser, 2006). Multi-sectoral management of water resources is also not a novel occurrence with the increase of IWRM, where integration requires moving beyond sole reliance towards consistent collaboration and commitment through the fostering of cooperation, coordination and trust amongst sectors (Child and Armour, 1995; Bernstein, 1996; Pollard, 2008; Shiroyama et al., 2012).

Water is a crucial shared resource for governments, businesses and populations across many areas of the world (Lankford and Hepworth, 2010; SAB, GTZ and WWF, 2010). Outside of the water resources management literature, there is also recognition that "governments share responsibility with other levels of government, with private companies and with non-profit organisations" (Donahue and

Zeckhauser, 2006: 499). The 'common' water-related concerns represent an opportunity for cooperation or partnership to manage the shared water challenges (Pegram et al., 2009). Government and business face similar opportunities and risks because of their common dependence on water (Pegram et al., 2009; Morrison et al., 2010; Barton et al., 2011; CDP, 2011; DEG and WWF, 2011; Hecht et al., 2012). The growing recognition of the linkages between private and public sector risks is indicated by the increasing use of terms such as collective action, creating shared value and shared water risks over the past 10 years, representing a change in the perceived role of the private sector and water resources management (Sadoff et al., 2008; Morrison et al., 2009; Orr et al., 2009; Greenwood et al., 2012; CDP, 2012; Hepworth, 2012). The concepts of collective action, creating shared value and shared water risk may refer to the private sector and NGOs too, for example. However, the over-arching concept remains the same, communication between different sectors "leads to stronger outcomes than those achieved through unilateral action" (Greenwood et al., 2012:3). Shared values for example are shown to support positive, functioning partnerships between different organisations in both natural resource management literature and business literature (MacDonald Hatton et al., 2013). This is believed to be because one trusts those with similar values to you (Siegrist et al., 2000).

Neither the public nor private sector want to face increasing risks associated with water availability, quality, climate change or the failure of the water supply systems (Pegram et al., 2009; IFC, 2011). In response to increasing water risk, Bruns (2003: 1) suggests that stakeholders involved with water management need to "communicate, cooperate and coordinate" in new ways. One manner in which this can take place is through the sharing of knowledge and understanding of water risks with a range of stakeholders within a catchment (Shiroyama et al., 2012). Water management is not the responsibility of the public sector alone. The private sector is increasingly recognised as playing a role in responding to water risk. Improved water resources management may potentially benefit from and contribute to collective efforts from companies (SAB, GTZ and WWF, 2010). This common interest of managing water risk represents potential for government and the private sector being able to work together (Pegram et al., 2009). However, a WWF stakeholder session promoting the interaction of public and private sector representatives found that there are gaps in understanding between the public and private sector.

It is unclear how businesses can effectively be increasingly involved in water management (WWF and Sanlam, 2010). Government, recognising the enormity of the water challenges they face, have yet to recognise the potential of mitigating these risks through working together with the private sector (WWF and Sanlam, 2010). Therefore the way risk is conceived between sectors and disciplines is different, and these differences need to be investigated and understood before any sharing of risks or working together is likely to occur. This thesis seeks to understand the differences in public and private sector risks, suggesting a manner through which knowledge and understanding of risks may be shared.

Risks may include inadequate access to water for society or the environment which may result in "political or electoral opposition" (Orr et al., 2009: 34). This is similar to reputational risks private companies face if perceived to be over abstracting from a scare resource (Pegram et al., 2009). Therefore, should a particular region have poor economic development of inadequate access to water or housing, the risk is to the public and private sector. This is because the public sector is at risk by not meeting their mandate as government, while the private sector is at risk if profit is preferred over access to water for others. Another example of a form of sharing taking place is between the private sector and DWA in South Africa. The DWA has the responsibility to ensure access to water services as well as sustainable water resources management. One initiative, indicating public and private sector interest in mitigating water risks, is the Strategic Water Partners Network (SWPN). SABMiller, Sasol, Nestlé, Coca-Cola and Eskom all contribute to public policy discussions through the South Africa Strategic Water Partners Network (SWPN, 2012). SWPN is an example of a country level platform incorporating the public and private sector which was established at the World Economic Forum in South Africa in 2011. The public–private group is overseen by the DWA (SWPN, 2012). Information regarding the status quo and future water supply gaps is disseminated through a 'fact based economic analysis' using the 2030 Water Resources Group 'cost curves' (Mason, 2013). The messages garnered through demand and supply scenarios are presented to stakeholders including public and private representatives in order to develop strategies to respond to the future scenarios. Although the value of the method is questioned (Hepworth, 2012; Mason, 2013), the process is supportive of public–private partnerships transforming the water sector (Mason, 2013). Therefore 'sharing' between the public and private sector has a number of forms.

There are a range of motives for private involvement in what is traditionally a public sector mandate. Generally private sector involvement is in order to, "improve performance in the creation of public value" (Donahue and Zeckhauser, 2006: 505). According to Donahue and Zeckhauser (2006), the simplest rationale for collaboration between the private and public sector occurs when the government lacks resources or the ability to mobilise resources to accomplish its mission. A further consideration is that the private sector may command productive capacity which government does not have. Information is the third driver of public–private collaboration whereby government access to information is enhanced through private sector input. Lastly, legitimacy may be enhanced through the involvement of the private sector in particular tasks (Donahue and Zeckhauser, 2006). In addition to the drivers for collaboration between the private and public sector, there are risks too. These are explored at a later stage in this chapter.

There is no theoretical typology that identifies different forms of risk sharing. Therefore this study draws on the literature on public participation, collective action and stewardship to further develop the concept of sharing. Bruns (2003) investigates the power of participation with the public sector in water resources management. Synthesising the work of a range of authors from the field of

participatory governance (for example Arnstein, 1969; Potapchuk, 1991; Connor, 1998); Bruns developed an extended ladder of participation shown in Figure 8. The ladder indicates a range of forms that public participation may take between stakeholders. Each rung of the ladder represents a form of public participation with different emphasis on the information available and power regarding decision making (Bruns, 2003).

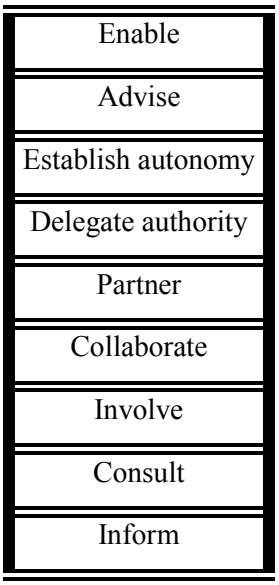

Figure 8: An extended ladder of participation (Bruns, 2003)

As indicated by Bruns (2003), participation may take a number of forms. The first rung of the ladder of participation is 'information'. Although this does not guarantee higher forms of participation, it facilitates other forms of participation. The information flow does not necessarily move in both directions. Reports, newsletters, newspapers, radio, television and training programs are all examples of how information may be shared among stakeholders (Bruns, 2003). Knowledge and understanding that inform water risks in the private and public sector is an important step towards further participation.

Consultation with others is another means towards sharing information. Bruns (2003) distinguishes consultation as a two-way instead of one-way direction of communication. The necessity of sharing knowledge and understanding of risks is in order to visualise and quantify interdependencies (Savenjie and van der Zaag, 2000). The interaction through the exchange of ideas and values to disseminate knowledge is a valuable way of identifying shared values as well as creating awareness of the problem, making stakeholders more responsive to risk (Savenjie and van der Zaag, 2000; Lulofs, 2005; Phills et al., 2008).

The third rung of the ladder, to 'involve', occurs through interactive discussion and dialogue (Bruns, 2003). More complex and in-depth sharing of information and data takes place at this stage of

participation then during the consultation stage. This is followed by the collaboration stage, where there is a 'representative' from each sector working together towards recommendations or alternatives. This stage is characterised by task forces and working groups (Bruns, 2003). During the 'collaborate' stage there is joint discussion, where all stakeholders actively collect and share knowledge and understanding in order to make the decision. During this phase of public participation however, government still makes the final decision (Bruns, 2003). This is different to the next rung, 'partner', whereby a number of stakeholders make a decision together through mutual agreement. This stage is characterised by co-management agreements or contracts (Bruns, 2003).

The final four rungs of the extended ladder of participation represent the formulation of an 'independent authority'. Authority is delegated to a group or organisation with specific authorisation to act on particular decisions (Bruns, 2003). For example, a water management authority in a specific region is delegated to a local organisation. This develops into the establishment of autonomy by communities or organisations, subject to particular laws or regulations from government. The next rung is the provision of 'advise' through information, guidance or technical assistance as inputs in decision-making. The final rung, 'enable', represents the point whereby government is able to provide status and recourse to organisations which then manage the resource themselves. Accountability is achieved through a charter or contract (Bruns, 2003). These rungs of the ladder are comparable to the different stages of information and knowledge sharing with respect to public and private sector water risks. Each form of public participation is characterised by different information or data requirements, level of communication, and power of decision making or sharing of knowledge and understanding. Although hierarchical in setup, the different rungs of participation do not imply that the highest form of participation is always required. Depending on the context, particular forms of 'lesser' participation may be sufficient to appease involvement needs of all parties (Collins and Ison, 2006).

Similar to the extended ladder of participation introduced by Bruns (2003), the CEO Water Mandate Guide to Water-related Collective Action identifies types of collective action which range from: information sharing (informative), seeking advice (consultative), pursuing common objectives (collaborative) and integrating decisions and resources (integrative) (Greenwood et al., 2012). The choice of collective action type depends on a number of considerations including the interest and capacity between the company and other stakeholder(s) as well as the risk concerned (Sadoff et al., 2008; Greenwood et al., 2012). Collective action supports the exchange of "experiences, perspectives and fresh ideas" which may result in a range of benefits including "credibility, an increased drive for positive change and the pooling of resources in order to address common objectives" (Greenwood et al., 2012). Sadoff et al. (2008) recognise that collective action enables benefits that would not have been possible if each actor had mitigated the risks alone. Greenwood et al. (2012) link levels of collective action with the dependency between two stakeholders as well as the reserve capacity and interest of the stakeholders in working together. Informative collective action involves just sharing

information with each other, while increasing levels of collective action require additional dependency, interest and capacity (Figure 9).

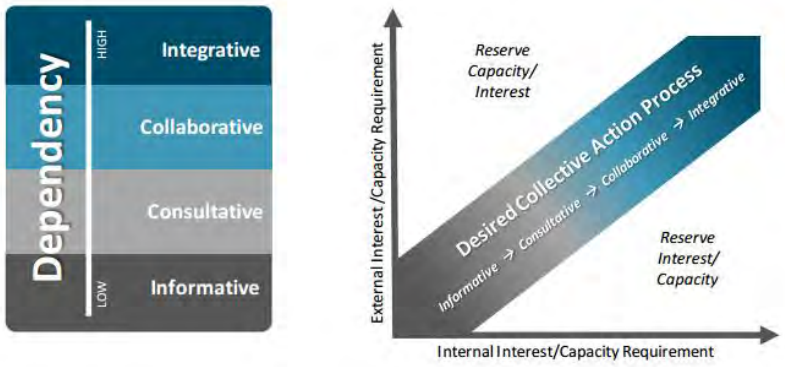

Figure 9: Mapping dependency, interest and capacity outcomes to collective action engagement levels (Greenwood et al., 2012)

This framework (Figure 9) is useful in illustrating the different and similar risks between public and private actors. The framework emphasises that although knowledge and understanding of the risks are important, the interest, capacity and dependency of each stakeholder is important in determining the level of collective action or sharing which may take place. Within collaborative governance literature, Ansell and Gash (2007) identify critical variables which will influence whether or not successful collaboration will ensue. Variables they suggest include incentives for stakeholders to participate, power and resources imbalances, leadership and institutional design. Factors which they identify as crucial include face-to-face dialogue, trust building and a shared understanding of the situation. A shared understanding is seen as part of a larger collaborative learning process whereby stakeholders develop a shared understanding of what they can collectively achieve together (Ansell and Gash, 2007).

Another useful concept to shared water risk is 'stewardship'. Companies may become involved in the planning, support or implementation of improved water management on a basin scale through communication and engagement with community, private sector and government stakeholders (Hecht et al., 2011; Sarni, 2012). Government (local, provincial and national) have the responsibility in managing this process. However, it is in the interest of all stakeholders to ensure government fulfils this role, "especially for those businesses that depend upon water in their production and supply chains" (Orr et al., 2011; WWF, WEF and Pegasys, 2010). The Alliance for Water Stewardship (AWS) defines water stewardship as, "the use of freshwater that is socially and economically beneficial as well as environmentally sustainable" (AWS, 2010; Hepworth et al., 2011). The basic premise of stewardship is that everyone is accountable for the sustainable management of public goods and that a 'collective response' is required to manage the resources (AWS, 2010). Many companies, as part of their environmental stewardship, contribute towards environmental health in

some way (Sarni, 2011; Hecht et al., 2012). Interest in a sustainable economy from a business perspective is influenced by , "rising energy costs, restrictions on material availability in global supply chains, government regulations and consumer awareness and expanding economic opportunities" (Hecht et al., 2012: 6). Through engaging in the promotion of sustainable practices, businesses are supporting an evolving relationship with their stakeholders and government towards improved cooperation. Therefore 'stewardship' supports the concept of public and private actors managing water, a shared resource, through the identification of risks and a stepwise approach of mitigating these risks. First a greater knowledge and understanding of the water risk is required. Among the other steps of stewardship, 'collective action' indicates the level of stewardship through which joint decisions are made regarding the shared resource.

SABMiller, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), WWF (2010) suggest a range of efforts companies may engage in including: the supply chain, by increasing water efficiency at farm level; and government, by improving water efficiency at the river basin scale to ensure savings made are assimilated into aquifer or river recharge (SAB, GTZ and WWF, 2010; 2011). The WWF Water Stewardship steps (WWF, 2013) are shown in Figure 10.

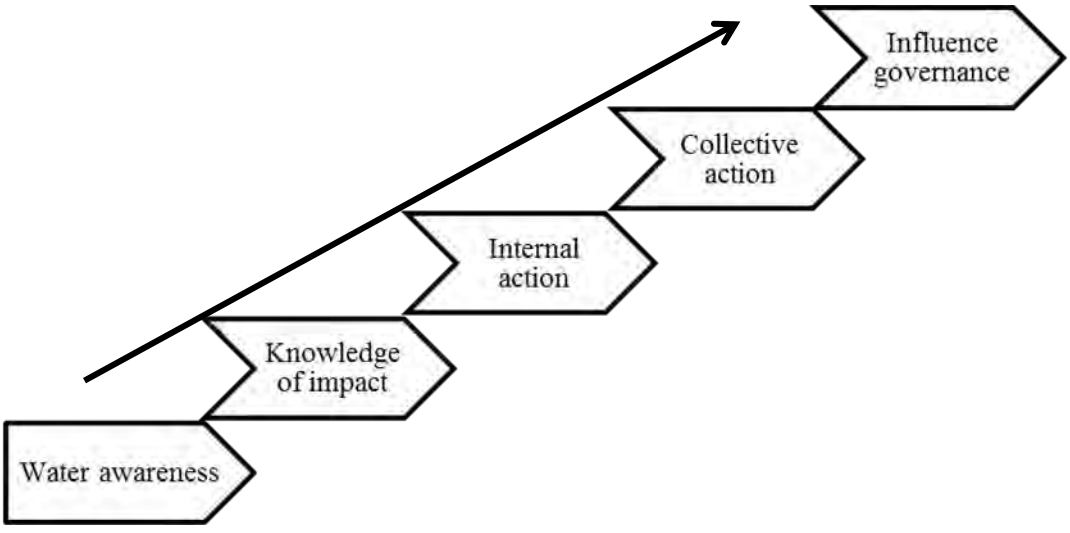

Figure 10: Steps to WWF's stewardship approach (WWF, 2013)

The steps of stewardship are considered in more depth in order to understand how the concept may contribute to the understanding of how risks are shared. Firstly, water awareness includes knowing how water impacts business and how business impacts water. This helps companies understand their dependence on freshwater and exposure to water-related risks. Secondly, knowledge of impact refers to the wider understanding of where a company's 'footprint' is located in terms of direct (company operations) and indirect (supply chain) water dependencies. A water footprint assessment – including

the context of the basin, as well as the identification of high risk caused by water quantity and/or quality issues – helps companies look beyond the fence line of their operations to understand the wider context of their water use (Hepworth et al., 2010; Jeswani and Azapagic, 2011).

Thirdly, internal action involves outlining goals, targets and plans that will help find the more immediate solutions to the problem. Internal action may include company targets to reduce baseline water use, the launch of water efficiency pilot projects, engagement with employees, suppliers and consumers to address opportunities and risks, improvement of water quantity and quality reporting, and pollution prevention. This is followed by collective action, which is the stage where the company may work with others in a water stewardship strategy. Collective action may be with other users in the watershed, NGO's, sector initiatives, public agencies and standard-setting bodies. There are many forms of collective action, from information sharing to collaboration or integration (Greenwood et al., 2012). Depending on the form of risks, collective action may help mitigate basin-related risks, boost reputation on water issues, and build brand trust and loyalty.

Following collective action is to influence governance. This is a stage of stewardship which must not be undertaken light-heartedly. It is the stage where engagement can bring about higher risk (often for short periods). This step may consist of advocacy, influencing or lobbying, partnership, financial support, facilitation or institutional strengthening. It may take place at the local, watershed, state or national level. In some places, companies may choose to use this strategy if risk is high or the imperative for better management from public authorities is seen as a future risk. Finally, basin governance encompasses a belief that through engagement, better management and governance we will be in place to protect the species and places we care about (WWF, 2013). Although these are introduced as steps, the process is far more chaotic, and is not carried out in a linear fashion (Laszlo and Zhexembayeva, 2011). However, what is suggested through the stewardship steps is that data and information about water resources is necessary to inform understanding and knowledge regarding water risk.

Porter and Kramer (2011) introduce the concept of Creating Shared Value (CSV) with the belief that opposing and contradictory attitudes between the private and public sector need to stop. The concept is used especially within Nestlé (Nestlé, 2011). No longer does each sector need to assume that the other is a barrier and obstacle which they need to overcome in order to pursue their goals (Porter and Kramer, 2011). "Traditional tensions between corporate environmental responsibility and profitability are giving way to a convergence between public and private sector interests" (Hecht et al., 2012). Hepworth (2012) takes note of the recent increase in reference to CSV by corporates. Companies have begun to recognise "it is not enough to create shared value for a company, you also have to create shared value for the community and society at large around you" (Hecht et al., 2012). This is relevant to the concept of reputational risk, where companies recognise they are part of a wider community.

The move towards shared value indicates a shift in how companies perceive their role in society (Bockstette and Stamp, 2012; Hamann, 2012). This is of relevance to the concept of shared risk where companies are not in isolation of stakeholders or the catchment in which they are situated.

The Carbon Disclosure Report is a synthesis of questionnaires sent to companies across the globe regarding their disclosure of water risks they face (CDP, 2012). The 2012 CDP Report states that "adoption of collective action initiatives reflects a strategic shift in thinking about water as a management issue to embodying water stewardship as a business strategy" (CDP, 2012: 11). Water viewed as a shared resource which is not owned by the company or a compliance or efficiency requirement enables longer term solutions which are more applicable to a wider network of stakeholders (CDP, 2012). Solutions are longer-term as a more complete approach of the risk mitigation has been taken by considering a range of stakeholder views (CDP, 2012). The United Nations CEO Water Mandate recently published a guide offering recommendations for companies wishing to engage in watershed governance or other aspects of water policy (Morrison et al., 2010). This, in addition to other authors (Pegram et al., 2009; Pegram and Eaglin, 2011), suggest the types of responses companies may consider relative to the risk concern. For example, an integrated risk management approach should be based on finding solutions for government, business and local water users. Policy engagement opportunities could include working with local communities, cooperating with civil society organisations helping ensure environmental and basic human needs are met, or supporting capacity building within the public sector (Pegram et al., 2009; Morrison et al., 2010; Kranz, 2011). A framework introduced by Pegram and Eaglin (2011) indicates the potential levels and scales the private sector may participate in water resources management (Figure 11). This is similar to the WWF Water Stewardship (2013) ladder presented in Figure 10. However, this framework takes a step further by suggesting potential organisations relevant at each scale of engagement. The x-axis of the figure also indicates whether or not the solutions are likely to be operational, strategic or policy solutions.

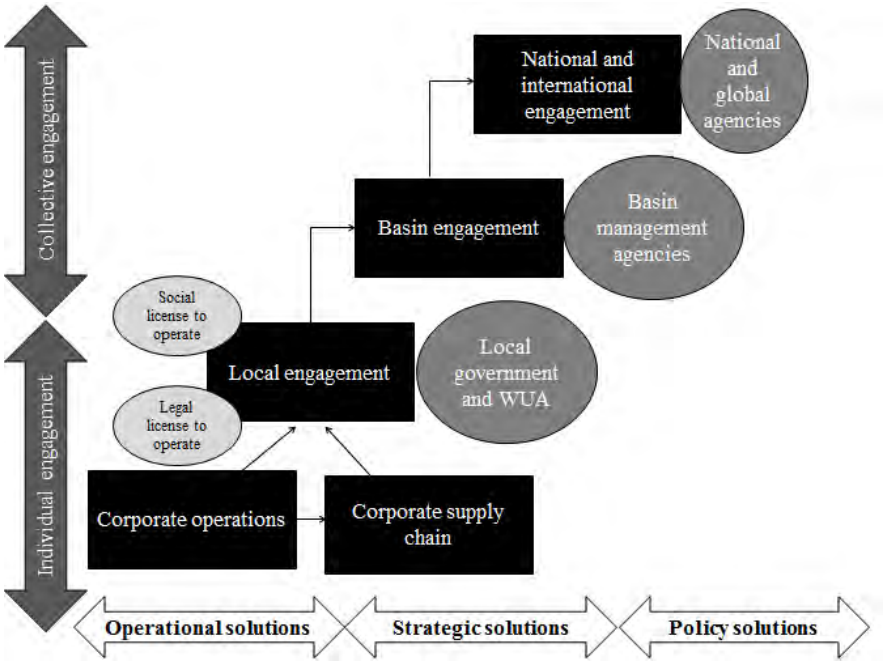

Figure 11: Private sector involvement with water resources management (Pegram and Eaglin, 2011: 37)

Pegram and Eaglin (2011) suggest the private sector may participate in water management as follows:

- *Operations and Supply Chain* includes the 'within factory fence' optimisation. At this stage a company has maximum control, and is able to ensure their processes are as efficient as possible. Once a company is aware of their own processes and relationship with water, engagement can be sought outside of the company.
- *Local level* engagement may be with the local government or stakeholders. Generally each individual company focuses on a specific concern (such as social or legal licence to operate), working together with the local municipal water agency or water user association.
- *Basin level* engagement typically takes place when individual action or local engagement is not sufficient. Multi-stakeholder platforms are generally formed, focused on sustainable availability of supplies and control of waste discharge at a catchment scale.
- *National level* engagement is largely around water policy and strategy development, and its linkages to food and energy. International institutions and large NGOs may also be present within this platform.

A company may choose to participate in one or many of the different levels or forms in water management. This is indicative of the concept that sharing itself does not have a single form, as depending on what the level of risk is, there are different levels of government or types of organisation that are of relevance. The response to water risk also depends on the capacity and interest of the company, public institution (or other stakeholder) with the water risk (Greenwood et al., 2012).

South Africa has a number of cases where companies have been proactive in recognising water as a risk that needs to be managed holistically (Morikawa et al., 2007; Amis and Nel, 2011). Some South African companies have begun to consider ways they may facilitate and engage in water resources management, recognising the capacity constraints within the public sector (CDE Roundtable, 2010). This reflects maturation beyond attempting to reduce regulation, towards a more cooperative form with government (Pegram and Eaglin, 2011). The NWRS 2 (DWA, 2013a) identifies the importance of partnerships between the public sector and other institutions in water provision as neither government nor the private sector is able to solve systemic water issues alone. Therefore, cooperation not only within formalised institutions, but throughout the sector, is crucial to effective water governance (DWA, 2013a).

2.6.1 The risks of sharing

The sharing of risk requires the input and participation of representatives from the public and private sector (Renn, 2008c). Through participation, people are made central to development, informing interventions that affect them and over which they have little influence (Cooke and Kothari, 2001). Multi-stakeholder participation has been lauded as useful in water resources governance, because of the complex nature of water and the need to include a range of stakeholder perceptions (Burris et al., 2005; Pahl-Wostl et al., 2009; Berry and Mollard, 2010). However, there are also challenges associated with increased participation and the sharing of water risk management responses (Cooke and Kothari, 2001; Swallow et al., 2004; Newig and Fritsch, 2009).

Firstly, the proposed improvements in environmental quality through participatory environmental governance are contested (Newig and Fritsch, 2009). Evidence of collaborative social participation improving the governance of natural resources is not adequately supported by empirical evidence (Koontz and Thomas, 2006; Newig and Fritsch, 2009) as promises of collaboration in theory have not always been achieved in practise. For example, collaboration is often lauded in the production of knowledge. However, evaluation of collaborative governance in practise has provided only limited insights into whether these outcomes are achieved (Taylor et al., 2012).

Secondly, critics have concerns regarding the methodological tools used and the theoretical, political and conceptual limitations of social participation (Cooke and Kothari, 2001; Newig and Fritsch, 2009). For example, the single use of the term ‘community’ hides substantial power relations which are found within ‘communities’ such as age, class, religion and gender. Cooke and Kothari (2001: 8) highlight three major considerations regarding participation: “1) Does the participatory process override existing legitimate decision-making processes? 2) Do the group dynamics lead to participatory decisions that reinforce those that are already powerful? And; 3) have the participatory methods driven out others which have advantages participation cannot provide?” In the case of public and private sector partnerships to manage water resources, the answer to these questions is not always

clear. The risk of corporate capture of water resources policy for example is a concern (Newborne and Hepworth, 2012).

Cooke and Kothari (2001:13) do acknowledge that some forms of participation, such as sharing of knowledge and negotiating relations are inevitable and "part of everyday life," while McDaniels et al. (1999) highlight examples where participation has resulted in positive outcomes. In this research, acknowledging the potential unequal actor interaction is critical to ensure that the participation of different actors contributes positively towards adequate water resources management. Participation is complex, and one cannot afford to be naïve regarding the subject. Therefore participation must include "a genuine and rigorous reflexivity" that acknowledges the processes of knowledge construction, and draws on a wide range of analyses and information (Cooke and Kothari, 2001; Cleaver and Franks, 2008). The same is also true for the concept of risk, which has a broad spectrum of understanding across sectors (Aven, 2011)

A further challenge is that although private sector involvement in public sector mandates can expand resources, improve efficiency or help increase the legitimacy of a public sector undertaking, there are also a range of potential losses. Donahue and Zeckhauser (2006) identify a number of barriers which contribute to private sector agents not fulfilling the public sectors' mandates as required. These include diluted control, where input from the private sector diminishes government authority and management of a resource. Higher spending is a risk due to erroneous prediction of private productivity advantages, higher transaction costs or because private actors exploit and extract resources from their government partner. Diminished capacity may result as government becomes increasingly dependent on private capabilities, putting itself in a disadvantaged position for future negotiation. These considerations need to be considered within the context of the collective action taking place, in order to weigh up the disadvantages and benefits for both sectors. As the demands for public value outpace governments' capacity to deliver it unaided (including water resource management and environmental preservation), the drive towards collaboration intensifies. Sharing of management or responsibility holds great benefit when used carefully and managed skilfully (Donahue and Zeckhauser, 2006).

Working with other water users or stakeholders within a shared catchment may present additional challenges to companies (and the public sector) and present additional risks (Hepworth, 2012; Daniel and Sojamo, 2012). Mention is made that "a greater role for the private sector in many ways also requires a stronger role for government" (Savenjie and van der Zaag, 2000: 29). Private sector intervention in a common-pool resource such as water requires a policy framework or regulation of some form. Donahue and Zeckhauser (2006) make mention of the additional analytical and managerial demands on the public sector when entering into collective management, while Hall and Lobina (2012) warn against the private sector meeting their water needs to the detriment of the

environment or society within the catchment. The overuse of risk concepts and analysis may promote the displacement of government responsibility to the private sector (Rayner, 2007). One of the failures of the shared risk approach is that it does not acknowledge the conflicts of interest between companies and society (Hall and Lobina, 2012; Mason, 2013). For example, regulatory risk in the form of stricter effluent discharge requirements is not a risk, but a benefit to the rest of society (Hall and Lobina, 2012; Hepworth, 2012). Pegram et al. (2009) acknowledge strong institutional capacity from the public sector is required to develop and implement plans, even just to start the initial dialogue. Mason (2013) however indicates that the public sector has been slow in responding. Intervention in the water management by the corporate sector may present some challenges as well as opportunities for government.

Determination of the boundaries where public responsibilities end and corporate responsibilities begin is not clear, as impacts and linkages with water and the environment are not always equal. The increase in collective action between the private and public sector results in an additional problem regarding assignment of "who should do what?" (Donahue and Zeckhauser, 2006: 496). Challenges to government include whether corporates in the water sector engage extensively, resulting in corporate capture, where planning and development processes are taken over by the higher-capacitated and resourced private sector. Perceived institutional capture, if not managed appropriately, may cause significant harm to the company, as well as the entire collaborative process (Pegram et al., 2009). Large multi-nationals operating in regions of weak governance may be more involved than in other areas (Lambooy, 2011; Hepworth, 2012; Daniel and Sojamo, 2012; Methner, 2012). The Centre for Development and Enterprise (CDE, 2010) recognises these risks, stressing that the public sector needs to create an appropriate framework through which the private sector may interact in order to reduce water risks.

The CEO Water Mandate (2010) "Framework for Responsible Business Engagement with Water Policy" recognises that internal management cannot address risk and capture opportunities stemming from external conditions alone. The framework makes a compelling case for responsible water policy engagement. It is supported by a guide on collective action highlighting insights, strategies, and tactics needed to improve collective management of water resources (Greenwood et al., 2012). However, sharing and cooperation are only beneficial when the alternatives do not provide greater benefits. Therefore, institutions will cooperate only "when they believe it is in their own interest to do so," (Sadoff et al., 2008; Pegram et al., 2009). Private-sector engagement with the public sector has its own risks which, in order for collaboration to take place, must be lower than that of the overall systemic risk reduction when entering a partnership. This is illustrated in Figure 12 (Pegram et al., 2009).

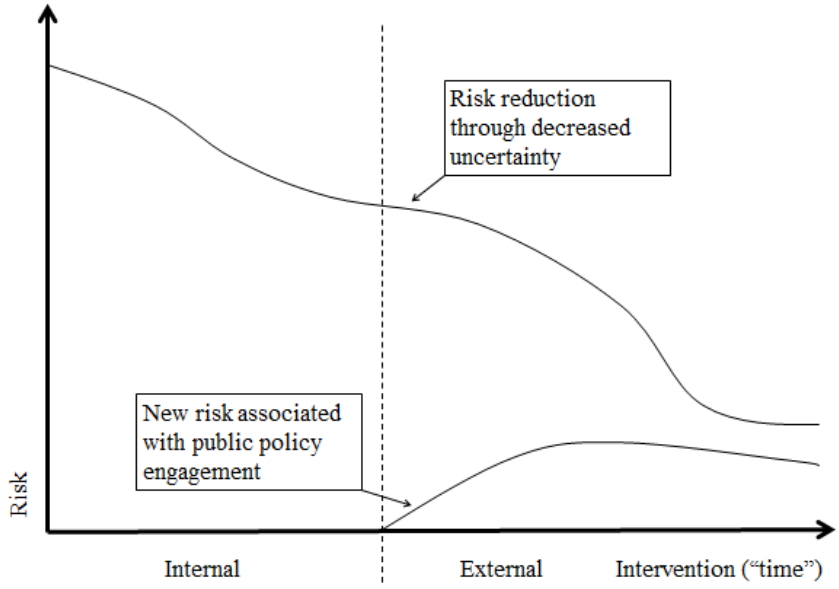

Figure 12: Risk over time associated with corporate water-related interventions (Pegram et al., 2009)

The first portion of risk reduction, before the dotted line, is attributed to internal operational and supply chain interventions carried out by the company. While this may reduce some exposure, over the longer term with increasing uncertainty, an additional intervention is necessary. Moving outside of the dotted line, into external engagement, may enable these risks to be reduced further. However, as indicated, entering into partnerships also has risks. At the initiation of engagement, while information is still being shared, the risks may not as significant as those during collaboration or integration of efforts within a partnership. The risks associated with entering a form of partnership may then decrease once the partnership is successful.

Government plays an important role in providing an appropriate governance framework through the setting of correct incentives. Capacity and skill are required in order for government to fulfil these tasks. However, management or human resource capacity issues in water resources management are commonly found in developing countries (Kranz, 2011; Methner, 2012; Schreiner, 2013). Failures in current water governance arrangements are likely to face further complications. New forms of governance with non-state actors may also increase the complexity and uncertainty within the governance frameworks (Kranz, 2011). Therefore, although the role of civil society is widely accepted for making water governance arrangements more accessible and transparent, the role of business is challenged (Kranz, 2011).

Addressing shared water risks requires a full understanding of the local watershed alongside the perspectives and positions of all other actors (SAB, GTZ and WWF, 2010; 2011). Understanding followed by change may take time, and needs to be built upon a solid foundation of internal capacity. "Shared value is more evolutionary than revolutionary," (Bockstette and Stamp, 2012). Integrity throughout the company towards stewardship is required as some companies have been accused of

'green-washing', where the extent of their stewardship was being exaggerated for publicity gains (Hecht et al., 2012; Spedding and Rose, 2008). This can quickly result in the opposite of the required effect. Other negatives to collaborating include the potential risk of continuously needing mutual consensus (Scearce, 2011). Scearce (2011) also notes the lack of a definite road-map on how to collaborate as a potential reason for why some members may contribute more than others. Considering the drawbacks and difficulties the sharing of risks between the public and private sector, improved or sustainable water resources management is not always the outcome following a risk sharing approach unless both the private and public sector recognise the wider risks of the entire catchment instead of individual concerns.

2.7 Summary

The mitigation of water-related risks to business or government may be internal or external, depending on the nature of water risk, type of company/municipality and interest and capacity of other interested stakeholder(s) as well as the socio-political environment (Greenwood et al., 2012). Risks stemming from the wider catchment may require proactive involvement of the inhabitants within the catchment, the supply chain or government/private sector, while internal responses might be required by the specific organisation (Orr et al., 2009; Greenwood et al., 2012). A growing number of institutions, tools, frameworks and documents support the inclusion of the private sector in WRM and governance through alignment with public policy to achieve some forms of mitigation in water risks (Orr et al., 2009; SAB, GTZ and WWF, 2010; Morrison et al., 2010; Greenwood et al., CDP, 2011; Barton et al., 2011; Hepworth, 2012). Evidence of this shift include new and evolving terms and concepts in literature such as stewardship, collective action, creating shared value and shared risks (Orr et al., 2009; Sarni, 2011; Porter and Kramer, 2011; Pegram et al., 2011; Greenwood et al., 2012).

Multi stakeholder partnerships, collaborative governance and adaptive management also mirror the shift in WRM and governance (Mandell and Steelman, 2003; Ansell and Gash, 2007; Huitema et al., 2009; Berry and Mollard, 2010). The inclusion of stakeholders such as the private sector is believed to increase the diversity of insights and transparency of WRM (Beery and Mollard, 2010; Carr et al., 2012; Diaz-Kope and Miller Stevens, 2014). However, there are also drawbacks associated with the inclusion of different stakeholders such as different temporal boundaries and conflicting opinions which need to be met (Bryson et al., 2006; Cleaver and Franks, 2008; Bressers and Lulofs, 2010). The challenge of this thesis is to explore how these barriers can be overcome through knowledge and understanding of private and public sector water risks.

This thesis investigates the knowledge and understanding of water risks within each sector. Although the concept of risk may be similar between the public and private sector, there are also differences in how risks are theoretically conceived within each sector. This literature review investigated the

similarities between risk management of water between the private and public sector, and integrating technical as well as social risk as suggested by Renn (2008c). Understanding water risks for each sector supports developing the theory of shared water risk. The identification of diverging water risks is aimed at understanding water risk within each of these sectors.

Concepts and theories such as collective action, creating shared value, stewardship and public participation support an understanding of shared risk, as there is a growing realisation that water risks cannot be managed alone. Tools and frameworks such as collective action suggest that knowledge and understanding inform how the private sector analyse their water risks. These tools and concepts are less developed for the public sector. Public sector awareness and readiness to partner with the private sector in mitigating water risk is less developed. Although shared water risks are mentioned in private sector water risk literature, there is a gap in understanding by the public sector. As collective action increases, the decision as to 'who does what' becomes increasingly complex and consequential (Donahue and Zeckhauser, 2006). This thesis will inform this gap through interviews with public and private sector representatives and analysis of public and private sector water risk frameworks to investigate how each sector understands their respective water-related risks as well as understanding the potential (or current) role in managing water resources collectively.

Shared water risk is identified as a potential framework through which water resources might be better managed in co-operation with the private and public sector (Pegram, 2010). However the concept of shared water risk is not yet fully developed, as knowledge and understanding of how private and public sector risks are understood is not widely known and is under-researched. This thesis, through the literature, interviews, contextual data and institutional analysis aims to inform how risks are understood and can be known and shared within each sector. The concept of shared water risk is examined through an investigation of what knowledge and understanding informs private and public sector water risks. It also involves a comparison between risk perspectives across private and public sectors.

Chapter 3: Methodology

3.1 Overview

The aim of the thesis is to understand, identify and characterise the different and similar water risks within and between the private and public sector actors. This will be perfromed using a case study research design that incorporates an array of data sources. The case study geographic unit of analysis is the Palmiet River Catchment, in the area surrounding the town of Grabouw and Elgin Valley (Figure 1).

A further aim of the thesis is to expand, refine and confirm an emergent framework and a typology of shared risk. The purpose of comparing public and private sector water risk perceptions is to interrogate the concept of shared water risk empirically (Sartori, 1991: 255). These aims are achieved through six objectives. Each objective has a corresponding methodological procedure. The objectives contribute toward answering three principle research questions:

1. *What is the knowledge and understanding of water risks within and between the public and private sector within a single catchment?*

2. How does the knowledge and understanding of public and private sector water risks help to map and understand shared water risks in a catchment?

3. How does the public and private sector respond to shared water risk?

3.2 Rationale for a qualitative exploratory case study and adaptive theory

A case study is used because the concept of shared water risk is still in its infancy, especially in the public sector domain. Yin (2009) claims that a case study approach offers a comprehensive and enlightened understanding of a situation. The case study method used in this thesis is designed to interrogate the complexity of a single case in order to explore detailed interaction of actors within their contexts through a range of data sources (Meyer, 2001; Yin, 2009).

Case study research is defined as a "method that involves investigating one or a small number of social entities or situations, about which information is collected using multiple sources of data and developing a holistic description through an iterative research process" (Easton, 2007: 119). The methodology follows the 'explanation building' method as suggested by Yin (2009), which is appropriate in new areas of exploration (Eisenhardt, 1989). A case study is the preferred research method when questions consider how or why a situation exists; when the researcher has little control over the events; or when the research is examining real life, contemporary phenomena which cannot be explained through surveys or experimental strategies alone (Starke, 1995; Yin, 2009).

Case studies are well suited to the use of adaptive theory and vice versa (Easton, 2007). Adaptive theory builds upon previous literature and theory through novel empirical research to further develop

a theoretical concept or framework (Layder, 1998; Charmaz, 2002; Goulding, 2005; Lingard et al., 2008).

Adaptive theory informs this research in a number of ways. Firstly, adaptive theory uses both inductive and deductive procedures for developing and elaborating theory (Layder, 1998). This is synonymous with the process of first investigating theory regarding shared water risk in academic and grey literature, followed by the collection of empirical data to further develop theory in this field. Secondly, adaptive theory is both objective and subjective, indicated by the use of both technical data and social perceptions of water risk. Adaptive theory assumes that the social world is complex and multi-faceted. This is indicated through the interrogation of a range of actors' perceptions of water risk within the case study catchment. Lastly, adaptive theory focuses on the many "interconnections between human agency, social activities and self-organisation" (Layder, 1998: 133). Thus a range of data sources in this research are combined in an iterative and adaptive process to develop theory.

3.3 Research design

The research design is outlined in Figure 13 which presents an overview of the case study research design and methods. These include document analysis and interviews. The interviews comprise a range of embedded units of analysis from public to private sector actors. The data collected through the empirical process was used alongside prior frameworks to develop a greater understanding of the concept of shared water risk. The result is the formulation of a shared water risk framework and sharing typology. These concepts were refined further in the final phase of the research process through additional interviews with representatives in the research area and presentations to stakeholders.

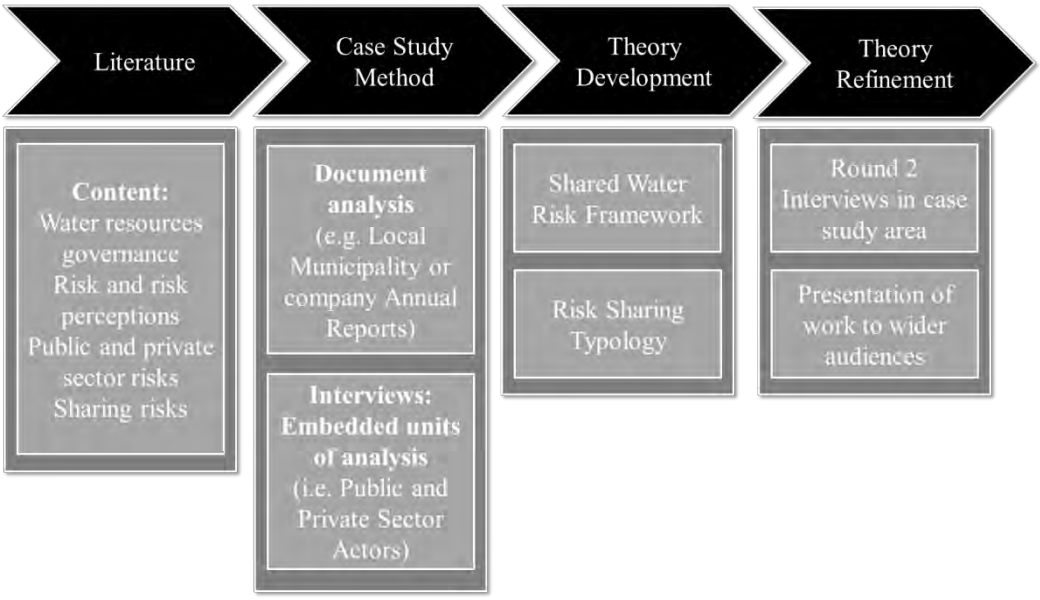

Figure 13: Research design

3.3.1 Literature

The literature review included an examination of water resource governance theories, risk and risk perceptions, the different framing of private and public sector risk as well as the sharing of risk. The focus of the review is to investigate the role of shared risk in the governance of water as a natural resource. Risk theory is used to inform actions and decisions which span public and private sectors.

3.3.2 Case Study Method

Multiple sources of data are a hallmark of this case study research, as they enhance the credibility of the process (Baxter and Jack, 2008; Yin, 2009). When a pattern from one data source is similar to evidence from another, the finding is better grounded, stronger and assumed to be more robust (Eisenhardt, 1989; Czarniawska, 2001). Layder's *Adaptive Theory* (1998) suggests multiple sources of data are considered within the research design, to triangulate findings to ensure, "strength, density and validity of theoretical ideas and concepts" (Layder, 1998: 68). As indicated by Figure 13, data sources in this research included document analysis from literature and interviews with actors within the catchment. The range of data sources has different roles and characteristics in the case study method.

Data sources were characterised according to their respective types. Layder (1998) and Yin (2009) classify three different data sources respectively. These are shown in relation to this research in the table below. The different forms of data are embedded units of analysis, which, when integrated, need to converge or complement evidence to triangulate findings in the case study (Yin, 2009). Layder's two main forms of data in *Adaptive Theory* (1998) include: empirical (emergent or extant) and theoretical data. In Yin (2009), the three layers of data are a primary interview layer, a secondary organisational layer and finally, a contextual layer. The interviews and direct observation used in the thesis are seen as part of the interview layer (Yin, 2009) and empirical, emergent research data (Layder, 1998). Multiple interviews were conducted with public and private sector representatives within the case study in order to ensure a range of converging public and private sector risk perspectives. The organisational layer (Yin, 2009) is classified as empirical extant research data by Layder (1998). Data in this category include municipal and corporate annual reports, website information on the companies or municipality and the catchment management plan of the region. The third form of data is classified as theoretical data and the context layer by Layder (1998) and Yin (2009) respectively. This category includes literature on the case study region or theoretical frameworks used to inform the case study research.

Table 2: Types of data in the case study based on Layder (1998) and Yin (2009)

Layder (1998)		Yin (2009)	Implementation in this research
Empirical	Emergent research data	Interview layer	*Questionnaire and semi-structured interviews with stakeholders in the Palmiet Catchment and stakeholders and experts within the research field*
			Direct Observation at GWUA Meetings
	Extant research data	Organisational layer	*Secondary data resources including government documents, catchment management plan and company websites*
Theoretical	Theoretical data- includes pre-existing general theory	Context layer	*Theories such as collective action, partnership and participation and contextual information on the catchment case study area*

This research is centred upon a single case study region, in which multiple units of analysis are captured and analysed in order to increase the potential to form reliable generalisations (Eisenhardt, 1989; Czarniawska, 2001; Yin 2009). The Palmiet Catchment around Grabouw and the Elgin Valley is used as the geographic unit of analysis. Additional case study areas were not selected, as sample size is less important than the gathering of valid and meaningful insights (Layder, 1998: 46). A case study, unlike an experiment, does not need repeated results in order to expand theory (Sayer, 2000; Yin, 2009).

Interviews: Theoretical framing

Interviews were used to capture the social and technical aspects of water risk perceptions. The interviews were used to "derive interpretations, not facts or laws from respondent answers" (Warren, 2001: 83, in Gubrium and Holstein) in order enrich the case study. Interviews are a useful form of data collection, as highly specific data can be obtained in a very short space of time as well as provide a useful overview of people's thoughts (Yin, 2009).

The data were used in an adaptive theory process to build on and refine the shared water risk framework. Interviews, as opposed to focus groups, were chosen as: 1) interviews are preferable when interested in eliciting individuals' narratives; 2) it is difficult to understand individual opinions in a group setting, as disjointed and jumbled accounts are likely to arise; and 3) logistics on getting elites together is difficult (Barbour, 2008: 49).

Interviews with public and private sector stakeholders within the catchment as well as researchers and practitioners with experience on the topic formed the primary data input of the interviews. A wide range of stakeholders were selected from a range of institutions and businesses active in the catchment (Figure 14). Grabouw, being an agriculture-based town, is heavily dependent on agricultural products and services, and therefore has a large agro-processing sector in the region (Toerien and Seaman,

2011). Companies selected in this research are specifically agro-processing companies, as it is an important economic sector in the region, and of specific importance with respect to water risk. A range of agro-processing companies were interviewed in an attempt to understand a broad suite of private sector water risks in the region. Within the public sector, all active public institutions were selected.

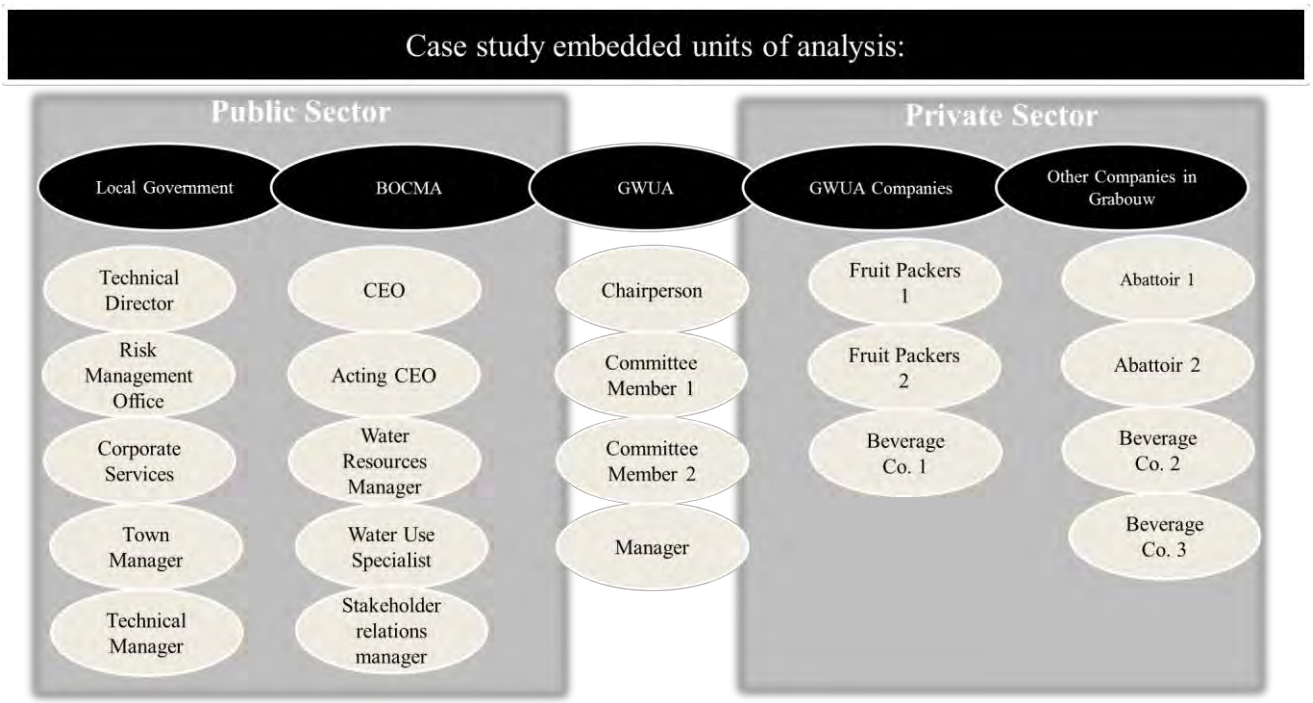

Figure 14: Case Study interviews embedded units of analysis

In Phase 1, the interview responses were used to investigate public and private actor perceptions of water risk within a catchment. In Phase 2, the interviews were used to validate and further develop the water risk framework and sharing typology developed. As indicated in the figure a range of actors represent the different embedded units of analysis. These include public sector representatives such as the local municipality. Purely private sector representatives include agro-processing businesses in the town of Grabouw. Sectors which sit between the purely public and private sector include the GWUA which has both public and private sector representation.

The structure of the interviews in Phase 1 was based on questionnaires and information requirements for other water risk frameworks including Morrison and Gleick (2004), Morrison et al. (2009), Pegram (2010) and the WWF Water Risk Filter questionnaire (Appendix D). Sarni (2011) uses a roadmap highlighting information required for corporate water stewardship programmes which informed the design of the case study process. Sarni (2011) states that water alone is not sufficient in understanding water scarcity risks. Water strategies must "acknowledge the complexity of water and incorporate environmental, social and economic elements" (Sarni, 2011:149). Sarni (2011) identifies three phases required in building a water strategy. The phases include understanding the technical

aspects of water use through water footprinting, the more complex understanding of risks and opportunities relating to water, and the way forward with regards to the information collected. Like Sarni (2011), this research has three key phases. First understand the underlying water situation of the case study through technical catchment management plans and water data. Second, different risk perspectives of public and private stakeholders are identified; and third, the concept of collaborating or co-managing risk concerns (sharing risks) was investigated as a potential response to the public and private sector water risks.

Another framework which informed the setup of the questions in the interviews was the WWF Water Risk Filter. The case study semi-structured interviews considered not only the company or institutions' water use, but the context of the wider catchment too. This is based on the method of the Water Risk Filter, which has two main data sources. Firstly, it uses a large set of risk indicators based on publically available datasets with global coverage in order to arrive at a risk evaluation for a specific river basin. The second source of data for the water risk assessment is based on specific information collated from the water risk questionnaire given to each specific company. The Risk Filter is able to provide a high level pre-assessment using purely the geographic location of the company and the relevant industry sector (Orr et al., 2011). Additional guidance on how to investigate water risks were incorporated from Pegram, (2010), Morrison et al. (2009), Morrison and Gleick, (2004), and Morikawa et al. (2007). Extracts of these can be found in Appendix D in addition to the WWF Water Risk Filter Questionnaire (Orr et al., 2009).

In Phase 2 of the interview process, respondents within the catchment were re-interviewed in order to report back on the frameworks developed. Questions regarding the usefulness of the frameworks, and the potential missing information were included. Critical insight into whether or not the framework informs current practise, and could be useful in water resources management, were considered through the questions.

Semi-structured interviews

This thesis is centred on further building the concept of shared water risk through the use of semi-structured interviews. Face-to-face, semi-structured, interviews are used to build theory. This form of interview is justified due to the flexibility, richness of information gathered, ability to illustrate findings and support for theory being developed (Goulding, 2005; Corburn, 2007; Henwood et al., 2010). Pre-prepared questions were developed to ensure all topics absolutely necessary for the comparison of data in the research were covered in the interview (Sjöberg, 2000; Barbour, 2008; Henwood, 2010). Open-ended questions were also used in the interview process to allow respondents to focus on areas important to them, and not only those initially indicated as important in the interview process (Barbour, 2008; Yin, 2009). In adaptive theory, Layder (1998) also suggests open-ended questions as the primary way to collect data, as interview questions may change according to

the theory that may begin to emerge. The aim of the semi-structured interview questions was not to impose answers, but to act as a guide in theory development.

Interviews were transcribed as the conversation took place to ensure maximum information was captured and direct quote testimonies could be used to support findings from the data. A confidentiality agreement was signed and clarified before the commencement of the interview. Information regarding the identification of the interviewee includes their sector and professional position.

In Phase 1 of the interview process, close-ended questions were aimed at understanding the water use and discharge of the company or public sector (Table 3). The make-up of the questions, as indicated previously, is based on the WWF Water Risk Filter framing of water-related risks. The purpose of the questions was to establish the relative importance of particular water-related risks over others. Questions either required a numerical response, or a ranking of different water risk concerns through a Lickert Scale (Yin, 2009).

Table 3: Selection of phase 1 close-ended questions

Category	Close-ended questions	Range of responses
Physical – Quantity and quality	What is the importance of having sufficient amounts of clean freshwater available for the production/operational site's operations?	*Not important at all; not overly important; neutral; important; very important – vital for operations.*
	Has the facility had/having problems withdrawing/obtaining the required quality and amount of water for its operations?	*No; don't know; no, but we anticipate problems in the future; yes, in the last five year; yes, regularly.*
	Are you able to change your water supply or quality situation?	*Many alternatives exist; alternatives exist, but it will be difficult or expensive; some flexibility exists; not flexible, there is a >5 year contract; not flexible, no other options*
Regulatory	What is the level of compliance of the facility to legal quality discharge standards for wastewater?	*Facility meets all existing legal standards; legal requirements will be set in the next 5 years; no legal requirements exist at the moment; the facility is planning to meet existing standards within the next five years; the facility is not meeting existing quality standards*
	Has the facility paid any penalties or fines for breaches of discharge regulations within the last five years?	*No; facility has been under investigation; yes, facility had to pay one or more small penalties or fines; yes, the facility had to pay one or more significant penalties or fines; yes, the facility is threatened with closure due to breaches*
	Is the facility exposed to planned or potential significant regulatory changes?	*No; changes in the water price or quality standards being discussed; changes in water rights or licenses to operate being discussed; yes, water price or quality changes will be effective in next five years; yes, water rights will expire, or license to operate will be withdrawn in the next five years.*
	Is there strong enforcement of water-related regulation in the catchment your facility operates in?	*Strong enforcement in the whole basin; strong enforcement in the direct surroundings; but weaker enforcement upstream regions of the basin; some (irregular) enforcement; no, but stronger*

Category	Close-ended questions	Range of responses
		enforcement is planned within the next 5 years; no
Reputational	Has there been any exposure to local/national media coverage? Positive or negative.	*Never; rarely (1 per year); occasionally (1 per 6 months); frequently (1 per month); often (1 per week)*
	Does the facility know who the other stakeholders are who are dependent on the water supply and quality within the water basin the facility operates in?	*Yes, facility knows all key stakeholders; yes, facility knows some stakeholders; facility has limited knowledge of stakeholders; no, facility does not know any stakeholders*
	Importance of facility as a water consumer in comparison to other stakeholders within the water basin	*One of the smallest; one of many average users; a major user; the largest user*
	Engagement with other local basin stakeholders (municipalities, government, companies, farmers, NGOs) to solve water-related conflicts and to manage local water resources	*Yes, actively engaging in a multi-lateral platform; yes, engaging with stakeholders in a bi-lateral discourse; yes, reactively engaging with other stakeholders as required; no, but engagement planned in next 5 years; no.*
	Is there a formal engagement platform set up?	*Yes, active forum which is actively engaging all stakeholders to sustainably manage the basin; yes, forum exists. Early results have been achieved, but not all stakeholders are engaged; yes, forum exists, but it is not yet in a position to influence; no, but some stakeholders are engaged to start cooperating in the next five years; no forum exists.*
	Involvement in any water-related disputes with other stakeholders in the catchment?	*No dispute in the last 5 years; one small dispute; multiple small disputes with a number of stakeholders; one major dispute; multiple major disputes with different basin stakeholders*
Water Management and Governance	What is the form of the water policy, strategy or management plan for the facility?	*Yes, the facility has an advanced water policy, strategy or plan with baselines and efficiency targets; yes, the facility has a water policy, strategy or plan with a basic baseline; yes, the facility has a high level water policy, strategy or plan with no specific measurement targets; no, not yet, but one will be introduced in the next 5 years; no.*
	Highest level of responsibility within the facility for the water policy, strategy or plan?	*CEO/Board of Directors; environmental manager at group level; facility or plant manager; facility environmental manager; nobody in particular*
	Discussions regarding monitoring of water and wastewater quantity and quality with top management	*Once per month; once per quarter; once per year; not yet, but planned; never.*
Financial	Water related actions have been taken at the facility to improve its own operations	*Extensive consumption metering, water efficiency measures and wastewater treatment; extensive consumption metering and discharge metering; high level consumption or discharge metering; not yet, but planned in the next 5 years; no water-related actions planned*
	Significant investments made or planned within are related to water issues being faced (water treatment plant, efficiency measures)	*Yes, significant investments in the process of being implemented; yes, significant investments planned; yes, minor investments planned; no investments planned*

A range of particular open-ended questions were pre-planned (Table 4) in addition to following on from comments made within the close-ended questions for clarification. Open-ended questions were asked in order to expand upon water risk concerns identified in the close-ended questions.

Investigating public and private responses to these questions contributed towards an improved understanding of the knowledge and understanding of risk within each sector. This information was useful in understanding elements of risk which are shared.

Table 4: Selection of Phase 1 open-ended questions

Category	Open-ended questions
Physical - quantity	Is your operation located in a water stressed region? Please clarify what you mean by a 'water-stressed' region?
Physical – quantity and quality	Do any of your inputs or raw materials come from regions which experience water related risks such as scarcity or poor quality?
Physical – quality	If your facility does not meet current or planned regulatory requirements, please expand on the situation.
	If the facility has faced any penalties for incorrect discharge of wastewater in the past, please expand.
Water management and governance	Please describe your policy, strategy or management plan, including the highest level of responsibility and geographical reach.

Interviews

Companies were selected through a snowballing technique. With each interview with the largest and most well-known industries in the region, further suggestions were offered to advance the number of participants. In addition, GWUA and Theewaterskloof Local Municipality were asked to suggest agro-processing water users with which they were familiar. Finally, business listings were considered to check that well-known or obvious agro-processing industries were not missed. Interviews were carried out with a range of institutions ranging between the public and private sector between March 2011 and March 2013, with the majority taking place between April and August 2012. A second round of interviews took place to validate and verify the design of the framework between January and June 2014.

In total, 12 individual companies were offered by GWUA in the category of industrial water users. Three agro-processing companies and the Theewaterskloof Local Municipality, totalling four of the GWUA industrial water users, representing 97% of the GWUA summer water quota were interviewed. Therefore, all major water users of the catchment were interviewed. Those not interviewed include three shops/stalls, three colleges/training centres and two fruit-packing facilities which did not have a large water consumption. The other companies interviewed include two of the three largest agro-processing industries in the town of Grabouw. Two companies that were not supplied with water by GWUA or Theewaterskloof, but are well-known agro-processing facilities in the region were included as case study companies. An overview of the companies interviewed is shown below in Table 5.

Table 5: Agro-processing companies interviewed in case study

Private Sector Respondents	Fruit Packers 1	Beverage Company 1	Abattoir 1	Beverage Company 2	Beverage Company 3	Abattoir 2	Fruit Packers 2
Water Source	Eikenhof Dam	Eikenhof Dam	Municipal	Own stream	Own dams	Municipal	Eikenhof Dam
Waste water discharge	Palmiet Tributary	Palmiet	Municipal	Own dam	Own dams	Municipal	Palmiet
Institution regulating water supply	GWUA	GWUA	TWK	DWA	DWA	TWK	GWUA
Institution regulating waste water discharge	DWA	DWA	TWK	DWA	DWA	TWK	DWA

The public sector in this research includes a number of institutions which represent the public interests in the form of the local municipality, catchment management authority and water users association. Interviews and information collected from a number of 'public sector' levels included: CMAs, WUAs, water treatment works, district municipal managers, local municipal managers, regional water resource managers and provincial water resource managers. These organisations have distinct mandates with respect to water, and thus are all interviewed with respect to their understanding of water risk.

In total 49 full semi-structured interviews were completed in Phase 1. These represented 18 public and 20 private institutions and 11 other researchers or specialists in the field (Table 6). Twenty-four interviews were conducted in the case study region itself, of which nine were with private and 13 with public representatives. The 13(+) indicates a number of short conversations held while attending GWUA quarterly committee meetings, also used as supporting empirical evidence for findings. The responses are summarised in Appendix E, while a more in-depth list of interview respondents are presented in Appendix F.

Table 6: Total interviews carried out in phase I and phase II

Phase of interviews	Number of Interviews	Private Sector	Public Sector	Other Interested	Total Interviews
Phase 1	Within Case Study	9	13 (+)	2	24
	Outside Case Study	11	5	9	25
	Total Phase 1	20	18	11	49
Phase 2	Within Case Study	4	10		14
	Outside Case Study	2	2	4	8
	Total Phase 2	6	12	4	22
	Total Interviews	26	30	14	71

Interviews conducted 'outside of the specific case study region' were to understand what the potential attributes are in order for effective collective action to take place between the private and public sector in general. The additional interviews helped clarify the broader understanding of water risks within the public and private sector, and give support to the overall aims and objectives of the thesis of expanding on the concept of shared water risk. The cases considered 'outside' of the case study were mostly examples of larger multi-national companies in South Africa engaging in water stewardship initiatives in water resource management. The cases were selected due to their reference by Greenwood et al. (2012) in their Water-related Collective Action Guide.

Interview Analysis

Close-ended question responses were quantified using a Likert scale, ranking the level of importance of the risk by respondents. While open-ended question responses were investigated through content analysis, as suggested by Yin (2009) and Strauss and Corbin (1990). The dimensions through which responses were analysed were sourced from existing literature on corporate water risks (Eisenhardt, 1989). Together, the interviews are embedded units of analysis in the greater case study suite of data.

In Phase 1 of the interview process, the interpretation of water scarcity risks and the potential for collaboration in responding to the risks between private and public sector actors was analysed to identify the possible root factors contributing to why different (or similar) water risks may exist (Eisenhardt, 1989). In order to organise the knowledge and understanding of the public and private sector, risks were categorised according to physical, regulatory and reputational risks. The choice of physical, regulatory and reputational risk categorisation was due to the framing used by theoretical sources such as the WWF Water Risk Filter and WRI Aqueduct water risk maps.

When asking respondents about particular risks and their understanding thereof, a Likert scale was used, requiring them to rank the importance of the risk across five categories (i.e. very low, low, medium, high, very high). This is a useful method of determining different risks (Sjöberg, 2000). The

ranking was, in addition to open-ended questions, developed to deeper understand water risk perspectives. Interviewees were invited to comment on the relevance of the questions posed and were encouraged to expand at length on issues they felt would enrich understanding of the dilemma facing the water sector.

Analysis of the data included the collection and collation of responses into similar groups. Similar responses were compared and contrasted. Comparing private and public sector differences in response to these question helps to identify where risks or underlying knowledge and understanding of risk is shared. As required in adaptive theory and case study research, the objectives and research questions are based on theory relevant to the case study (Yin, 2009). Therefore, theory provides a framework for critically understanding and organising the data collected (Silverman, 2006). In Table 7, close-ended questions and their respective responses from each sector representative are indicated. Responses in text are converted into colour-coded numerical values aligned with the Likert scale response options in order to better analyse the interview data. Where responses were open ended – subjective ranking of the importance of relative risks was done. See Appendix E for a summary of the question responses and an overview of the adaptive theory process.

The Likert scale was used to code (colour and numerically) the responses to particular questions during the interview. The scoring of the responses was as follows: 0 = not relevant; 1 = very low risk (dark green); 2 = low risk (light green), 3 = neutral/average risk (yellow), 4 = high risk (orange), 5 = very high risk (red).

Table 7: Summary of Phase 1 interview responses

		Private Sector							Public Sector					
Type	Questions	Fruit Processor 1	Beverage 1	Abattoir 1	Beverage 3	Beverage 2	Abattoir 2	FP 2	TWK 3	TWK 1	TWK 5	BOCMA	TWK 2	GWUA
Governance	Water policy, strategy or management plan	3	3	3	4	2	5	1	3	3	3	1	1	1
	Highest level of responsibility for water policy, strategy or plan	1	1	1	1	2	3	4	4	1	1	1	1	1
	Discussions of water with top management	1	1	1	1	2	2	3	1	1	1	1	1	2
	Contingency planning to respond to water risks	3	2	1	3	4	4	3	3	1	1	4	2	3
	Water related actions as operations to improve efficiency	2	2	1	1	1	4	2	3	1	1	0	2	1
	Investments related to water	2	2	2	2	2	4	2	1	1	2	2	2	1
	Annual Report mentions sustainability/water	1	1	1	1	1	4	1	1	1	1	1	1	1
Physical	Water stressed region?	3	3	3	1	1	3	3	4	4	1	3	1	1
	Inputs from water stressed region	2	3	2	1	1	2	1	0	0	0	0	0	0
	Importance of freshwater for operations	5	5	5	1	3	5	5	5	5	5	5	5	5

		Private Sector							Public Sector					
Type	Questions	Fruit Processor 1	Beverage 1	Abattoir 1	Beverage 3	Beverage 2	Abattoir 2	FP 2	TWK 3	TWK 1	TWK 5	BOCMA	TWK 2	GWUA
	Operations water problems in past	3	3	3	1	2	3	0	4	4	5	1	3	3
	Flexibility to change suppliers: Water	5	5	5	3	3	5	3	3	4	4	5	4	5
	Flexibility to change suppliers: Inputs	3	3	4	3	2	3	4	0	0	0	0	0	5
	Quality concern	4	4	4	1	2	3	4	3	4	4	4	4	5
	Physical concern	2	4	3	1	2	3	2	3	2	3	2	3	1
Regulatory	Discharge compliance	1	3	5	1	2	4	1	3	4	4	4	1	0
	Penalties or fees for discharge regulations	0	3	0	3	0	3	0	3	4	3	3	1	0
	Exposed to regulatory changes - planned or potential	0	3	3	3	3	3	3	3	3	3	3	4	3
	Strong enforcement of regulations in area of operations	3	3	3	3	3	3	4	2	3	4	4	4	5
	Strong concern over HACCP or SANS type regulations	3	5	5	3	5	3	5	4	3	4	3	5	1
	Supply to Woolworths - mentioned regulations as a driver	1	3	4	1	1	1	1	0	0	0	0	0	0
Reputational	Exposure of facility to local/national media (criticizing or positive for water issue)	0	0	0	0	4	4	0	3	4	4	4	4	3
	Does facility know other key stakeholders	2	2	4	1	1	4	2	3	4	3	1	2	1
	importance of facility as a consumer compared to other stakeholders	3	4	2	1	3	1	3	4	5	4	5	5	3
	Engagement with other stakeholders to manage water	3	2	3	1	1	5	1	1	2	3	2	4	1
	Active forum engaging all stakeholders	2	2	2	2	1	5	1	2	3	4	3	4	1
	Involvement in water disputes with other stakeholders	0	0	0	0	0	1	0	3	3	3	5	4	1
	Media - sustainability mentioned in website	1	1	1	3	1	4	1	1	1	1	1	1	1
	Media - water mentioned in website	1	1	2	3	1	4	3	3	3	3	1	1	1
Financial	Relative importance of finances regarding water	5	4	4	3	3	5	4	3	4	4	3	4	3

The design of the research uses various sources of data which converge, confirm and strengthen the case study in order to build upon the concept of shared water risk. “Construct validity”, for example, is related to data collection and the composition of key informants used (Yin, 2009: 41). Multiple sources of evidence are used to minimise concerns regarding construct validity. This includes perspectives from a wide range of private and public sector representatives within the catchment. Due to the smaller size of the catchment, the majority of public and private organisation representatives

possible were interviewed within the case study catchment. Techniques such as explanation building are suggested by Yin (2009) to improve internal validity. Explanation building combines all the data sources in an effort to triangulate and find corroboration of findings in the literature with those of the interviews, for example. The external validity of case study research is ensured through adequate research design. In this thesis, interviews with a number of stakeholders within the catchment help ensure validity within the public and private sector representatives through the collusion of data from different sources. Finally, the reliability of the research is ensured through following a semi-structured interview framework for all respondents applicable. The case study database can be found in Appendix F.

3.3.3 Contribution to theory

The intention of the case study interviews and contextual data collection was to contribute towards the theory of shared water risk through the establishment of a conceptual map and typology of shared water risk using an adaptive theory process. The generation of theory incorporates both technical and non-technical sources of data which is refined through additional interviews (Baxter and Jack, 2008; Layder, 1998).

Frameworks such as those used in the WWF Water Risk Filter, Enterprise Risk Management (ERM) and National Treasury Risk Management Framework as well as additional empirical data and non-theoretical sources were used to formulate the emerging theory. Through triangulation, the multiple sources increase the "strength, density and validity of theoretical ideas and concepts that emerge from data collection and analysis" (Jick, 1979; Layder, 1998: 68). Therefore, this thesis, in addition to interview data, investigates the socio-economic and environmental context of the case study area. Data sources include company annual reports, municipal reviews, the catchment management plan and any related documentation regarding the area.

Throughout this method, adaptive theory was used to inform the empirical evidence collected in order to improve on current theoretical understanding. Adaptive theory was used to build on the current literature of shared water risk and collective responses to managing the commons through involving the public and private sector. Interview data alongside literature on risk frameworks including the WWF Water Risk Filter and National Treasury Risk Management Framework were used in an inductive reasoning approach as suggested by Layder (1998) and Yin (2009). The use of interview data and case study context data alongside the framing of literature is a form of parallel mixed analyses or triangulation of mixed data sources (Jick, 1979). The moving back and forth between the different stages and data sources of the research is an advantage of case study research not shared by many other research procedures (Yin, 2009) as empirical interview data, case study context data and institutional analysis enrich current risk literature. See Appendix E for an overview of the adaptive theory process, where empirical data of public and private risk perceptions helped to inform the

concept of shared risk. The purpose of the case study was a descriptive analysis of water risks of the public and private sector to extend an understanding of collective action within the catchment.

Conceptual framework

Hydrological (quantitative) and interview (qualitative) data were combined into an analytical framework able to communicate the different risk perspectives and how they map onto the water scarcity and socio-economic and political contexts. Previous research as well as frameworks of water risk were included.

The key feature of adaptive theory is its iterative study design, which is where data collection and analysis take place together. The next round of data collection is moulded from prior insights. Depending on what is expected in the data (through the literature analysis beforehand) pre-coding may be used (Layder, 1998: 53). The theory itself does not emerge from the coded phrases, but is helped through memo writing which tests the sense of "codes, concepts and categories emerging from the interview and other data sources" (Layder, 1998: 59). Like grounded theory, adaptive theory supports continuous analysis to allow constant comparison and refinement of the theoretical constructs that may emerge (Charmaz, 2002).

In the shift from the coding to theory, a move from the detailed, factual observations to general and abstract ideas and concerns is needed. Application of the "same principles, standards and criteria across a broad range of situations and examples" is necessary in order to generalise the theory (Layder, 1998: 100). Following the construction of the conceptual framework, opportunities for using the framework and conceptualisation of different water risks was investigated for water management. This is explored through an extensive literature review on opportunities for collaborative management and engagement, partnerships and risk sharing. The conceptual framework may be used as a framework of interaction between the private and public sectors in the case study region, indicating forums where communication and potential risk sharing may take place.

A conceptual framework describes the connection of observations to research in practice with the function to inform, confirm of revise a previous model (Kane and Trochim, 2009: 435). The conceptual framework is developed using water risk frameworks as a basis on which empirical interview evidence is built. Kane and Trochim (2009: 500) state that "concepts are nested within other concepts, constituting a hierarchical, interrelated and complementary structure of meaning". The conceptual model indicates how concepts in theory are related to each other and to their empirical manifestations or theories they are intended to support. The development of the conceptual framework takes place following the characterisation and sorting of interview and other data. The development of the framework is inherently a mixed methods approach, which integrates the qualitative input and quantitative analysis. Links and relationships between the different and similar risk concerns are

mapped. The linking of these frameworks is then brought together through a single representation introducing the different water risk concerns within a single catchment.

The construction of the conceptual framework included a number of considerations. The scale at which risks may be experienced including primary, secondary and catchment context were indicated. This conceptualisation is based on the WWF Water Risk Filter which separates internal risks with those which are external. Following the conceptualisation of scale, the three risk categories were linked with each scale. Although not always the case, in many occasions a particular risk is linked with a specific scale. The use of the three risk categories is based on a number of risk frameworks and tools including WWF and Aqueduct. Within each risk category, there are differences in the knowledge and understanding of these risks between the public and private sector. These differences were collated and compared following the interviews and a high level summary are indicated on the conceptual framework. The analysis of the interview data followed an adaptive theory process, using literature such as shared water risk and collective action to inform the categories and classification of risk. The concept of shared risk is expanded through considering the public and private sector perspectives, in addition to understanding the South Africa context of multi-sector water risks.

Risk-sharing typology

According to Robichau (2011), the construction of descriptive categories (through a typology, for example) is a useful way to simplify a theoretical concept in a state of flux. Due to the emergent concept of risk sharing between the public and private sector in water resources management, a typology in order to better understand the progression which may take place between public and private actors was developed.

A risk-sharing typology was developed through iteration of literature and the case study empirical evidence. The WWF stewardship ladder (WWF, 2013), the Bruns (2003) typology of participation and the Greenwood et al. (2012) typology of collective action formed the basis of the understanding regarding the range of stages for risk sharing. As indicated by adaptive theory, empirical evidence of each phase in the typology was introduced in an iterative process to further develop the concept.

Literature regarding public and private sector roles in public participation was investigated to better understand the stages of public participation. Each stage represents increased communication, knowledge sharing and understanding of the issue of interest. Knowledge and information are assumed to be drivers for building ‘shared’ risks and action. The concept of collective action and stewardship was used in understanding the sharing of water risk as it involves the collective efforts of both the public and private sector in mitigating water risks. As suggested by adaptive theory, this was expanded upon through empirical data in order to further develop the understanding of water-related risks within a catchment. The typology is intended to strengthen the collective action around shared

water risks by acting as a catalyst of information sharing, improving cooperation between the public and private sector.

3.3.4 Theory refinement

The refinement of theory takes place through the convergence of data, building and improving the understanding through case studies (Baxter and Jack, 2008). In this research the case study is particularly valuable in refining theory as embedded units of analysis are repeated to test the development of the ideas and theories (Yin, 2009). The refinement and verification of the shared water risk framework and sharing typology development in this thesis take place through a second phase of interviews with key informants in the case study. Refinement to the framework and typology are supported by testimonials of the interviews or literature. The evaluation of a theory-building process and outcome has no standardised guidelines. According to Eisenhardt (1989), good theory is coherent logically, testable and parsimonious, resulting in new insights instead of purely repeating past theory.

In this research, the process of theory refinement includes a two-part process of 1) refining the definition of the construct, and 2) building evidence which measures the construct (Eisenhardt, 1989). In this case study, additional interviews were carried out to query the communication of shared risk through the framework and shared water risk typology. Verification that the emergent framework and typology fit with the evidence of each respondent was investigated. The primary aim for the refinement of the shared water risk framework and sharing typology through an additional phase of interviews is because it is assumed that the convergence of data builds strength and an improved understanding of a particular case (Baxter and Jack, 2008). The constant comparing of theory and data helps the iteration towards a theory which closely fits the data (Eisenhardt, 1989). Refinement of the theories developed adaptively in this research process help to promote learning and sharing of information between actors within the catchment.

Questions in Phase 2 of the interview process were less based on theoretical frameworks, and more iterative with the actors being interviewed. Reflections included the process of the research, the way in which information is illustrated and the usefulness of the process as a whole.

In Phase 2 of the interviews, the structure of the interviews was primarily open-ended in an effort to gather feedback regarding the layout and structure of the framework and typology presented. The same interviewees used in Phase 1 of the typology and framework development were contacted. Where possible, the same informants were used. The function of the interviews was to report the findings of the research in addition to further build and expand on nuances from the respondents. Pre-planned questions are in Table 8 below, however, many issues and points of considerations were expanded on further. These included whether or not the framework is realistic and how it may work in practice. Examples of risk sharing were identified outside of the GWUA in an attempt to identify

other forms of risk sharing. This commentary was done in a more open-ended format to ensure discussion and free comment on the theory developed.

Table 8: Phase 2 interviews open-ended questions

Interview section	Questions
Shared water risk concept	What do you understand by 'shared water risk'?
	Please list a few major opportunities and challenges in sharing water risks.
Shared water risk framework	Risk scales: Are there any additional major characteristics within each of the risk scales which are not listed in the framework? Primary – Secondary – Catchment
	Risk forms: Are there any additional major characteristics within each of the risk forms which are not listed in the framework? Physical – Regulatory – Reputational
Risk sharing typology	From your experience, at what stage within the typology do you think the process of meeting as a Water Users Association (or any other platform mentioned) is?
	Please describe your experience at the stage of sharing.
	Does the risk framework help to clarify the concept of shared water risk?

The responses to the above questions added to the empirical data for the development of both the shared water risk framework and water risk sharing typology developed.

3.4 Ethical considerations

Ethical challenges in carrying out interviews primarily involve the confidentiality of participants. In this research, interviewees were asked to sign a confidentiality agreement, which allowed an indication of the level of confidentiality they preferred. These included whether or not they wanted their name, general position, company or sector shared. Water can be a highly charged and emotive subject, especially in agricultural regions; therefore, in many cases the respondents preferred not to have their views publically known. Although water is not yet theoretically 'stressed' in the study catchment, widespread concern regarding increased regulation for the private sector meant that honesty regarding pollution or actual water use may have been swayed. These influences were reduced only through ensuring anonymity. Another potentially perverse outcome from the interviews may have been the emphasis of water risks. Through identifying water as a potential concern there may be unintended consequences. Water risks may be elevated in importance through the catchment when in fact there are other more pressing risks to take cognisance of. An example from the public sector perspective is housing issues.

3.5 Research limitations and challenges

There were difficulties and challenges at a number of scales in this research process. A critical challenge, which has contributed to the case study and adaptive theory design chosen, is the lack of theoretical literature on this specific subject. However, one of the reasons why many researchers do

not adopt a theory-building approach is due to the bewildering complexity, the very nature of which is itself one of the limitations of the complexity framework and this study. It is difficult to evaluate the consequences of different risk mitigation decisions under complex consequences, as the risks themselves are not stable. This is especially true when the risk is affected by uncertainty and ambiguity (as is the case in water management) (Florig et al., 2013).

There are a range of challenges involved with carrying out case study research. Yin (2009: 14) introduces common perceived drawbacks to doing case study research. These include apprehension over the lack of rigour, a concern that case studies provide little basis for scientific generalisation and that they take too long. In addition, the analysis of case study research is not well established. This is overcome in this thesis using a general analytic strategy where Yin (2009: 126) suggests, amongst others, "explanation building" to analyse data. Computer software was not used to analyse case study data as the sample size was small enough to investigate using simple Boolean search phrases within the written interview text. This is because, as indicated by Yin (2009: 129), there are a number of data sources, which are not applicable for the computer-generated outputs. Additional difficulties attributed to carrying out case study research include trying to identify the stage where the sector has been well represented. The diversity of private sector companies and public sector governance levels, in addition to the personalities and individual characteristics of each respondent, meant that the range of responses varied a great deal, making a representative population difficult to pinpoint. However, this was felt to be a lesser concern due to the smaller nature of the case study catchment, as the majority of institutions were represented.

Water data requirements were a challenge to this research. This is a globally recognised challenge as the IFC (2011) highlights the difficulty to "quantify and meaningfully analyse water risks and impacts due to a lack of systematic measurement and data". Hydrological data was incomplete or did not include all the information required. Gaps in technical data were ameliorated through the additional of social data through interviews. Water risks are informed both by technical and social information.

An assumption of this research is that increased knowledge and communication of the water risks will improve management. Determining whether water management has improved does not fall within the scope of this research. Instead, this thesis has focused on understanding the nature of what shared water risks may involve and on investigating how each sector understands their own water risks.

Chapter 4: Case Study Overview: Palmiet Catchment

4.1 Introduction

The case study region of the Elgin Valley and town of Grabouw within the Palmiet River Catchment is shown in Figure 15. The Palmiet Catchment (blue) falls within the Breede -Overberg Water Management Area (yellow) and the Theewaterskloof Local Municipality (black). The case study was chosen because of the range of water management institutions in the catchment alongside an active agro-processing industry that is dependent on sufficient water quantity and quality. Although not water-stressed, the catchment demands are nearing current water supply (1 071 Mm^3/annum demand vs. 1 909 Mm^3/annum supply).

Figure 15: Breede-Overberg Water Management Area. Theewaterskloof Local Municipality and Palmiet Catchment (Adapted from AfriGIS, 2013)

Water resources management and water services are managed separately in South Africa, as indicated in Figure 16. Linkages and relationships between actors within the case study area are indicated with reference to water resources management as well as supply and sanitation. Grabouw and the Elgin Valley are situated in the Palmiet Catchment, where water resources are managed by the Breede-Overberg Catchment Management Agency (BOCMA) (shown in blue below). Water services (shown

in green below) are the mandate of local government. The local government is represented within the CMA forum. Under the Municipal Systems Act (MSA, No. 32 of 2000) and Water Services Act (WSA, No. 108 of 1997), local government (Theewaterskloof Local Municipality) is responsible for water supply and sanitation services. As a Water Services Authority (WSA), "financial and management responsibility for the development and operation of water services lies with local government" (Mazibuko and Pegram, 2006: 22). Water is the responsibility of the technical director at the local municipality scale (TWK IDP; 2012a, 2012b).

In this case study, as indicated in the figure below, the Theewaterskloof Local Municipality is responsible for water service provision, and is accountable to the Western Cape (WC) Department of Water Affairs (DWA) Regional Office (RO). The RO is in turn accountable to the national DWA (Figure 16). The municipality buys water from the GWUA through a water quota contract. During drought years, a percentage of the quotas are available, putting all users of water from GWUA under pressure. Data on water resource availability in the catchment informs how water resources are apportioned between users during drought years.

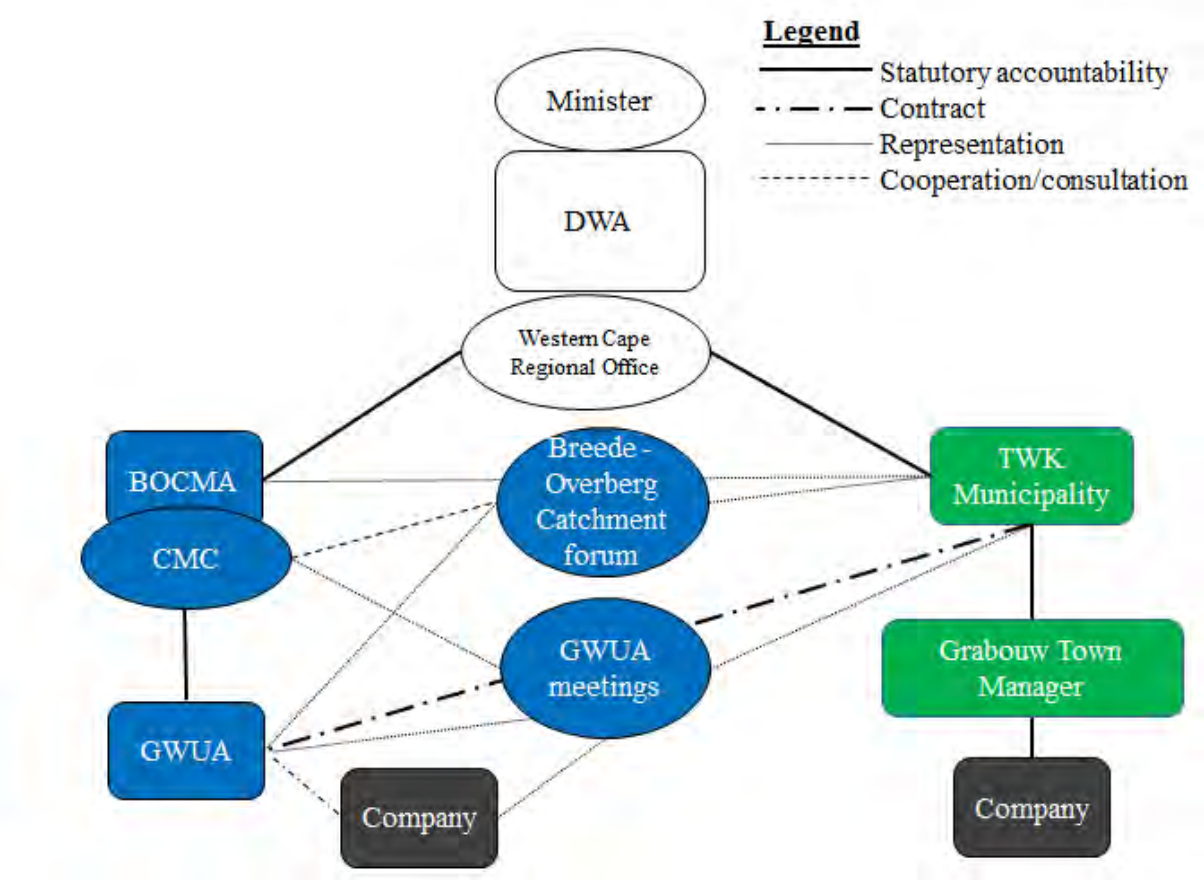

Figure 16: Relationships between water sector institutions in the Palmiet Catchment (Adapted from Mazibuko and Pegram, 2006)

Since the promulgation of the National Water Act (1998), each Water Management Area (WMA) in South Africa needs to be governed or managed by a CMA (Breede-Overberg Catchment Management Strategy (BOCMA CMS, 2011). CMAs are statutory bodies governed by a board appointed by the Minister, representing the interests of water users, stakeholders and government. The agencies are established as stipulated by Chapter 7 of the NWA. The DWA announced a restructuring of the CMAs in March 2012, where one CMA will be established in each of the nine WMAs (DWA, 2012a). Where there is no agency in place, the DWA RO assumes the responsibility (Mazibuko and Pegram, 2006).

A CMA is accountable to the state for all regional (intra-WMA) WRM implementation functions including protection, use, development, conservation, management and control of water resources. The CMA also plays a role in coordinating government, sector partners and stakeholders through the catchment management forum. A range of stakeholders and institutions are represented within the CMA forum including the local municipality, Catchment Management Committee and Water Users Association. Through the catchment management forum, the CMA committee is able to consult and coordinate water resources management with other stakeholders in the catchment.

Several WUAs fall under a single CMA where both levels of organisation are mandated to oversee equal access to water for all and safeguard against water wastage and pollution. The WUAs are held accountable through statutory regulation to the CMA. WUAs are established to manage local water infrastructure such as irrigation and to implement management decisions (Mazibuko and Pegram, 2006). Users of water from the GWUA are allocated water through service contracts.

4.2 Water resources management scale

4.2.1 Water resources management: Breede–Overberg Catchment Management Agency

The Breede-Overberg Catchment Management Agency (BOCMA) is guided by a Catchment Management Strategy (CMS), which is consistent with the National Water Resources Strategy and drawn up through stakeholder involvement from a range of representatives in the catchment (Mazibuko and Pegram, 2006; BOCMA CMS, 2011). The BOCMA CMS (2011: 5) identifies one of the greatest challenges in the catchment as the "promotion of social redress and economic development without jeopardising the environmental functioning of the aquatic ecosystems of the region".

Agriculture and related agro-processing contributes 25% of the GDP (BOCMA CMS, 2011) (Figure 17). The economy of the Breede-Overberg is closely dependent upon the availability and health of water resources in the Water Management Area (BOCMA CMS, 2011). The mean annual precipitation ranges from 1 500 mm in the mountains to 400 mm in the lower lying regions (BOCMA CMS, 2011; Paxton and Ractliffe, 2010). Land use patterns tend to follow the rainfall variation. Rain-

fed grains dominate the centre and south, while irrigated fruit and vegetables are the main crops in the north and west of the WMA (BOCMA CMS, 2011).

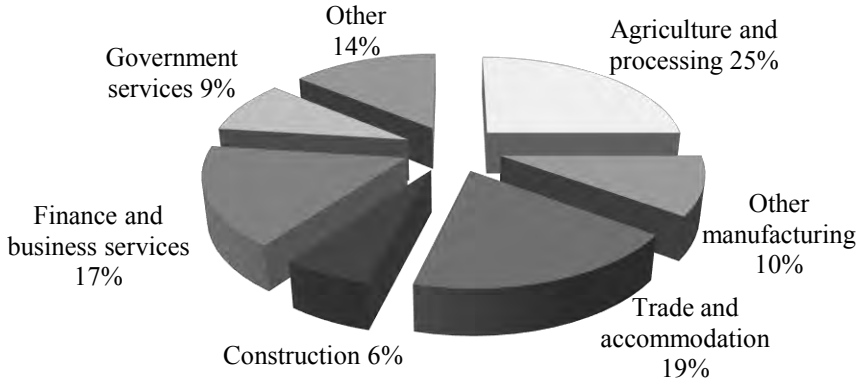

Figure 17: Economic Sector Contribution to Regional GDP (BOCMA CMS, 2011)

Water demand (1 071 Mm^3/annum) in the WMA is approaching the supply of available resources (1 909 Mm^3/annum)(Western Cape Government, 2011). The natural mean annual runoff is 2 472 million m^3/annum. The Breede-Overberg WMA transfers approximately 250 million m^3 (18 %) of water per annum to the Berg WMA (Western Cape Government, 2011) (Figure 18). The majority of this water demand is required by the City of Cape Town (CoCT, 2007; Western Cape Government, 2011). The Breede-Overberg is the only WMA in the Western Cape that has a surplus supply (Western Cape Government, 2011). However, according to the Breede-Overberg CMS, during drier years, summer abstraction during low flow periods "exceeds what is available" (BOCMA CMS, 2011: 25).

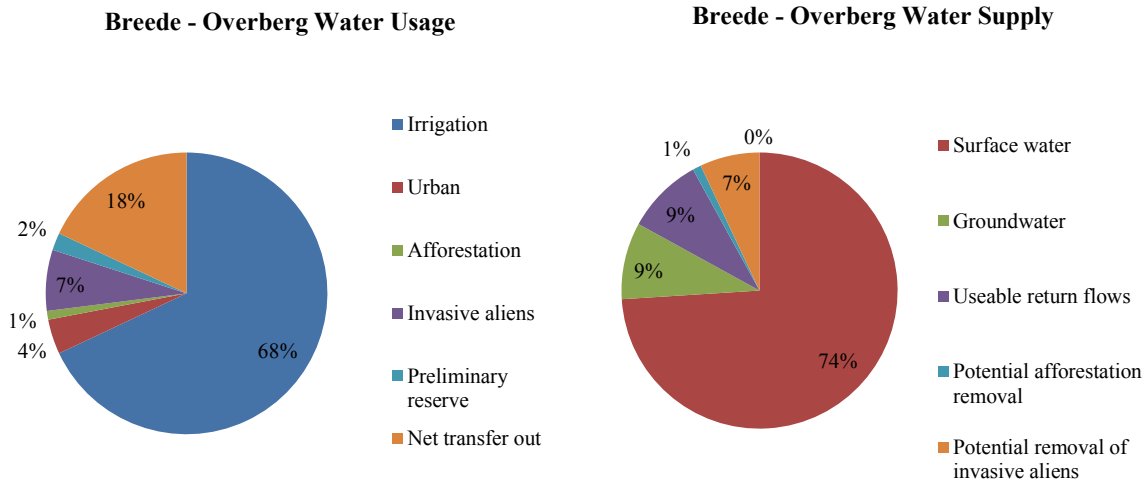

Figure 18: Breede - Overberg WMA water usage and supply (Western Cape Government; 2011)

The small gap between the demand and supply is a risk to the region as the natural variability of stressed systems may "tip the critical balance between demand and supply into a crisis", as seen through the recent droughts in the neighbouring Gouritz River catchment of the Southern Cape around Mossel Bay and George (Breede–Overberg CMS, 2011). In addition to the risk of increasing demand for water surpassing supply, climate variability may shift what crops are able to grow. According to the BOCMA CMS (2011), the Breede–Overberg climate is projected to become warmer and drier with more extreme events. Figure 19 illustrates the historical decadal (10 day composite) rainfall data from Grabouw from 2004 to 2013. Although this does not represent a substantial time frame, the variability indicated shows that natural variability in the region is common.

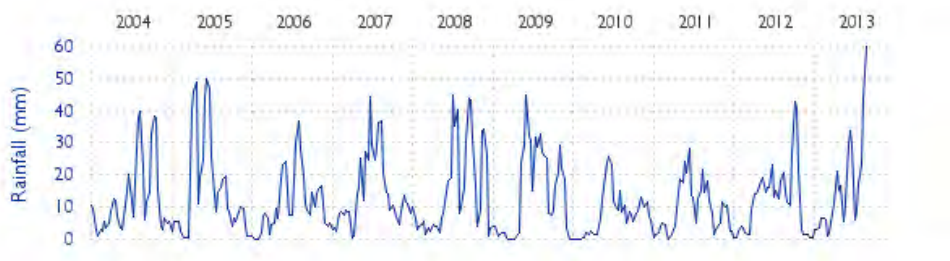

Figure 19: Time series of rainfall for Grabouw (2004 – 2013) (EU, 2010)

4.2.2 Palmiet River Catchment

The Palmiet River has one of the smallest catchments in the south-western Cape, at 535 km^2 in area. It is 70 km long and is fed by 11 perennial tributaries (Brown et al., 2000). Stream flow in the Palmiet is seasonal under the influence of Mediterranean climate conditions (Figure 20).

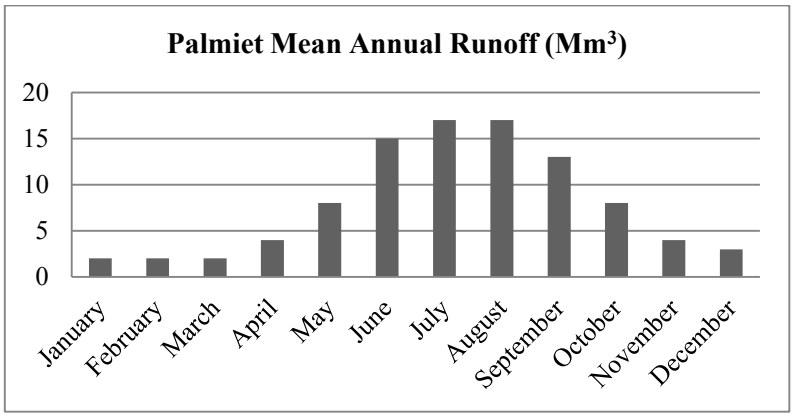

Figure 20: Palmiet River average monthly stream flow (Mm^3) (BOCMA CMS; 2011)

Figure 21 illustrates the major dams and tributaries of the Palmiet. Flows indicated on the figure include the Mean Annual Runoff (MAR) following Palmiet Phase 1 (the inter-basin transfer into the Steenbras River), the present day MAR (taking into account current withdrawals and infrastructure) and the natural MAR (theoretical run-off without infrastructure and water use).

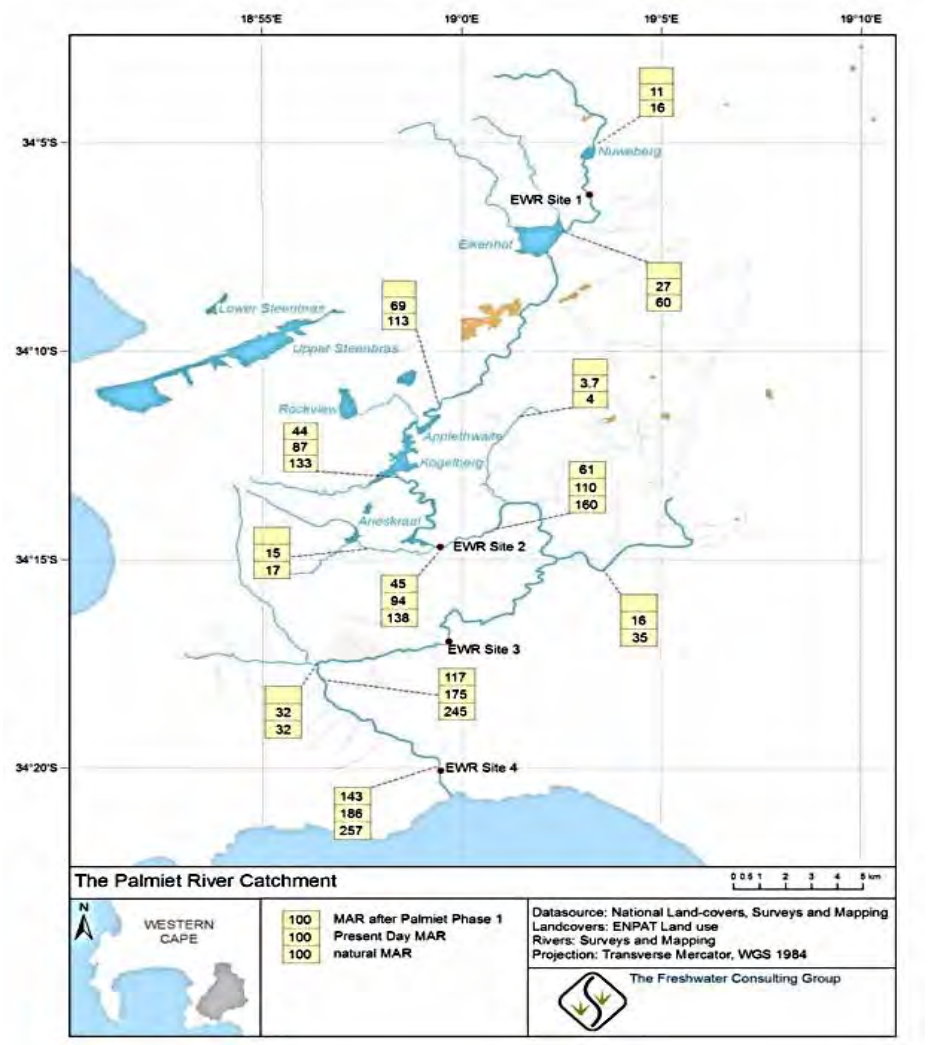

Figure 21: Palmiet River Catchment showing present day and natural Mean Annual Runoff (MAR) (Mm^3/annum) for selected river reaches (Paxton and Ractliffe, 2010)

Cool winters experience higher rainfall between 20-25 mm/month, while hot summers are drier, receiving 5-10 mm/month, as indicated by the annual rainfall changes in Figure 22 (BOCMA CMS, 2011). Orographic rain, as a result of the high mountains, is the predominant rainfall pattern of the area (BOCMA, CMS, 2011).

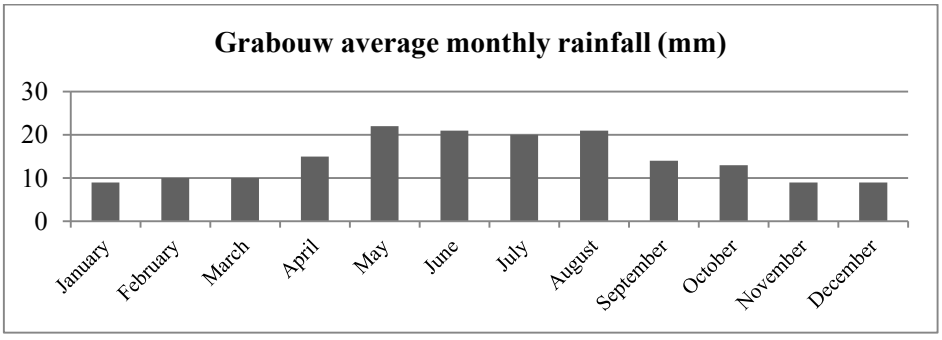

Figure 22: Grabouw average monthly rainfall (EU, 2010)

According to the Breede–Overberg Catchment Management Strategy (BOCMA CMS, 2011), water use within the Palmiet catchment is primarily for agriculture (69%). A relatively small proportion of the total water within the catchment is for urban use (1%). Transfers out of the catchment for urban or industrial water use within the City of Cape Town are larger (30%) (BOCMA CMS, 2011).

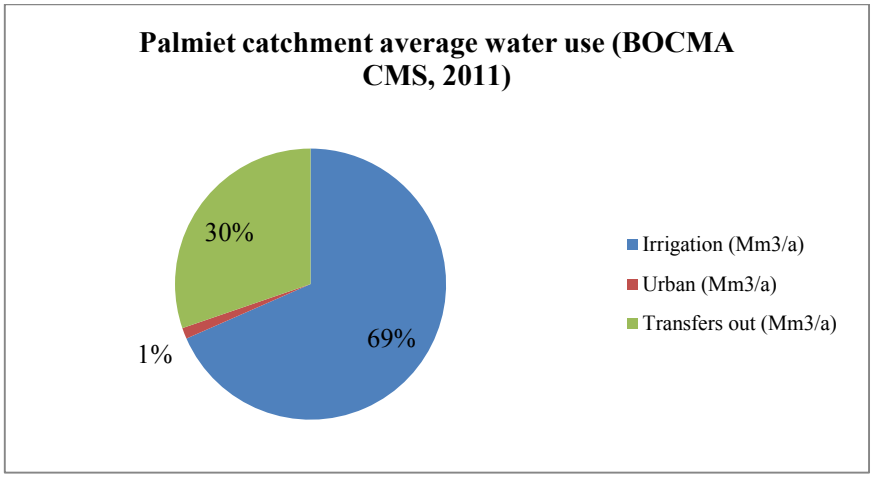

Figure 23: Palmiet catchment average water use per sector

The river is sub-divided into management units by sub-catchments and land use (Paxton and Ractliffe, 2010). The Palmiet begins in the Nuweberg Nature Reserve, categorised as good, healthy conditions (ecological category B), within the upper regions of the Hottentots Holland Mountains (River Health Programme, 2003; Paxton and Ractliffe, 2010). The first dam on the Palmiet, the Nuweberg Dam is approximately 8 km from the source of the river. It has a capacity of 3.9 Mm^3 and is owned by the Nuweberg Dam Syndicate and used for irrigation purposes. The Eikenhof Dam is 4.5 km further downstream, and is of particular interest in this study. The storage capacity of the dam is 29 Mm^3, and it is owned by GWUA. The dam supplies irrigation water to 5 865 ha of agricultural land, domestic water to Grabouw and industries in the Elgin Valley region. The total annual yield from the Eikenhof Dam is 38.38 Mm^3/year (Bosch, 2008), and is registered to supply:

- Agriculture: 21. 71 million m^3 (summer allocation) and 10.75 million m^3 (winter allocation). Water use entitlements are based on 6 000 m^3/ha/year for the area
- Industrial: 0. 85 million m^3 (summer allocation) and 0. 65 million m^3 (winter allocation); and
- Domestic: 2. 72 million m^3 (summer allocation) and 1. 70 million m^3 (winter allocation).

The Palmiet then extends from the Eikenhof Dam outlet to the confluence with the Krom River. At this stage the Palmiet meanders through Grabouw and the Elgin Valley (Paxton and Ractliffe, 2010). Mainly deciduous fruits are farmed along with some forestry in the upper and middle reaches of the catchment. The Palmiet River catchment is one of the most intensively farmed regions in the Overberg (66% is under agricultural production) (DWA, 2004; Paxton and Ractliffe, 2010). Paxton

and Ractliffe (2010: 18) examined the Environmental Water Reserve (EWR), concluding that "water pollution, poor management of the riparian zone and reduced flows (especially summer low flows) were major issues" that needed to be addressed. Their study indicates that downstream of Grabouw and the sewerage works, high phosphate levels are making the river hypertrophic (Paxton and Ractliffe, 2010: 37). A figure of the quality changes across the course of the catchment can be found in Appendix G.

Further downstream, the Peninsula Dam is owned by Elgin Orchards, Weltevreden Farm, Applethwaite Farm, Shannon Vineyards and Water Wheel Investments. It is used for irrigation only. Applethwaite Farm has its own dam with a storage capacity of 2.9 Mm^3. The dam opens directly onto the Kogelberg Dam which has a capacity of 33.7 Mm^3. The Kogelberg Dam is joined to the off-channel Rockview Dam and eventually the Steenbras Dam through the Palmiet Pumped Storage Scheme. During winter, once flows measured at the Campanula weir reach or exceed 4.33 m^3/s, water is allowed to be transferred to the Steenbras Dam (22M m^3/a). In 2007, the transfer from the Palmiet represented 5 % of the City of Cape Town (CoCT) total water requirement (CoCT, 2007). Whether or not this is being followed, however, is under contention, as the Palmiet Catchment Management Plan (CMP) (Paxton and Ractliffe, 2010: 24) states that "there are no exact records of water volumes abstracted directly from the Kogelberg Dam, for the City of Cape Town available". However, according to the City of Cape Town long-term water conservation and water demand strategy (CoCT, 2007), only 22 Mm^3/annum is abstracted (CoCT, 2007). The Arieskraal Dam follows 950 m downstream of the Kogelberg Dam, which has a capacity of 5.5 Mm^3 and is owned by the Arieskraal Syndicate for irrigation. End-to-end the four dams occupy 15% of the length of the Palmiet (Paxton and Ractliffe, 2010).

According to the Palmiet Catchment Management Plan (Paxton and Ractliffe, 2010), water quality indicators range from fair to poor (River Health Programme, 2003). In 2009, GWUA agreed to release the water from the Nuweberg Dam to flow directly through the Eikenhof Dam. This increased the summer flow rate, helping to dilute "return effluent from industrial and residential point and non-point sources as well as the Grabouw waste water treatment works" in the Palmiet River (Paxton and Ractliffe, 2010: 19).

The Klein Palmiet and Krom rivers join the Palmiet before it enters the Kogelberg Nature Reserve. Within the Reserve, the Palmiet it is joined by the Dwars and Louws tributaries, before being discharged into the small estuary near Kleinmond (Paxton and Ractliffe, 2010). There are no dams on the Palmiet within the Kogelberg Nature Reserve. Good quality water entering the river from the Nature Reserve helps to improve the quality status of this stretch of the river to good except for the fish index (poor) and aquatic invertebrate index (fair) (River Health Programme, 2003; Paxton and Ractliffe, 2010). The estuary is designated a national priority and is receiving on-going attention such

as regular alien clearing (BOCMA CMS, 2011). The natural MAR from the Palmiet estuary is one of the highest in the Breede –Overberg Catchment (256 million m^3). The present day MAR is 67% of the natural MAR (BOCMA CMS, 2011). The Breede–Overberg Catchment Management Plan anticipates that the predicted EWR will remain at 67% of the natural MAR, as the Palmiet Estuary is a national priority estuary for biodiversity and conservation (Paxton and Ractliffe 2010; BOCMA CMS, 2011).

In the case study region, GWUA is the main authority responsible for the bulk water supply. According to the Groenland Constitution, the WUA has a legal mandate to ensure compliance of water legislation and charge levies for water use (Groenland, n.d.(a)). The objective of the WUA, within its area of operation, is to control, manage and maintain raw water from the Eikenhof Dam through its water distribution network. The WUA must also protect the water resources.

The WUA has a water entitlement in accordance with section 22(1) of the NWA for extraction of 38 million m^3 which is registered with the Department of Water Affairs (DWA) (Permit No: B191/2/740/1) (Groenland, n.d.(b)). According to the GWUA rules and regulations, "the water available from the Department of Water Affairs on an annual basis from the Eikenhof Dam and which may be pumped through the reticulation system, has currently been fully allocated to all the holders/users by way of quotas" (Groenland, n.d.(b)). The quotas are allocated to individual properties and are registered in their title deeds. GWUA members, who are property owners, are able to temporarily transfer water quotas for periods up to a year if such a transfer is physically possible (Groenland, n.d.(b)). During times of drought, the quota available from the DWA is reduced proportionally. For three months of the year during winter, the water tariff is three times higher due to the higher electricity charges set by Eskom through the winter Ruraflex tariffs (Groenland, n.d.(b)). According to the GWUA constitution, the management of the GWUA (Groenland, n.d.(a)) must consist of 20 members, and is set out to include representation of the following groups in Table 9.

Table 9: Groenland Water Users Association management representation (Groenland, n.d. (a))

Representative	Number
Sub-district 1	5
Sub-area 1	1
Sub-area 2	1
Sub-area 3	1
Sub-area 4	1
Municipalities:	1
~ Theewaterskloof	1
~ Overstrand	1
~ City of Cape Town	1
Local Industries	1
National Industries	1
Individual Users/Farm Labourers	2
Emerging Farmers	2
Public Environmental Organizations	1

Representative	Number
Recreational Users	1

This diverse group of stakeholders gives an indication of the variety of interests being met through the association. The representatives of sub-district 1 originate from the previous Groenland Irrigation Board, and own the infrastructure of the dam (Groenland, n.d.(b)). As the owners of the infrastructure, they form an important role ensuring water supply to stakeholders within the GWUA (Groenland, n.d.(b)). Management and maintenance of the infrastructure is the responsibility of the sub-district.

The majority of agro-processing industries are located in the upper reaches of the Palmiet, between Eikenhof, Arieskraal and the Klein Palmiet. The Palmiet is not volumetrically critically water stressed (there is still a small surplus between supply and demand) however, there are significant quality concerns in stretches of the river. The Palmiet Catchment Management Plan (Paxton and Ractliffe, 2010) offers valuable knowledge and understanding of the flows and quality changes within the river. GWUA supplies only raw water, and not treated potable water to the municipality. Potable treated water and the subsequent treatment of effluent is managed by the Water Services Authority (WSA), the Theewaterskloof Local Municipality.

4.3 Water services provision scale

The overview of the hydrology of the Palmiet within the Breede-Overberg described the water resources institutions involved in water management. The context of the case study now shifts to the water services supply and management of Grabouw and the Elgin Valley. This falls under the administration of the Theewaterskloof Local Municipality as the WSA (Western Cape Government, 2013).

According to the TWK Integrated Development Plan (IDP) (2012b), 35% of the local economy is supported by agricultural production, while agro-processing represents 90% of manufacturing turnover. Manufacturing represents 12.46% of the local economy (Table 10). Beverage manufacturing contributes 41% to the manufacturing sector GDP. Processed and canned fruits contribute a further 37% (DWA, 2011; TWK IDP, 2012a, 2012b). In 2005 agriculture represented 36.47% of the GDP of the TWK economy, with an average growth of 4.47% between 2004 and 2005 (Table 10). This is the third-largest growing contribution after construction and retail. Therefore primary agriculture and agro-processing are important sectors in the Theewaterskloof economy.

Table 10: Key economic activities in Theewaterskloof Local Municipality (TWK IDP, 2012b)

Key economic activities	1995	2000	2005	Share	Average growth	Average growth	Average growth
	Rm	Rm	Rm	2005 (%)	1995 - 2005	2000 - 2005	2004 - 2005
Agriculture, forestry and fishing	421.81	481.67	535	36.47	2.41	2.12	4.47

Manufacturing	204.47	188.63	182.82	12.48	(1.11)	(0.62)	1.68
Electricity and water	17.57	19.17	20.85	1.42	1.73	1.7	2.08
Construction	40.4	41.14	51.14	3.49	2.39	4.45	6.06
Wholesale and retail; catering and accommodation	121.88	158.67	203.58	13.88	5.26	5.11	6.07
Transport and communication	56.9	82.09	105.9	7.22	6.41	5.22	3.41
Financial and business services	114.2	130.53	174.11	11.87	4.31	5.93	4.21
CSP services	68.86	72.02	74.57	5.08	0.8	0.7	3.25

The population figure for Theewaterskloof is uncertain. Table 11 indicates that the projected population for 2010 was 108 406 (TWK, 2011a). However, according to the Theewaterskloof Annual Report (TWK, 2011a), "population estimates vary between 86 719 (Community Survey 2007) and 103 281 (Centre for Actual Research, 2005). Informal estimates from the Municipality are even higher at around 110 000 people" (TWK, 2011a). According to Statistics South Africa, the TWK population is 108 794 (StatSA, 2011). Note that Grabouw has the highest population growth rate out of all the other towns in the local municipality (TWK, 2011a).

Table 11: Theewaterskloof Local Municipality Total Population (TWK, 2011a)

Town	Census 2001	2001 - 2010	Projections for 2010
	Population	Growth (%)	Population
Botriver	4 053	3	5 226
Caledon	11 153	2	13 401
Genadendal	5 440	0	5 589
Grabouw	21 578	4	29 546
Greyton	1 099	n/a	3 681
Riviersonderend	3 298	1	3 693
Tesselaarsdal			1 117
Villiersdorp	7 614	2	9 409
Farms	38 707	(1)	36 686
Total	91 242	2	108 406

The uncertainty of the population size is in part due to the growing number of people entering the informal settlements outside of Grabouw. The influx of migrants into the region is listed in the IDP (TWK IDP, 2012) as one of the stressors on the financial viability of the municipality. "The uncontrolled influx of indigent people places a burden on the capacity levels of the municipality and threatens the financial viability and sustainability of the Municipality" (TWK IDP, 2012a: 32). The first draft of the 2012 IDP states that, "we believe that the influx of people to this area was originally caused by farm owners importing cheap labour from the Eastern Cape during the harvesting season.

Most of these workers refuse to return to their original places after the harvesting season has passed. These impact the Municipality as additional provision needs to be made with respect to housing and basic services" (TWK IDP, 2012a: 33). This is magnified by the amount of people without jobs. According to the Theewaterskloof Local Municipality Annual Report 2010/2011 (2011), the unemployment rate is 42%, where 31% of households have no income. The importance of agriculture is further indicated by the large contribution to employment in the region, accounting for 50% of employment within the TWK municipality (TWK IDP, 2012a).

The TWK municipality is responsible for the provision of water and sanitation services to seven small towns, including Grabouw, and outlying rural areas within its jurisdiction. The municipality sets tariffs for all services provided, including the cost of water and sanitation. The price of water includes monthly operational and maintenance charges for an assurance of supply. The capital budget set aside from the municipality for services is shown in Table 12. Water and sanitation are not as large as housing, for example. However, there is a notable increase in budget set aside for sanitation in 2011/2012. The backlog in infrastructure is noted as a major concern for the financial viability of the municipality. "Due to bulk operations already exceeding design capacity, it would be a challenge to ensure that the growth needs of the municipality are addressed" (TWK IDP, 2012a: 32).

Table 12: Budget growth of Theewaterskloof Local Municipality (TWK IDP, 2012a)

Budget Growth	2007/2008	2008/2009	2009/2010	2010/2011	2011/2012
	R'000 Actual	R'000 Actual	R'000 Actual	R'000 Actual	R'000 Budgeted
Operational budget	R 177,098	R 216,881	R 239,609	R 266,234	R 351,393
Capital budget	R 82,659	R 60,454	R 56,384	R 64,589	R 87,303
Housing	R 33,692	R 12,637	R 24,673	R 29,330	R 33,977
Water	R 11,304	R 22,797	R 26,736	R 12,899	R 13,332
Sanitation	R 26,028	R 6,252	R 4,301	R 12,369	R 21,259
Electricity	R 2,104	R 3,069	R 5,392	R 1,481	R 7,921
Roads	R 3,542	R 2,193	R 18,309	R 5,567	R 5,228

Aside from budgetary constraints, lack of human capacity within Theewaterskloof is a concern. One hundred and thirty-seven posts are vacant within the municipality, while 559 are filled, with a turnover rate in 2010/2011 of 3.93% (TWK IDP, 2012b). Table 13 gives an indication of the functional areas of Theewaterskloof where there are vacancies.

Table 13: Filled posts and vacancies within Theewaterskloof Local Municipality (TWK IDP, 2012b)

Functional areas	Filled	Vacant	% Vacant
Corporate services	21	11	34
Finance	37	6	14
Development	22	15	41

Operations	448	92	17
Technical Services	31	13	30
Total	559	137	20

The context outlined above indicates the large number of concerns facing the Theewaterskloof Local Municipality. Immigration in the region, a small tax base, infrastructure backlogs and human resource pressures all contribute to the risks they face in meeting public sector mandates required by law. In order to manage the risks facing the local municipality holistically, Theewaterskloof has implemented a risk management framework based on the principles of Enterprise Risk Management (ERM). The framework shown in Figure 24 indicates the drivers for the municipality in using the ERM framework. As indicated, this is driven primarily through regulation, although enablers of the ERM framework are listed as well.

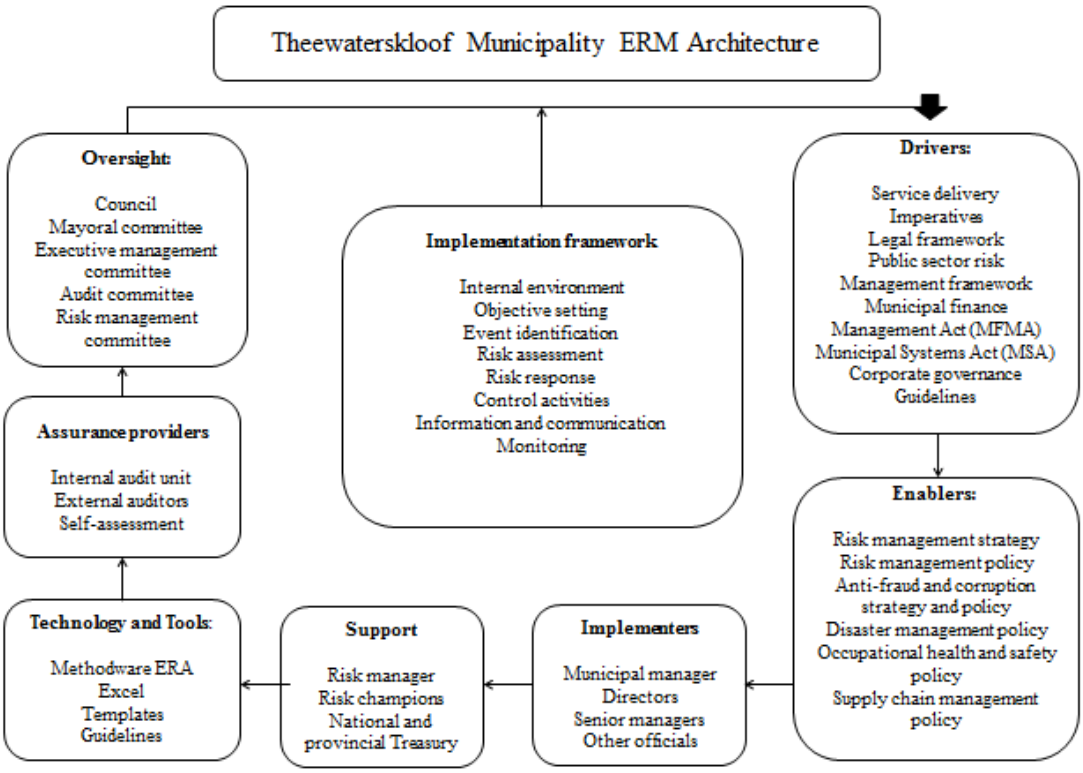

Figure 24: TWK Risk Policy Framework (TWK Risk Policy, 2011)

The Theewaterskloof Local Municipality (TWK) risk framework originated from the National Treasury framework in an effort to integrate and proactively manage potential risks in the region. According to the Risk Policy Framework, risk is defined as: "the likelihood that an event will occur and adversely affect the achievement of set objectives". According to the Theewaterskloof Risk Management Implementation Plan (2012), effective risk management is an important requirement in achieving the objectives identified in the IDP. By using an ERM framework, it indicates that TWK

endeavours to manage risk within the entirety of the municipality, as opposed to within separate disciplines of the municipality. In the introduction of the TWK framework, mention is made of the fact that the traditional financial risk focus of organisations is no longer relevant in the current environment. The current strategy considers the following additional areas of risk: strategy, people, technology, processes, external environment and natural factors and legal compliance (TWK Risk Policy, 2011).

The use of ERM as a framework highlights that risks are recognised as dynamic and interdependent and should not be considered or managed in isolation. One of the reasons for using ERM within the TWK Municipality is due to the value of being able to anticipate future risks. "Effective risk management processes are critical in ensuring the municipality achieves its objectives as outlined in the IDP as well as the various service delivery objectives of the Municipality" (TWK Risk Policy, 2011:2). Whether for profit or not, organisations exist primarily to add value to their stakeholders. Within the context of the TWK, there are a broad range of stakeholders who expect value. Management decisions at both a strategic and operational level are able to create, preserve or destroy value. ERM is used in order to better anticipate and plan for future uncertainties in order to deliver value to their stakeholders (TWK Risk Policy, 2011).

The integrated nature of the risk management model establishes a common standard, process, language and risk culture. The integrated understanding of the risks is also useful where, in the case of the public sector, poor management of one risk results in direct impacts on other areas, including service delivery. This realisation is both a risk and an opportunity for local government. All governance structures outlined through the MSA (RSA, 2000a) are inextricably linked. "A failure in systems and process has a significant effect on the ability of municipality to function in an effective, efficient and economic manner" (TWK Risk Policy, 2011: 5).

A Risk Management Office in TWK Municipality is designed to support the effective management of risk. The final responsibility rests with the Municipal Manager in ensuring effective risk management processes. This is to ensure that risk management is performed throughout the organisation, a task that is assigned to the Director of Finance within TWK.

The TWK Risk Framework Policy is shown below. Figure 25 indicates how risks are segregated into strategic and operational risks. Strategy considers the high level goals, aligned with and supporting the mission of the municipality. Operations consider whether or not resources are being used efficiently and effectively. The TWK Risk Policy Framework (2011) also mentions communication through reporting and compliance with laws and regulations as two areas the risk management process considers.

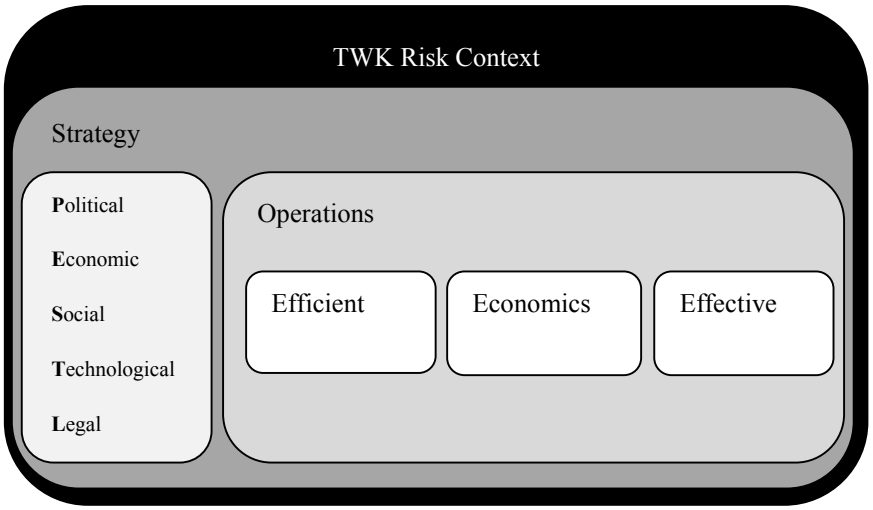

Figure 25: TWK Risk Policy Framework (TWK Risk Policy Framework, 2011)

In addition to the Risk Policy Framework a special water sector IDP report was compiled in 2012 (WSDP, 2012). The function of the report was to integrate all the sectors within the municipality dealing with water. The report considers water services delivery, resources and infrastructure planning together (WSDP, 2012). The report identifies issues that are important in water services development planning that need to be addressed in an IDP. The focus of the report is to ensure access to water, and does not necessarily consider whether or not resources are available. The document also acknowledges that interaction with sectors outside of the public works programme itself is lacking (Theewaterskloof Local Municipality, 2012). Although some elements are still missing from the report (i.e. water resources availability aspects), the effort of integrating the public sector objectives is a useful starting point for sharing an understanding of the water system.

4.3.1 Grabouw

Each town within Theewaterskloof has its own local authority, headed by the town manager. The Grabouw local authority, the administrative arm of TWK in Grabouw, is directly responsible for water purification and reticulation to households, businesses and industry in Grabouw as well as wastewater treatment through the sewage treatment works.

Grabouw is situated in the Elgin Valley and is an agriculturally dependent economy (24% turnover and 24% jobs from agriculture in 2011 StatSA agricultural census) (BOCMA CMS, 2011; TWK IDP, 2012a). Approximately 60% of all apples grown in South Africa come from this region, while 65% of all apples exported from South Africa are from this region (BOCMA CMS, 2011). It is also an important pear producing region. The town represents two thirds of the manufacturing base of the municipality, with large fruit processors, including a juice company and two large international fruit distributors (Hamann et al., 2008).

The 2012 IDP indicates "high human needs" with a medium level development status in comparison to the other towns in Theewaterskloof (Table 14). A number of factors were considered, as shown in the table (TWK IDP, 2012b)

Table 14: Growth potential of selected towns in Theewaterskloof Local Municipality (TWK IDP, 2012b)

Town	Human needs	Development Status		Economic Base	Place Identity
		Quantitative	Qualitative		
Caledon	Very low	Medium	Medium	Agriculture Service centre	Hot springs and Casino
Grabouw	High	Medium	Medium	Agriculture Service centre	The apple town
Greyton	Low	Low	Low	Retirement/second homes	Victorian village with a serene lifestyle
Villiersdorp	High	Low	Low	Agriculture Service centre	Fruit/scenic mountains

The 'high human needs' suggested in the 2012 IDP (Table 14) are in part due to the high unemployment and immigration challenges in Grabouw (TWK IDP, 2003: 29). During the fruit season, families earn substantially more than out of the season, forcing a large proportion of families to depend on social grants or subsidies when not in fruit-picking season (TWK IDP, 2012a).

Water to Grabouw is supplied from the Eikenhof Dam. Previously there was an alternative supply from Wesselsgat, a weir off the Klip River. However, this was "decommissioned due to high maintenance requirements" (Wise and Drake, 2012: 11). Eikenhof and Wesselsgat are primarily irrigation dams. The Eikenhof Dam is privately owned and administered by GWUA. Individual farmers and industries, apply for quotas to the board for their allocation. The infrastructure used for the extraction, pumping and conveyance of raw water from the Eikenhof Dam to the Grabouw water treatment works (WTW) is owned, operated and maintained by the municipality. The Eikenhof Dam has a total storage capacity of 29 000 Mm^3 of which 5 000 Mm^3 is allocated to meet the TWK Municipality annual domestic and industrial demands (TWK IDP, 2012b).

The graphs (Figure 26 and Figure 27) indicate the licences for water abstraction per annum according to institution or sector. This data was supplied by GWUA. Farmers account for the largest proportion of water use. Within the domestic and industrial use, the municipality itself is the most significant water user. This detail hides the agro-processing facilities that are supplied with water by the municipality. There are a number of agro-processing industries within the town of Grabouw that are supplied by municipal water. As GWUA supplies only raw water to the municipality, they do not have data regarding the water users within the municipal supply.

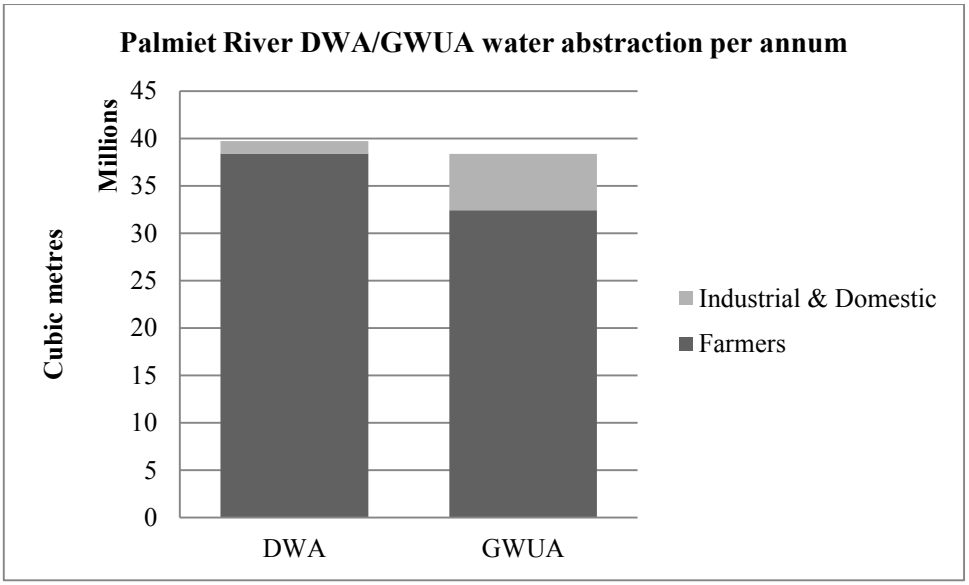

Figure 26: Total Palmiet River water abstraction per annum (GWUA, 2011)

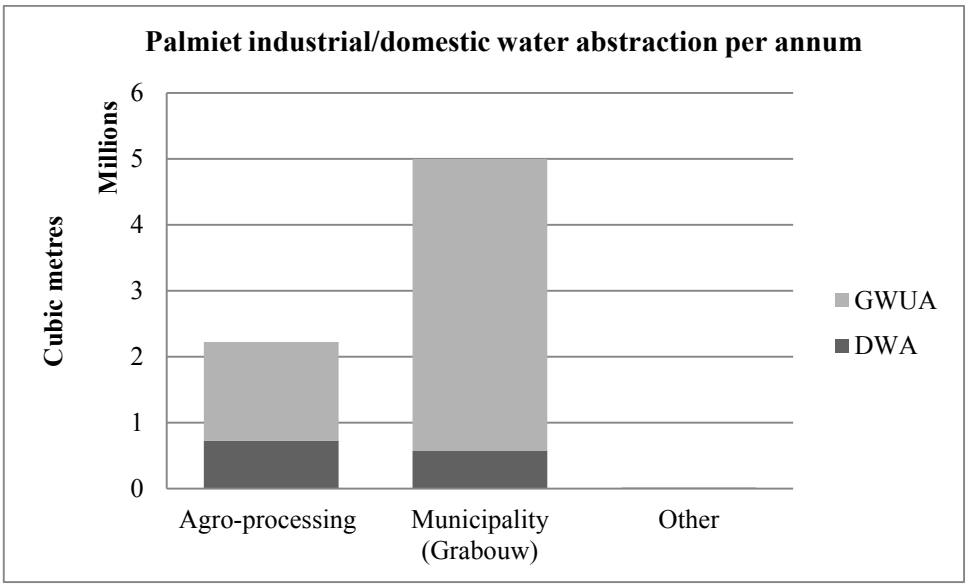

Figure 27: Palmiet industrial and domestic water abstraction per annum (GWUA, 2011)

According to the All Towns Study for Grabouw, with the current permit of 5 000 Mm^3/annum from the GWUA, the town has sufficient water for a future low-growth scenario (Figure 28; DWA, 2011; TWK IDP, 2012b). However, in anticipation of more growth, the municipality is exploring alternatives. These include the possible "rising of the dam wall" (TWK IDP, 2012b: 20). This is because with a high-growth scenario, there is an expected shortfall of one million m^3/year by 2035 (Figure 28; DWA, 2011). All water from the Eikenhof dam has been allocated. Therefore the purchase of future additional water required by the town would need to be unused farmers' portions (Wilson, 2006). The All Towns Study suggests diversification of the town water supply to groundwater in order to increase their resilience against droughts as well as water restrictions (DWA,

2011). Studies have also investigated reuse of effluent (TWK IDP, 2012b), but as yet no proposals or interventions have been offered.

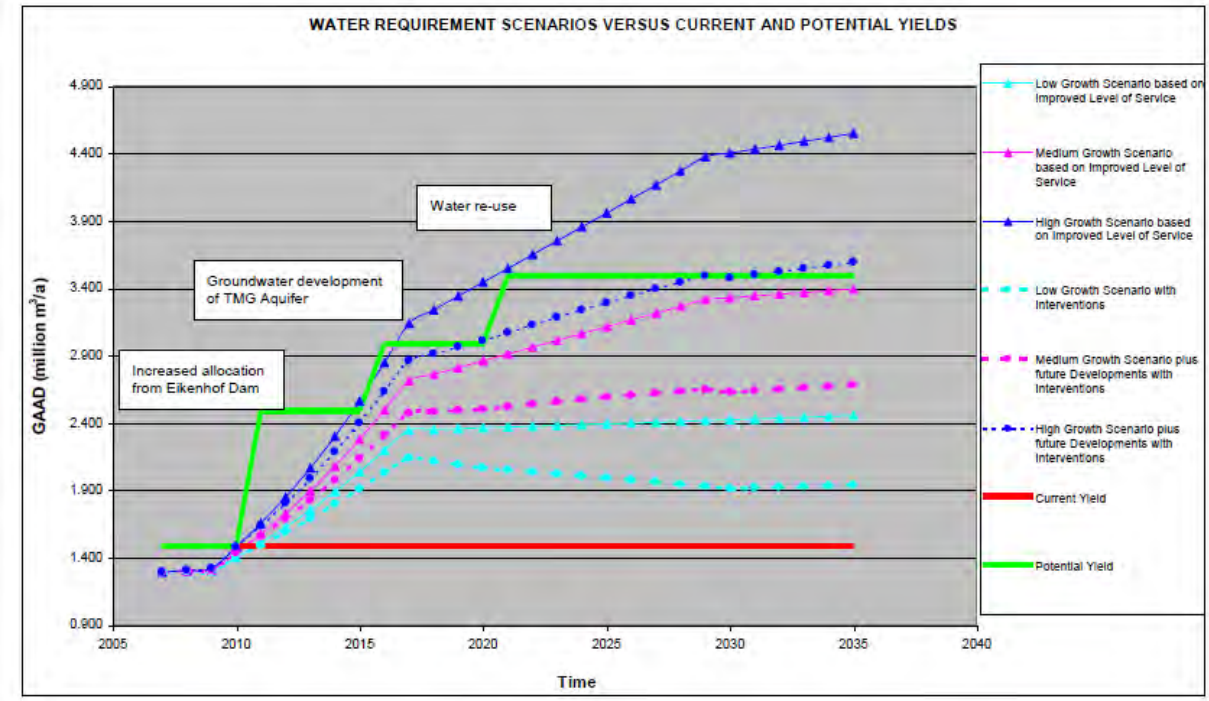

Figure 28: Grabouw intervention options: measures to reduce demand and potential sources (DWA, 2010)

Aside from the actual water supply constraints, the town of Grabouw faces infrastructure capacity constraints. Concerns with upkeep of infrastructure are widespread across South Africa as the South Africa Institution of Civil Engineering (SAICE, 2011), indicate that DWA has not been able to keep up with the infrastructure maintenance requirements of water and wastewater services. This is especially a concern regarding water quality, as until now, water supply has received most attention. In a number of local municipalities, governance failures are as a result of inadequate skills capacity of engineers (SAICE, 2011). In this case study, Theewaterskloof Local Municipality is faced with water supply and sanitation provision backlogs in the town of Grabouw (TWK IDP, 2012b).

The wastewater treatment works (WWTW) in Grabouw services approximately 90% of the industrial and domestic effluent produced in the region. Population pressure from the growing town has exceeded the plant design capacity, often resulting in failure to meet discharge standards for the Palmiet River (TWK IDP, 2012b; Hamann et al., 2008). A lack of contingency plans in the case of pump station failure is seen as a potential risk, while the un-serviced areas, particularly in the informal settlement, are an added concern (Hamann et al., 2008).

Water services supply and quality provision is listed in the current TWK IDP (2012b) as one of the key infrastructural issues that must be addressed in Grabouw as there have been cuts to water supply and inadequate wastewater treatment in the past (Wilson, 2006). This is noted in the 2005 IDP, where

service delivery protests for water and electricity were common (TWK IDP, 2006: 6-12). Indicators of the infrastructure operations include leakage or unaccounted-for water. According to the All Towns Study (DWA, 2011), unaccounted for water in Grabouw was in the range of 30% to 40% and has been reduced to 17% (TWK, IDP, 2012b). Other indicators of infrastructure inadequacy include the current reservoir storage capacity of 22 hours, and not the required 48 hours, ageing pipelines (i.e. more than 30 years old) and refurbishment that has not taken place because of resource constraints (Wilson, 2006).

Water and wastewater service provision by TWK is monitored by DWA through the Blue (water) and Green (wastewater) Drop Certification programme for Water Services Authorities (DWA, 2012b). The assessment considers the overall management of the drinking water and wastewater system and not quality standards alone. In order to receive a Blue or Green Drop award a WSA must score 95% or higher when assessed against the programme requirements. Table 15 is the Blue Drop scorecard for the Grabouw WTW in 2012. A score of 55% for drinking water compliance, and 65% overall indicates the difficulties the facility has had in meeting required standards.

Table 15: Grabouw Blue Drop Score 2012 (DWA, 2012b)

Performance Area	2012 Scores
Water Safety Planning (35%)	70
Treatment Process Management (10%)	75
DWQ Compliance (30%)	55
Management, accountability (10%)	58
Asset Management (15%)	58
Bonus Scores	3.34
Penalties	-0.93
2012 Blue Drop Score	65.25 %
System Design Capacity (Ml/d)	15
Operational Capacity (% i.t.o. Design)	20
Population served	56 400
Average daily consumption (l/p/d)	53.19
Microbial compliance	99%
Chemical compliance	80.6%

The change in Blue Drop scores over the past three years is shown in Table 16. Note that the metric on how Blue Drop scores are calculated has changed. However, in general the steady increase in score indicates increasing investment into infrastructure, management and human capacity in the municipality. Although an increase is indicated, the condition of the WTW still requires “urgent attention and investment” (Wise and Drake, 2012: 11).

Table 16: Grabouw Blue Drop Scores 2010 – 2012 (DWA, 2012b)

Year	%
2010	51.94
2011	64.10
2012	65.25

Selected scores of interest are shown from the Green Drop score card for the Grabouw WWTW in 2012 in Table 17. This has dropped in rating since last year, although it is still significantly better than the scores recorded for 2010 and 2009 (Table 18). Note that the operational capacity is running at 108.8% and is therefore exceeding its design capacity. Comments from the DWA over the 2011 Green Drop scorecard (2011) noted the huge improvement in score since the previous certification process (Grabouw itself, improving from 30% to 68%). This is as a result of the increase in capacity at the waste water treatment works, as well as improved management procedures at the facility (DWA, 2012b).

Table 17: Grabouw 2012 Green Drop Assessment (DWA, 2012b)

Assessment areas	Grabouw
Design capacity (Ml/d)	3.4
Operational % i.t.o. Design capacity	108.8%
Microbial compliance	25%
Chemical compliance	54.2%
Physical compliance	83.3%
Annual average effluent quality compliance	54.2%
Wastewater risk rating	64.7%

Table 18: Grabouw Wastewater Treatment Works Scores 2009 – 2012 (DWA 2012b)

Year	%
2009	30
2010	30
2011	68.3
2012	64.7

The 2012 Green drop score card for Grabouw states that the highest risk area is that flow currently exceeds the plant capacity, causing poor effluent quality to be released (DWA, 2012b). The annual average effluent quality compliance is 54.2%. This comprises 25% microbial compliance, 54.2% chemical compliance and 83.3% physical compliance (DWA, 2012b). These low scores are linked to the infrastructure backlogs of the Grabouw WWTW "bulk water capacity upgrading (Phase 3 and Phase 5), water network replacement and Wesselsgat Dam inspection," while sanitation backlogs include the "upgrading of the Grabouw WWTP, a master plan, septic tank eradication in selected

areas, reticulation in the area east of the Palmiet Bridge and sewer network replacement" (TWK IDP, 2012b: 22). Planning for the upgrading of the WWTW has been finalised, and construction began in the 2010/2011 financial year (TWK IDPb, 2012). These poor WWTW scores are roughly aligned with poor water quality findings of Paxton and Ractliffe (2010) below the wastewater treatment works.

The first Water Safety Plan (WSP) for the Grabouw Water Supply System was compiled in 2011 (Wise and Drake, 2012). The report identifies and rates hazards (mostly related to the Grabouw Water Treatment Works) in terms of risk. Control measures which include corrective actions in order to mitigate the risks are included.

4.4 Summary

The different water resource institutions (BOCMA and GWUA) and water service institutions (Theewaterskloof and Grabouw) face a number of challenges in supplying sufficient water quantity and quality to the region. Grabouw and the Elgin Valley were selected for the case study for a number of reasons. Firstly, they provide a case scenario for water governance institutions in South Africa. This case study is situated in one of only two functioning catchment management areas in the country at present. The WUA is active and there is an updated catchment management plan. Natural water quantity stress in the catchment is limited according to the mean annual runoff and flow data. However increasing demand, infrastructure shortages and other quality concerns result in the catchment facing water risk. Within the catchment there is a strong private sector presence through agro-processing industries, which are reliant on sufficient water supply and quality. Therefore, the catchment is particularly suitable for investigating the knowledge and understanding of water risks between the private and public sector. The opportunity for sharing is investigated by comparing how the different risks are informed and understood within the catchment.

The water resources management institutions are linked to the water services institutions through a number of channels including representation at WUA forums or CMA forums and service contracts. Communication between the two areas of water management is through their representation on catchment forum meetings held quarterly. Monthly newsletters published on the BOCMA website are an additional form of information dissemination used by the CMA. At a local level scale, in the Palmiet River Catchment (compared to the wider Breede-Overberg CMA), information is shared between the private and public sector through the GWUA quarterly meetings. Here, the local municipality, CMA as well as farmers and local industries (supplied by GWUA) are present (Groenland, n.d.a.). WUAs are a subsidiary governance body within a CMA. As organs of state, they are co-operative associations, developed to support the functions of a CMA in water management at a local level (Mazibuko and Pegram, 2006). WUAs comprise water users who "undertake water related activities for their mutual benefit," and "promote cooperative governance" (Mazibuko and Pegram, 2006: 21). Therefore, GWUA forms an important forum for information exchange between public and

private sector water users at the local scale through committee meetings and publication of quarterly meeting minutes. The CMA is also a platform where stakeholders are intended to make strategic water management decisions collaboratively (Du Toit and Pollard, 2008: 707).

The Water for Growth and Development Plan (WfGD; DWA, 2009) framework identifies the complex set of institutional relationships governing the water sector from a number of levels is a risk. Herrfahrdt-Pahle (2011) suggests that the different boundaries of the local municipality and CMA are potential reasons why the institutional relationships are complex. The strengthening of institutional capacity to overcome divisions between DWA is supported in the WfGD Framework (DWA, 2009; Herrfahrdt-Pahle, 2011). Du Toit and Pollard (2008) further apportion a lack of meaningful public participation to inadequate guidelines explicitly outlining the needs for public participation in Integrated Water Resources Management (IWRM). This chapter investigated the water management institutions in the case study in order to understand the complexities suggested in the WfGD Framework (DWA, 2009) and Herrfahrdt-Pahle, (2011). The key attributes of sustainable water management and range of levels of public participation suggested by Du Toit and Pollard (2008) and Pollard and Du Toit (2008) are useful in further understanding the role of CMAs and WUAs in water resource management.

This chapter has given an overview of the case study area. The water resources management and water and supply and sanitation institutions have been identified and characterised. In addition, the hydrology and socio-economic context of the area has been given, indicating the regions importance. The environmental importance of a functioning ecosystem, especially for the estuary is also clear. Following the contextual overview of the case study, gathered primarily from secondary literature on the catchment, is the empirical data gathering from representatives from within the catchment. Through interviews with public and private sector actors within the catchment, in addition to other stakeholders, the real and perceived water-related risks in the catchment are indicated. These findings, within the context of this catchment, will be used to develop and understanding of water risk perspectives between different sectors.

Chapter 5: Case study: actors, agency and actions

5.1 Introduction

In this chapter results from interviews within the case study are investigated with the aim of identifying the knowledge and understanding of public and private actor water risks. The main purpose of the analysis is to investigate the similarities and differences between public and private actor knowledge and understanding of risk through the development of a conceptual framework. The case study and interviews consider risks within the 'factory fence' as well the broader context of the catchment. A typology of risk identifies the progression of knowledge and understanding of the risks. The framework and typology of risk sharing are expanded upon, tested and validated through additional interviews with public and private actors within the case study region.

Interviews were carried out with selected private agro-processing companies, representatives of the Groenland Water Users Association (GWUA), Breede-Overberg Catchment Management Agency (BOCMA) and Theewaterskloof Municipality (TWK). Representatives were interviewed using a semi-structured format to allow for comparability, but also enabling further exploration and understanding the risks within each sector. Data and information extracted from the interviews were condensed into direct quotes or summaries used to explain and build upon their distinct concepts of water risk. Comparing public and private sector responses to the same questions within the case catchment informs whether or not risks are understood in the same manner.

The form of the risks were characterised into physical (availability and quality of water), regulatory or reputational risks which were identified in the literature earlier. The characterisation of physical, regulatory and reputational risk is used in private sector water risk frameworks including the WWF Water Risk Filter and WRI Aqueduct Tool. The characterisation of water risks in this form is less common in the public sector. Through empirical data collection, public sector knowledge and understanding of physical, regulatory and reputational risks is compared to that of the private sector. In addition to understanding water risks, questions were asked about the current water governance policy within the company or institution and opportunities for communicating risks among stakeholders. Through adaptive theory, using empirical data built upon previous literature, the shared water risk theory is expanded upon.

5.2 Physical water risk

Physical water security is divided into quantity and quality of water. Questions regarding physical water stress included (among others), whether or not the respondent felt they were situated in a water stressed region, their understanding of what it means to be water stressed, whether or not quality of water was a concern and whether or not there were any alternative supply options. Responses to these questions were collated and compared as suggested by Layder (1998) using adaptive theory.

Responses were grouped into 1) the understanding of current and future water risk concerns, 2) investments made to mitigate risk concerns, and 3) data collected by each respondent to inform the perceived risks. The coding used to rank risk from high to low is shown in Table 19. Circles in black indicate relatively distinct scores which were then interrogated further. Selected testimonials of importance are used to support the justification of particular elements of the framework.

Table 19: Selection of physical water risk responses and coding which was used to identify relative differences between interviews graphically

		Private Sector							Public Sector					
Type	**Questions**	Fruit Processor 1	Beverage 1	Abattoir 1	Beverage 3	Beverage 2	Abattoir 2	FP 2	TWK 3	TWK 1	TWK 5	BOCMA	TWK 2	GWUA
Physical	Water stressed region?	3	3	3	1	1	3	3	4	4	1	3	1	1
	Inputs from water stressed region	2	3	2	1	1	2	1	0	0	0	0	0	0
	Importance of freshwater for operations	5	5	5	1	3	5	5	5	5	5	5	5	5
	Operations water problems in past	3	3	3	1	2	3	0	4	4	5	1	3	3
	Flexibility to change suppliers: Water	5	5	5	3	3	5	3	3	4	4	5	4	5
	Flexibility to change suppliers: Inputs	3	3	4	3	2	3	4	0	0	0	0	0	5
	Quality concern	4	4	4	1	2	3	4	3	4	4	4	4	5
	Physical concern	2	4	3	1	2	3	2	3	2	3	2	3	1

5.2.1 Quantity

Perceptions on water quantity stress

All respondents, both public and private, believed that neither themselves, nor their water supply were currently being sourced from a climatically water-stressed region. The high mean annual rainfall (MAR) was quoted as being "*one of the highest in the country*" (Beverage 1; GWUA 1). This understanding corresponds with data quoted earlier indicating the relatively high runoff and rainfall received in the region. Two respondents mentioned that in comparison to other parts of the country, they were situated in a water rich region (Bev 2, GWUA 1). *"In theory we have enough water…. and in comparison to the Hemel en Aarde Valley, no, we are not water- stressed"* (Beverage 2). The Hemel en Aarde Valley is a nearby catchment where there is less water than the Palmiet. *"Sheep farming here vs. sheep farming in the Karoo has far more water"* (GWUA 1).

Each respondent in the survey from the agro-processing industry mentioned future water scarcity as a concern. The causes of increasing stress were cited as the growing population in Grabouw due to immigration from the Eastern Cape (Fruit Processing 2) as well as the increasing demand for water that is required to supply Metropolitan Cape Town. The increasing water demand by the City of Cape Town was noted by six respondents. The following three quotes indicate their concerns about the rising demand for water by the City of Cape Town (CoCT).

"BOCMA transfers water to Cape Town, which wants even more water" (FP 2).

"There is a risk if Cape Town comes to take water. Domestic is worth more than agriculture" (GWUA 1).

"We still have water because of the environmental management plan to determine how much water Cape Town could take. Otherwise we would have been sucked dry" (GWUA 3).

Although some respondents believed their water was protected due to the requirements of the environmental reserve, the Palmiet Catchment Management Plan states that through raising the Lower Steenbras Dam, additional transfers out of the Palmiet Pumped Storage Scheme are being considered beyond 2019 (Paxton and Ractliffe, 2010).

A BOCMA representative mentioned that *"BOCMA has 500 000 people. Cape Town has 2 million. If someone stood back, economically it would make sense to transfer all the water to Cape Town. But, water is not only economics. Water employs 100 000 people in BOCMA through irrigation of farms. Therefore, it is critical for the area"* (BOCMA 1). The threat of Cape Town's demand is also reported in the BOCMA CMS (2011) citing restrictions on the volume of water that can be transferred from the Palmiet Catchment to the City of Cape Town. The importance of the Elgin and Grabouw region with regard to agricultural contributions to the economy is used as a reason why water should be kept in the region. However, it was also acknowledged that the higher economic value of the water in Cape Town, as well as the support through markets for produce grown in the region, tourism, financial services and health services provision which the city gives to the region in turn, makes the decision more complex (BOCMA CMS, 2011).

The BOCMA CMS (2011) calculates the value of blue (irrigation) water in the catchment relative to employment and gross farming income (Figure 29). A ratio of the amount of jobs per m^3 and GDP contribution per m^3 is shown per crop and per region. The data is based on the StatSA agricultural census in 2001. Regions within the Breede–Overberg Water Management Area are broken down further into distinct river basins regions namely: Upper, Middle and Lower Breede, Riviersonderend (RVS), Overberg East and Overberg West. Grabouw is situated within Overberg West. This study is a valuable contribution towards better informing the knowledge and understanding of water risks in the economy of the Breede–Overberg Catchment. Data regarding the larger number of jobs lost as a result of a weak apple or pear industry is a useful indicator regarding the importance of deciduous fruit farming in the region, and therefore the relative importance of adequate irrigation water for example. In Overberg West (Figure 29) the relatively high contribution to GDP as well as jobs with regards to apple and pear production represents a region which is at higher risk should water not be available for irrigation (BOCMA CMS, 2011).

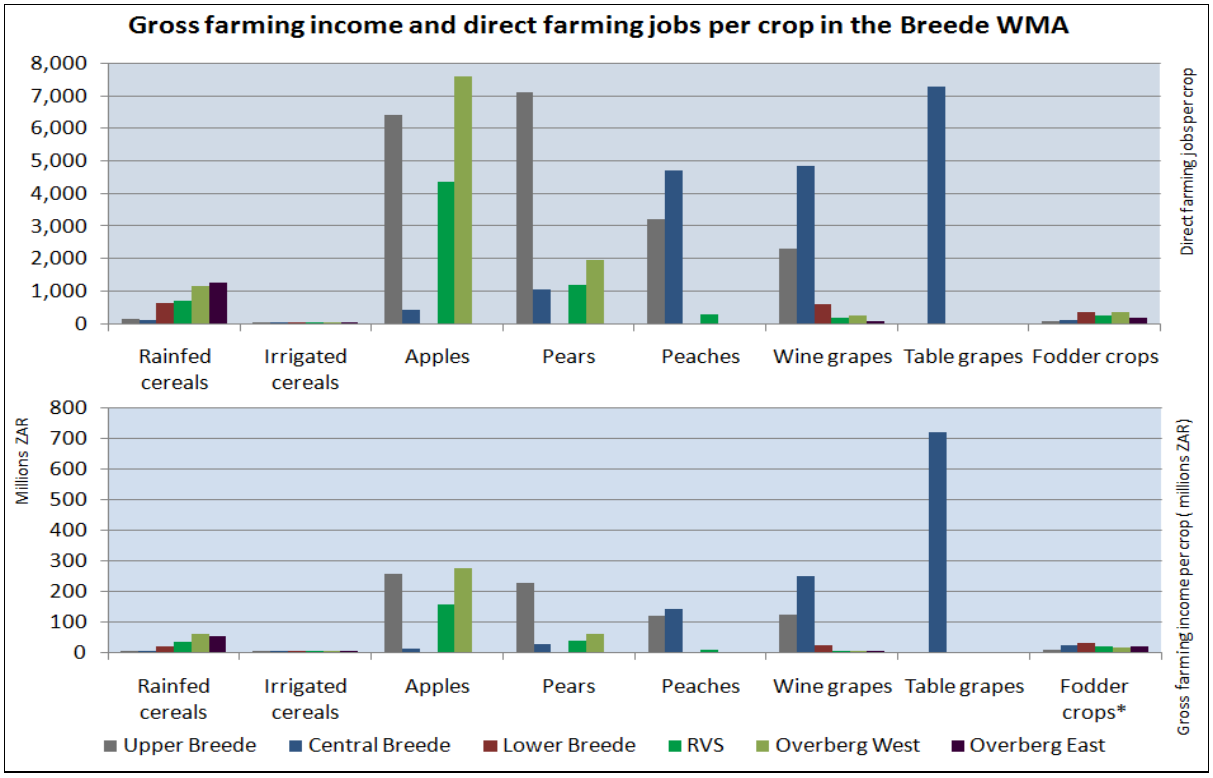

Figure 29: Gross farming income and direct farming jobs per crop in the Breede WMA (BOCMA CMS, 2011: 79)

The CoCT integrated risk management department indicate that they will require more water from the Palmiet for the same reasons as Grabouw (i.e. growing population forcing a growth in demand) (CoCT). The risks of CoCT not receiving the water, and the alternative water supply the city has, is also an important consideration. These need to be compared and contrasted with full knowledge and understandings of all risks to both the Palmiet Catchment and CoCT to best make a decision. As with the Theewaterskloof Municipality, the CoCT uses a risk management policy to score and rank risks across the municipality.

Climate change was listed by interviewees as a potential future stressor for water risk. The change in cropping patterns is more noticeable (currently) than any changes in water supply as Beverage 2 and Fruit-processing (FP) 1 mentioned the slow migration from apple to grape farming as temperatures increased. FP 1 also mentioned the fact that both the highest and lowest apple sugar contents had been recorded in the past five years. This was seen to be as a result of fluctuating climate. However, the relatively small water need of agro-processing companies was noted in comparison to the risks farmers face with climate variability: *"Agriculture, farmers, are at even higher risk"* (FP, 2). In one respondent's office (FP 1), a picture of snow cover in the mountains behind Grabouw was used as an illustration of how climate has shifted over time. Another respondent, when asked whether the catchment is water-stressed, responded, *"No, we are water rich, although some winters are drier. We used to get a lot of snow. But not for a while now"* (Abattoir 2).

Options for mitigating or managing water quantity stress

During the interviews, a number of options for mitigating or managing the supply water risks were mentioned. For example, boreholes were mentioned as an alternative supply for many. However, one company representative recognised that, *"We have a borehole, but if Eikenhof is dry because of no rain, the borehole is too"* (FP 2). This suggests an understanding of the hydrology of water within the catchment which is informing the respondents' knowledge of potential water risks. The investigation of alternative water supplies indicates that information or past experiences have informed stakeholders of potential water stress.

All seven private companies were planning or had just begun their own investments into additional emergency water supply. In every case a concern had sparked the need for investment. *"We have had supply hassles where the white water line was shut down. We have a 400 000 litre reservoir store for emergency and are looking into sand filters as a way of making white water"* (FP, 2). [White water is water which is used in the product, and is of higher quality.] Companies supplied by municipal water were considering the installation of additional reservoirs to stockpile water in anticipation of future water supply cuts or restrictions (Abattoir 1, Abattoir 2). *"We are too small to build our own dam. One option is to put in 20 000 litre water tanks at the back to finish off the day's job"* (Abattoir 2). What the respondent meant is that they are looking into an option of extra supply so that should the municipal connection be cut off, they are able to complete the orders for the day and clean the equipment.

The same is true for the public sector where the local municipality is investigating alternative sources of water. The municipality is also considering reinstating the Wesselsgat pipeline as well as a previously used borehole (TWK, 2). In the Grabouw Water Safety Plan it is stated that "the municipality intend constructing their own pump station at Eikenhof Dam to increase surety of supply" (Wise and Drake, 2012: 11). In the IDP (TWK IDP, 2012b), reference is made to improving infrastructure for supply, while in the All Towns Study alternative augmentation options are explored such as groundwater or reuse (DWA, 2010).

BOCMA advocates that "all water use must be metered, compulsory, and must be enforced" (BOCMA, 2010: 2). *"Measurement of water is not yet a legal requirement. We sent a proposal to the minister [to make metering a legal requirement]. If you don't measure, how do you manage?* (BOCMA 2). However, this has not been met with agreement by some of the GWUA members due to the potential increased costs of metering. At the GWUA meeting 5 June 2012 it was agreed that the request of the DWA to meter all water demand was not practical. "However, all members should be informed that the metering of water consumption would be beneficial for protection of water rights and allocations in future and be done where possible" (GWUA, 2012). One GWUA member (GWUA 3) supported an effort for water users to monitor their use. "*We need to look after water in our valley.*

In order to answer any criticism, it would be useful to understand flows and the use of the river. Metering is not necessary for all, but it is good to have an idea." This statement indicates a realisation that it is only when armed with data to inform knowledge and understanding that constructive discussions on how to mitigate risks can take place.

Data collection and knowledge management of water quantity risks

The measurement and collection of water use data using water meters is widely used by companies, especially where water is vital for their operations. Some agreed that the low cost of water was not an incentive to conserve water. *"Water is ridiculously cheap because it is gravity fed from Eikenhof. We pay less than R10 000 a year"* (Fruit Processing 2). Where water was not vital for operations, companies were less concerned about efficiency. In some cases extensive water recycling was undertaken and therefore the water demand greatly reduced or water was not used in the product itself (Beverage 3). A further reason for water not being vital was at production facilities where the agricultural input (e.g. apples or grapes) of the process was grown or farmed by the same company (Beverage 2). *"Irrigation quality water is very important. In the cellar, it is a very small amount in comparison"* (Beverage 2). The relative amount of water for operations in agro-processing is reduced when considering the irrigation water for the crops too. Water footprint studies of agro-processing facilities have found that the majority of water embedded within a product stems from the growing of the crop (SAB and WWF, 2009). For example, SAB have carried out a water footprint analysis of their beer production in South Africa, and found that 98.3% of the total product footprint originated in crop cultivation, rather than the beer production and processing itself (SAB and WWF, 2009).

Companies may have different reasons for 'doing the right thing' for the environment. One company is taking a responsible, 'no regrets' approach: *"We have always just done what is best. If the water level drops, we stop drawing from the stream, and use water from GWUA"* (Beverage 3). Another companies' water conservation practises are to meet regulatory requirements. *"According to the Poultry Meat Act, water use must be 15l/bird. We have implemented a goal and set KPI targets to limit the amount of water per bird"* (Abattoir 1). Other companies are driven by stewardship initiatives aligned with their company's value system, and include efforts such as reducing the water used per unit of product, or using natural treatment systems for wastewater. In order to show commitment to these goals, data capture is needed to assure the efforts that have been met to the regulators. Whatever the motivation for reducing water demand or improving water effluent discharge for example, knowledge and understanding of the risk is needed to inform what investments need to be made. Monitoring of the effectiveness of the investment is also necessary to show how the company has mitigated the water risk.

From the public sector perspective, water data is collected, but at different scales and by different public institutions. Private sector respondents felt that public sector monitoring, although done in

places, was not consistent and was irregular (FP 1, FP 2, Bev 1, Bev 2). GWUA meter and measure their stakeholders' water consumption. They are able to identify whether or not their quota has been reached, and differentiate between summer and winter water consumption. This is not necessarily achieved by metering every farm, but according to a quota system and the pumping used to move the water from the Eikenhof Dam to the farm border. GWUA does not know the water usage statistics within the municipality as it is not part of their mandate (GWUA). Therefore, although each public sector institution is metering water use, there is no single, centralised data repository for the catchment. This indicates an opportunity for sharing information, so that actual water flows within the catchment may be understood in greater depth.

5.2.2 Quality

Perspectives on water quality stress in the Palmiet Catchment

In the private sector, water quality issues and concerns differed depending on whether the water was supplied by the municipality or GWUA or each user had its own water source. Companies being supplied by the local municipality stressed the need for particular quality standards for their industry accreditation. The reason for TWK municipality not being able to meet quality targets was most often perceived as a lack of capacity in infrastructure as well as human resources: *"We made a meeting with the municipality regarding the water quality issues (high aluminium in the water). They came to our business and acknowledge that they are under-capacitated"* (Abattoir 1). The respondent went on to say that although there was some empathy for the municipal capacity (human resources and infrastructure) issues, certain water quality standards are critical for business, and must be met. Companies supplied by the municipality mentioned a lack of an alternative water treatment facility as a risk: "*A month ago, the municipality had to supply us with a vehicle with water. This is a hygiene problem"* (Abattoir, 2). Although no major cases of inadequate quality water were reported, this was noted as something that may become a growing concern, dependent on the administration of the municipality. The poor quality water being supplied from the municipality is linked to the infrastructure backlog mentioned in the IDP (TWK IDP, 2012a). The poor Green Drop scores support the perceived risk of the two companies (DWA, 2012a).

Facilities supplied with raw water from the DWA and GWUA have no expectation of water quality levels, treating the bulk water in their own treatment facilities. However, if the entire catchment's water quality were to deteriorate, the efficacy of their on-site treatment systems, especially the chlorination stage, would be reduced, thus also putting them at risk (FP 1; Beverage 1).

Water quality concerns from the private sector agro-processing companies were high priority, especially where water was an input, or the product was being exported. Fruit processing 1 and 2 in particular stressed the strict Eurepgap requirements, which include pathogen tests on the crops. Eurepgap is a subsection of GlobalGap, which includes regulatory requirements for farmers to export

to Europe. GAP is an acronym for Good Agricultural Practises. The standard uses Hazard and Critical Control Point Analysis (HACCP) guidelines from the UN Food and Agriculture Organisation. For crop and vegetable producers there are standards regarding propagation material, soil management, fertilizer application and pest management for example (GlobalGap; 2012): "*We do not want to be like the farmers in the Breede, and realise too late*" (FP 1). Only two respondents did not list water quality as a high concern. The one was because water does not enter into their final product, and only used as a cooling agent. The other did not find water quality a concern as the facility draws water from dams high in the mountains, away from any domestic, industrial or agricultural contamination.

Companies either discharge their wastewater directly into the municipal waste system, paying the municipality to treat the discharge with domestic waste water from the town. Alternatively, companies not situated in the town, have developed their own on-site treatment systems, reaching quality standards specific by the DWA before discharge into open water bodies including the Palmiet River. Municipal waste water discharge is not enforced on a regular basis by the municipality at the moment (Abattoir 1, Abattoir 2). However, respondents do anticipate legal wastewater discharge compliance requirements within the next five years (FP 2).

Water quality is a concern for the Breede-Overberg CMA, indicated by the vision for the catchment: 'Quality water for all forever.' The failures of the Grabouw Wastewater Treatment works were mentioned in addition to unregulated industries, treating their own effluent and discharging this into the Palmiet: "*There are no effluent by-laws for this, and therefore effluent standards from industry are not being monitored*" (BOCMA 3). For the municipality, infrastructure investment backlogs including treatment site capacity are their greatest quality risk concerns. This is indicated in the TWK IDP (2012b) infrastructure investment. First, the necessary infrastructure capacity is required, "*before we can fine companies for non-compliance*" (TWK, 2). The lack of engineers in smaller local municipalities was also noted as a significant risk (BOCMA 2). This is supported in the Water for Growth and Development Framework of South Africa (DWA, 2009). The municipal capacity assessment (TWK, 2011a) also supports this claim, where it states that "there is a chronic shortage of municipal engineers in South Africa". Public sector investments have recently been put into expanding the water and waste water treatment utilities for the town, recognising the water quality concerns of both supply and effluent in the region (TWK IDP, 2012b). The following quote indicates that the CMA, although critical of the municipality and how it has managed water risks, recognises the trade-offs that need to be made: "*In the municipality they first build houses, then they build the services, then they upgrade the municipal treatment works. This is not a good scenario, but there is no other option"* (BOCMA 1).

The growing informal settlements as well as over use of agricultural fertilisers were cited by the municipality as causes for poor water quality in the catchment: *"Untreated sewage from the informal*

settlements is causing a health risk to both humans and the environment" (TWK 3). GWUA (1) identified similar water quality concerns, adding that the effects of poor water quality are risks to the private sector export economy, in turn damaging the GDP and income for the entire catchment.

Technical managers at the municipality mentioned the natural iron (Fe) levels in the water from the mountains causing water quality concerns (TWK 2, TWK 4). As a result of the high iron concentration, large amounts of alum (hydrated potassium aluminium sulphate) are needed in order to precipitate the iron. "*This is not good. People don't like the taste, and for the industries, too much alum will cause them to fail their product tests* (TWK 1)." This was also mentioned as a concern by Abattoir 1: "*We are not quantity stressed but quality. The water is high in aluminium because the municipality is trying to bring down the iron content."* Comments on the Grabouw Blue Drop Scorecard included the persistent aluminium failures at the water treatment works. New initiatives are currently underway, investigating alterative coagulant dosing methods to deal with the problem (DWA, 2012b). Therefore, even within the public sector, perceived causes of water quality concerns were different.

Data collection and knowledge management of water quality risks

Data collection of water quality and use is extensively measured by companies as required by regulation. Water consumption and discharge volumes are typically undertaken by the various companies. However, where important for processing or an input, additional factors such as COD/BOD or temperature or pH are analysed (Beverage 3). Industries with strict regulations regarding the quality of fruit or agricultural products (e.g. Meat Safety Act No. 40 of 2000; HACCP; SANS 241) were especially concerned about water quality.

The quality of effluent being sent either to the municipal wastewater treatment works or into the Palmiet River is also monitored. Again the regulatory pressure was mentioned:

"The effluent is checked monthly. It is important that the water meets particular standards for Eurepgap requirements" (Beverage 2).

"We are required by law to check the dam. Once every three months. We must do ground sampling too" (Beverage 3).

"As a government-required measure we put in a COD meter" (Abattoir 2).

Companies sending their effluent to the municipal wastewater treatment works are currently not monitored for the quality of effluent discharged into their system. However, stricter regulations are anticipated. Abattoir 1 tests water quality to determine whether or not they would meet the regulated effluent quality requirements. *"At the moment there is no legal requirement, but if we were to measure COD, we would fail"* (Abattoir 1). The reliance on government to monitor and enforce the

regulations of wastewater quality was also mentioned when Fruit Processing 2 was asked about their effluent quality discharge: *"Ask DWA, it is measured every three months. Only if there are problems they contact us"* (FP 2). *"We are meant to have quarterly dam inspections, but no-one checks"* (Beverage 2). This statement indicates a distinction between the private and public sector and the separation of roles and expectations with regards to securing water supply and quality. Companies have varying degrees of concern regarding effluent water quality. Companies supplied by GWUA and DWA had invested in their own wastewater treatment facilities, and comply with regulatory requirements regarding wastewater discharge as it is in their own interests to do so. Those discharging to the municipal wastewater system have considered pre-treating wastewater effluent before going to the municipality, but until regulation is implemented they continue to breach the proposed standards and reduce costs (Abattoir 1, Abattoir 2).

It is a regulatory requirement that the municipality test incoming and outgoing water and wastewater. "Monthly monitoring is currently being independently undertaken by external consultants (A.L. Abbotts and Associates) in terms of the South African National Standards (SANS) 241 for drinking water quality specifications" (Wise and Drake, 2012: 47). The enforcement of regulation for industrial water use was not done however, as "*first the necessary infrastructure to treat the effluent is required before fines can be sent*" (TWK 1). The GWUA, when asked about their wastewater quality monitoring responded saying: "*Annual quality reports are published on our website"* (GWUA). At the GWUA meeting in June 2012 (Groenland, 2012), there was a presentation from a consultant regarding the water quality of the Palmiet, indicating possible causes of the pollution. The cost of the study was covered by the GWUA, in an attempt to gain better knowledge regarding the quality changes through the river. Following the presentation, discussion between the members included re-activating monitoring stations at GWUA's cost where they are no longer operational. The recognition that data is required for the catchment as a whole is an indication that risks are being taken into account, and planning is being made in order to mitigate them (BOCMA 1, GWUA). GWUA recognise that this cannot take place until the system as a whole is better understood.

5.2.3 Summary of physical risk similarities and differences

Most respondents believe the Palmiet is not currently in a water-stressed area, but anticipate stress in the future. Similar quantity concerns between the private and public sector include climate change, population growth (Grabouw and Cape Town), and transfers out of the catchment. Quality concerns include increasing fertiliser use, municipal capacity and un-serviced informal settlements.

Within the private sector, there were differences in perceived exposure to risk depending on whether or not the company is supplied by DWA, GWUA or the local municipality. Within the public sector, differences in perceived exposure to risk are linked with the level of water resources management. For example, the municipal manager of Grabouw is focused primarily on service delivery and operational

risks, while the GWUA CEO has a larger perspective of the entire catchment, considering the wider context and strategic risks of the municipality as a whole. Their understanding of water flows within the catchment is therefore different. GWUA collect a large amount of data regarding water use and quality changes in the catchment. The knowledge gained from the data helps to understand the wider catchment. GWUA relay communication to their stakeholders through the minutes of their meetings and a short newsletter to all members. Information conveyed includes the current projects taking place in the catchment, changes in organisational structure and communication between GWUA, BOCMA and DWA (Groenland, 2012).

Investments into supply and quality assurance are being planned or are in the process of completion. These activities indicate a risk response from both the private and public sector. From the public sector perspective, the results of investments into water supply and sanitation should be seen through a decrease in Blue and Green Drop risk scores. The budget set aside in the TWK IDP in order to meet infrastructure backlogs is also an indication of the public sector awareness regarding the risks it faces. From the private sector perspective, investments also have been made into water supply and quality assurance. The factors driving these investments all stem from to a need to ensure a licence to operate and being able to produce water for use in the catchment.

Water quality risks are particularly important in this catchment. Industries exporting or producing food with strict quality regulatory requirements are especially at risk. The public sector is also at risk of non-compliance if it supplies water that does not meet required standards. However, the wider catchment is also at risk as businesses may close and move away if they are unable to ensure the necessary input standards.

Table 20 summarises the physical water risks mentioned by the public and private sector in Phase I interviews

Table 20: Physical water risks summary

Physical Indicator		Private	Public
Physical: Quantity	Current water security	Rainfall high compared to other areas, MAR high	MAR high, inadequate infrastructure, small tax base, immigration
	Future water security	Grabouw and CT demand, climate change, infrastructure insufficient	Grabouw and CT demand, climate change, lack infrastructure
	Supply-related investments	Emergency reservoir supplies	Alternative water sources and repairing alternative supplies (borehole/Wesselsgat)
	Data collection	Metering where water is an input or used in large amounts	Meter, but not enforced
Physical: Quality	Current water quality	Municipality under capacitated, human resources and infrastructure	Infrastructure backlog, lack of engineers
	Future water quality	Municipal water and wastewater treatment, inadequate sanitation in informal settlements	Non-point source pollution, informal settlements, agricultural fertilizer use

Physical Indicator		Private	Public
	Quality-related investments	Supply and effluent treatment solutions to comply with regulations	Increase capacity of WWTW (in the process)
	Data collection	Quality testing required when by regulation	Quality testing required by regulation, not yet enforced

5.3 Regulatory risk

The private sector has to comply with increasing and complex regulations from industry standards related to production, to good corporate governance requirements, to water effluent quality requirements. Responses to questions regarding the regulatory risks private companies or public sector institutions face are indicated in Table 21. Higher risk scores of compliance to regulatory requirements across the private and public sector are shown.

Table 21: Selection of regulatory water risk responses and coding which was used to identify relative differences between interviews graphically

		Private Sector							Public Sector					
Type	**Questions**	Fruit Processor 1	Beverage 1	Abattoir 1	Beverage 3	Beverage 2	Abattoir 2	FP 2	TWK 3	TWK 1	TWK 5	BOCMA	TWK 2	GWUA
Regulatory	Discharge compliance	1	3	5	1	2	4	1	3	4	4	4	1	0
	Penalties or fees for discharge regulations	0	3	0	3	0	3	0	3	4	3	3	1	0
	Exposed to regulatory changes - planned or potential	0	3	3	3	3	3	3	3	3	3	3	4	3
	Strong enforcement of regulations in area of operations	3	3	3	3	3	3	4	2	3	4	4	4	5
	Strong concern over HACCP or SANS type regulations	3	5	5	3	5	3	5	4	3	4	3	5	1
	Supply to Woolworths - mentioned regulations as a driver	1	3	4	1	1	1	1	0	0	0	0	0	0

Drivers of regulatory risks for the private and public sector

Most companies listed regulations outside of the direct water sector as factors determining water quantity and quality monitoring and safely plans. For example, a certificate of analysis from the Grabouw Water Treatment works is requested every month for regulatory purposes (Abattoir 1). Regulatory requirements also include retail outlets, for example: *"Woolworths requires certain standards"* (Beverage 2). Facilities involved in export in particular, were concerned about what requirements needed to be met. Therefore, industry regulations seem to be a larger driving force regarding engagement with water risk than any water regulations at the moment: "*The Meat Safety Act requires us to treat the incoming water to a certain level. The Waste Management Act requires us to use a certain procedure for the wastewater. A separate company does this for us"* (Abattoir 1). *"We are also facing pressure from Woolworths to look into an environmental plan"* (Abattoir 1). Other

regulations mentioned by the companies included HACCP (SABS, 2008), Eurepgap and SANS 241 (SABS 2011a; 2011b).

For some private company respondents, increasing regulation was not seen as a risk, but instead a potential opportunity. Most respondents mentioned the increasing demand for water in Cape Town as a pressure on the Palmiet Catchment and Water Transfer scheme. GWUA 3, a farmer in the region, noted that according to the national environmental flow requirements, no further water could be transferred from the catchment, and therefore their supply was safe "*as long as the regulation is able to be implemented*". GWUA 1 mentioned that the environmental flow requirements might apply pressure as there is no longer as much water available in the catchment. However, in having to meet the requirements, there is also no water available for transfer. Therefore the meeting of flow requirements has been helpful to the catchment water security.

Aside from actual regulatory requirements, institutions enforcing particular regulations can be seen as a risk. Institutions responsible for water supply were mentioned as a risk to water supply by the private sector. This is another form of regulatory risk. Companies supplied with water from TWK Local Municipality, compared to those supplied by GWUA or DWA, had different concerns with respect to water supply. One particular respondent (Fruit processing (FP) 2) mentioned being grateful that their water was not supplied by the local municipality because assured supply of quantity and quality of water would then be a concern: *"Luckily we do not depend on the municipality"* (FP 2). Abattoir 1 and Abattoir 2 (both supplied by municipal water) mentioned cases where, due to insufficient management from the municipality, their water was not available. Sometimes this was not strictly due to supply, but pressure: *"Supply is not a problem, but sometimes, especially when they are doing work on the water lines, the pressure is not enough. We need a certain pressure to run our machines. We have very close communication with the municipality when this happens"* (Abattoir 1). Evidence to suggest the extent of the risk regarding municipal infrastructure is found in the unaccounted-for water. In 2007, the Grabouw All Towns Study (DWA, 2010) estimated total unaccounted-for water (UAW) in Grabouw as 0.531 million m^3/a, representing 41.1 % total losses. The bulk losses are assumed to be 0.259 million m^3/a (20 %), and the internal losses are calculated as 0.272 million m^3/a (26.3 %). These concerns are also supported by the low Green and Blue Drop scores achieved by the Grabouw water and wastewater treatment works before investments were made.

In the public sector, a technical manager of the municipality pointed out that "*although water is available, the infrastructure is not sufficient to meet the requirements of the municipality*" (TWK 1). A number of reasons were given as to why the municipality is unable to supply water to all of the population. These include the small number of people paying rates and taxes as well as the influx of migrant labour into the region: *"Grabouw is under large strain because there is a large population*

which does not pay its rates and taxes. The municipality is not able to provide capacity, human or infrastructure" (TWK 3), and *"migrant labour puts extra stress on the system. This is because people from the Eastern Cape come to Grabouw as a stepping stone before going to Cape Town"* (TWK 3).

These statements are supported in the TWK IDP (2012). "In order to meet its existing infrastructure backlogs and maintenance requirements, Theewaterskloof needs between R60 and R72 million in capital funding per annum for the next ten years. With the current rates base, this would incur a deficit of R50 million on the operating account by 2016" (TWK IDP, 2012a: 34). "TWK attracts migrant labour, hence the expansion in the population due to inward migration" (TWK IDP, 2012a: 7). In the TWK IDP (2012b) the influx of people into the municipality is stated as a risk to the municipality's financial viability. Data supporting this includes the uncertainty of population growth and high unemployment statistics (unemployment rate is 42%, where 31% of households have no income) quoted in the Theewaterskloof Annual Report (TWK, 2011a). The municipal utility is also under-capacitated in terms of human resources. The Grabouw Water Safety Plan states that, "class 3 process controllers are supposed to be operating the WTW; however, the process controllers are classified as having a class 0 classification due to the lack of formal qualification" (Wise and Drake, 2012: 13). Research by Mukheibir and Sparks (2005) found that water shortages due to poor infrastructure management as opposed to climate variability were common in smaller municipalities; hence smaller towns may require further risk assessment due to their human resources situation. Often "small communities have far smaller populations at risk, but often far higher proportions of their populations can be vulnerable" (Cross, 2001: 1).

Failing or over-regulating institutions and unstable policies are specifically a concern to companies who are heavily regulated by food and export requirements such as Eurepgap (FP 2). Some public sector respondents also recognised their role in amplifying regulatory risks: *"There is a risk of failing institutions. Industry that gets water from an institution is at greater risk than if it is pumped straight out of the river. But if there is no regulation, industries will take or pollute freely"* (BOCMA 2). Mention was also made that increasing the number of institutions responsible may not be the answer. The establishment of CMAs across the country may be an example of this, where, if the CMA is not completely operational, there may be insufficient resource planning and management, which could result in a strategic risk to future operations (BOCMA, 3). A BOCMA respondent, however, recognised the limitations of what an institution is able to achieve in the face of increasing scarcity: *"If there is water stress… There are a few scenarios. The company will move. They will become efficient or use dry processing or they will look for an alternative source. In these cases, an institution doesn't help"* (BOCMA 2). Another comment made in this light is the following: *"The function of a municipality is to supply clean water. When it cannot perform, you make your own plan. It is like the function of the police is to give you security. When they can't you hire private security. If this becomes the norm municipalities will give everything to industries. This is a catch 22. If industry steps in, the*

municipality steps back" (BOCMA 1). The above comments from different representatives of BOCMA indicate the risks and opportunities of private sector engagement in water management.

Future regulatory risk concerns

All respondents felt that water regulation was irregular, and anticipated this changing to a more formalised, monitored system in the future. *"Regulation will increase. When? It depends on the government's timing"* (Beverage 3). *"The municipality has talked about COD regulations and increasing the price"* (Abattoir 2). The respondent was not sure however if this had been implemented already, indicating a gap in communication. Another indication of the lack of communication between companies and the regulator (whether the DWA or municipality) is shown in the following quote: *"We have heard nothing from DWA, and so we assume good compliance"* (FP 2). This quote is in reference to effluent quality being discharged into the Palmiet River. This is also seen between different private sector companies: *"All of our water goes into the neighbours' dam, he tests"* (Beverage 2). This indicates a transferral of responsibility (and risk) to users downstream to monitor and check on water quality concerns.

Abattoir 1 and Abattoir 2 anticipated increased regulation from the public sector that would require investment to improve their effluent quality within reasonable standards: *"We are busy trying to manage our wastewater quality. An American company has come to help. We want to reduce our waste to the municipality"* (Abattoir 2). Another company is quoted saying: *"We are considering re-use, as water is an expense. We are also looking at digestion of effluent water for energy for the boilers to save costs. First we look at the data to build awareness and monitor"* (Abattoir 1). Later on in the interview, the respondent mentioned having meetings with the municipality in anticipation of the stricter regulation from the municipality regarding effluent quality. The company is looking into a waste management plan to improve the effluent quality. However, "*the investments necessary are huge, and there is no guarantee it will be the solution*" (Abattoir 1). Beverage 3 mentioned on-going work to improve the quality of water going into their effluent dam. pH correction using lime dosing was being done in order to correct the pH for use in the boiler. This is in order to save water consumption through recycling, and also to meet regulatory requirements of the effluent dam water quality.

Private companies recognise the investment requirements they will need to make to ensure compliance. Many (especially those facing wastewater effluent regulations from the municipality) are in the process of identifying ways of meeting the anticipated regulations, but at the moment seem to be waiting for the public sector to act. One private sector respondent speculated whether payment to the municipality was preferable to trying to treat the effluent themselves beforehand (Abattoir 2). This perspective was due to a number of factors, including that it was not core business to treat wastewater, and therefore it would be more effective to outsource it. Additional reasons were the financial

implications of investing in wastewater treatment facilities when the economies of scale were better sending the discharge to the municipality: *"We are too small. If we are forced by regulation, we will close down"* (Abattoir 2). Also, the company felt targeted, saying the municipality was attempting to raise funds from fining business for effluent, when they themselves were not able to treat wastewater to the desired standards: *"The municipality cannot cope at the wastewater works. It smells. The squatter camps are partly to blame. Instead the abattoir is blamed. We are easy money"* (Abattoir 2).

Two municipal representatives claimed that regulation was the most important consideration regarding risk (although two respondents stressed that reputation was in fact the most important consideration of a municipality). As stipulated by the Municipal Systems Act no. 32 of 2000 (MSA; RSA, 2000a) and Municipal Finance Management Act no. 56 of 2003 (MFMA, RSA, 2003), local municipalities need to show good governance. This is mirrored in the National Treasury Risk Management Framework laid out for the municipality. Compliance with respect to legislation by the municipality is an important reason why risk registers are completed on a quarterly basis, for example. Water supply and wastewater treatment are factors included in the risk register for consideration by the municipal council.

From the municipal perspective, lack of finances for maintenance was highlighted as a risk. Infrastructure development as opposed to maintenance is far easier to assign funding towards (BOCMA 2). *"Money for projects is easy, but money for bolts and nuts is difficult"* (BOCMA 2). Another indication of the frustrations of public sector bureaucracy and difficulty in carrying out maintenance is shown in the following quote: *"Supply chain management is a barrier to sorting out the problems"* (BOCMA 2). The example given was: *"If there was a specialised impellor for the WWTW, you could not take a precautionary approach and make it beforehand. This is not allowed"* (BOCMA 2). These checks and balances put in place to protect the public sector from other risks such as fraud or mismanagement mean that the public sector is unable to act as quickly, putting water provision for example at risk.

The CMA representatives voiced concern regarding the lack of sufficient monitoring by the local municipality. Suggestions include a revisiting of the local by-law as currently the municipality is carrying the cost of wastewater treatment, which should be met by industry in some way too: *"Management is a problem. The municipality does not check restaurants or industrial works. They need to revisit the bylaws. They do not collect fines"* (BOCMA 2). Without collecting the fines, the municipality may be losing significant income. However, admission was made of the wider systemic issue of environmental health practitioners being moved to district municipality level, effectively removing 'on the ground' responsibility of the impact of water on human health (BOCMA, 3). This indicates a realisation that the human resources available within the municipality are stretched, and they are not always successful in complete implementation and enforcement of legislation. The

municipality, believe that "*now with an integrated task team, this has improved*" (TWK, 3). This is supported by a quote from BOCMA, where *"the integrated task teams with the municipality have helped get cooperation"* (BOCMA 2).

All TWK representatives mentioned that they could not regulate an industry for effluent quality if they themselves could not treat the effluent in the first place. Therefore, before upgrading the Grabouw WWTW, no monitoring for compliance was possible. Now, however, with the recent upgrading of the sewage works, the municipality mentioned that they would be "*better equipped to justify charges for non-compliant wastewater discharges*" (TWK 2). Sustainable solutions using renewable energy were sought during the upgrade of the Grabouw WWTW. The municipality identified the need for an upgrade in 2007, where innovative solutions, identified by the consulting engineers include*: "taking dewatered sludge from the incoming raw sewage directly to composting"* (Mattheus, 2013). Challenges through the project, however, included gaining environmental approval. According to the consulting engineer, this was surprising, considering the public support for the project (Mattheus, 2013). This type of response indicates the predominantly technical or operational scale of the engineer, characterised by Renn (2008a).

In monitoring municipal management of water and wastewater treatment, it was acknowledged that *"the Blue and Green Drop reports are a good way to judge municipalities"* (BOCMA 2). BOCMA also identified the Blue and Green Drop monitoring carried out by the DWA as a "*useful way of communicating and working together with the municipality*" (BOCMA 3). The process is able to highlight high risk areas, which then can promote collaboration in mitigating the problems. BOCMA also recognises the power of separating public sector institutions responsible for regulation and operations: *"BOCMA does not have all water management delegations transferred. It is good to keep another brother watching. Water Affairs must play the regulatory role, BOCMA the operations"* (BOCMA, 2).

One particular risk of regulation is confusion between regulating bodies. For example, tension between the local municipality and BOCMA became evident at the June 5 committee meeting (GWUA, 2012) where the local municipality had applied for a basic assessment report from the Department of Environment Affairs in order to de-silt parts of the river. According to BOCMA a proper survey of the depth of the riverbed needs to be done in order to determine what type of licence to award. Depending on the results a General Authorisation, awarded by DWA and BOCMA may be required. This discussion [sometimes heated; the argument had to be taken outside of the GWUA Committee meeting] has been on-going for two years (GWUA 2). This is a risk to the entire catchment if there is tension between the different public sector institutions, resulting in inaction.

5.3.1 Summary of regulatory risk similarities and differences

Both the private and public sector are influenced by regulations. Currently private sector risk management plans are formulated according to the water sector's regulations as well as the food and beverage industry compliance requirements. As regulation from the public sector regarding water discharge into the sewers increases, this may change. For the public sector, risk management is required by municipalities, in accordance with the risk management framework, MFMA (RSA, 2003) and MSA (RSA, 2000a).

The greatest concern to the private sector is that the institutions responsible for managing water fail, causing a disruption in water availability, whether supply or quality. Unstable policy, causing uncertainty, was also listed as a result of failing institutions. The public sector recognises the risk of mismanagement of water resources. The factors driving their inability to manage water effectively include a lack of finance and human capacity resulting in a lack of infrastructure and enforcement. Regardless of the regulatory concerns, all sectors anticipated improved regulation going forward.

For the public sector, investment in wastewater treatment infrastructure at the Grabouw WWTW indicates a response to regulatory risk. The investment in infrastructure mentioned in the interviews, and seen in the IDP budget outlines, is an effort to meet compliance to certain standards. Non-compliance of treatment standards is a regulatory risk facing the public sector. The improvement in effluent quality is indicated by the lowering risk scores on the Grabouw Green Drop Score Card. The investments are a good indicator of a risk response.

Table 22: Summary of regulatory risks mentioned by the public and private sector

Regulatory Indicator	Private	Public
Causes of regulatory risk	Failing institutions, unstable policy	Failing institutions through lack of monitoring and finance. Bureaucracy
Regulations to comply with	HACCP, SANS 241, Eurepgap, Meat Act	PFMA, MFMA, MSA, Blue/Green Drop
Future regulations	Municipality and BOCMA becoming more organised	Once infrastructure sufficient meets basic requirements will regulate, integrated task teams
Opportunity to use regulation	Use requirement of Palmiet EWR to stop transfers to CT	

5.4 Reputational Risk

In this study, respondents were asked about their real and perceived reputation. Examples of the responses to questions regarding reputational risks are shown in Table 23. The importance of larger water using/polluting actors relative to others is seen as a major contributor of reputational risks as indicated by the highlighted areas.

Table 23: Selection of reputational water risk responses and coding which was used to identify relative differences between interviews graphically

		Private Sector							Public Sector					
Type	**Questions**	Fruit Processor 1	Beverage 1	Abattoir 1	Beverage 3	Beverage 2	Abattoir 2	FP 2	TWK 3	TWK 1	TWK 5	BOCMA	TWK 2	GWUA
	Exposure of facility to local/national media (criticizing or positive for water issue)	0	0	0	0	4	4	0	3	4	4	4	4	3
	Does facility know other key stakeholders	2	2	4	1	1	4	2	3	4	3	1	2	1
	Importance of facility as a consumer compared to other stakeholders	3	4	2	1	3	1	3	4	5	4	5	5	3
	Engagement with other stakeholders to manage water	3	2	3	1	1	5	1	1	2	3	2	4	1
	Active forum engaging all stakeholders	2	2	2	2	1	5	1	2	3	4	3	4	1
	Involvement in water disputes with other stakeholders	0	0	0	0	0	1	0	3	3	3	5	4	1
	Media - sustainability mentioned in website	1	1	1	3	1	4	1	1	1	1	1	1	1
Reputational	Media - water mentioned in website	1	1	2	3	1	4	3	3	3	3	1	1	1

Negative media exposure was something all private sector companies (except Abattoir 2) had not experienced. In contrast, the local municipality identified 'frequent' or 'occasional' negative media, mostly regarding the inadequate wastewater treatment works or service delivery protests (TWK 1, TWK 3). This represents a reputational risk to the municipality as consumers of the water begin to distrust the municipality. "For most water utilities and regulators, the biggest fear is the loss of consumer confidence" (Pollard et al., 2004:10).

Some companies recognise a weak local government in their area as a "significant risk to operations as well as global reputation" (Hamann, 2012). Abattoir 2 felt that poor publicity to their company was due to poor WWTW management. *"There are complaints to the municipality about the wastewater works. Blame goes to the abattoir"* (Abattoir, 2). This comment supports those of Hepworth (2012) regarding Coca-Cola in Kerala, India and the fact that they were blamed for water shortages they were not solely responsible for. Negative reputations take a long time to change, as seen by Nike and their poor image a number of years ago "concerning child labour in third world countries" (Senge et al., 2010: 105).

Some municipal representatives stressed that reputation is one of the largest risks they face: "*A good reputation will help with the next election*" (TWK 3). Others felt regulatory compliance was more important. The reputation of a municipality heavily influences the amount of investment it may receive from business (TWK 4). Theewaterskloof Technical Director explained that "*Theewaterskloof has a large indigent population, and is heavily dependent on subsidies. Subsidies are not sufficient to provide Theewaterskloof with a thriving and first class municipality as cost cutting is needed*" (TWK 3). With a reputation of being able to supply sufficient water, energy and other services required by industry, the municipality may be able to attract more industry to the region, which will contribute to

the financial health of the region (TWK IDP, 2012b; TWK, 3). According to Mattheus (2013), there was a moratorium on expanding development in Grabouw until the wastewater treatment works had been finalised. Now, with the added capacity, the regional economy may develop further (Mattheus, 2013). The focus on increasing investment to improve social development in the region is supported through other initiatives as well. The DBSA's Rural Economic Development Initiative (REDI, 2011), through a pilot study on Theewaterskloof Local Municipality, developed an economic stimulus plan. Although currently focused on the shorter term, the long-term development intentions include increasing the "financial sustainability of the Municipality by stimulating the local economy and growing the number of rate payers" (REDI, 2011). A number of initiatives support this. These include a strengthening of the tourism sector and strengthening the partnerships between the local municipality and the private sector stakeholders and investors. Further suggestions from REDI include broadening participation in the local economy and trying to uplift the local economy through private sector investment (REDI, 2011). Therefore, although not directly linked to water, reputation and the assurance of a stable municipality are an important objective for Theewaterskloof.

An indicator of potential reputational risk is to consider the context in which the company is situated. The socio-economic profile of the community, environmental health and water security are all external factors that may influence a company's reputation. Also, the relative size of the company is important. To negate a potentially poor reputation, companies may decide to invest in stewardship or corporate social investment (CSI) initiatives. Some of the companies in the catchment mention employment, social upliftment through some form of Black Economic Empowerment (BEE) or educational projects, and the environment as indicated by the below summaries extracted from their public websites. References to these quotations have been removed to protect the identity of the specific companies.

One fruit processor mentions their "burgeoning social responsibility programme" which makes the company a "trusted brand." The website also lists the number of employees (permanent and seasonal) throughout the facility. "The Company's largest shareholder is black and is also a member of the Board." Consideration of the environment is indicated by the following: "The Company's commitment towards the environment is demonstrated by its eco-friendly waste-handling procedures which include the recycling of packing material and all process water via a natural filtration system." Conservation of natural resources including electricity is mentioned.

Another fruit processor situated on the banks of the Palmiet River in the outskirts of Grabouw, is "committed to producing high quality fruit employing sound environmental practices." Their company has a strong focus on social support to uplift the community. "The training and development of our staff remains one of our most important strategic objectives. Only by doing this will we be able to curb the skills shortage that we are experiencing in South Africa." In addition to being measured on

a yearly basis according to BEE requirements, the company is "committed to promoting land reform in the geographical areas where our producers farm."

A major agro-processing industry in the catchment is quoted on their website: "We have supported the growth and development of the Grabouw, Elgin region." They have an extensive website that outlines their approach to corporate social investment. "Driving Corporate Social Investment has enabled a more holistic approach to sustainability – leaving a rich legacy in the livelihood of the local community." Their sustainable footprint is based on three core pillars: social investment, environment and transformation. Within their environmental pillar, the following two strategies are water focused:

- "Water Stewardship: Water scarcity is a growing concern around the world. As our products rely on this precious resource we want to improve our water efficiency. We currently utilise 4.2HL (hectolitres) of water per HL of finished product and our aim is to meet the 3.5HL/HL target. We are therefore working on improved utilisation and targeted water management efforts.
- Zero Manufacturing Waste: Operational waste at is minimal, with the 3.8HL/HL effluents treated and used for irrigation of orchards at the neighbouring farm. However, reducing losses is a main priority of our World Class Manufacturing efforts."

One of the large beverage companies is a "2000+ hectare estate which forms part of the UNESCO world heritage site, the Kogelberg Biosphere. Half of the estate has been set aside for conservation into perpetuity." The company is a founder member of the "world's first wine and biodiversity route", as well as initiator of "South Africa's first BEE wine brand" and "world's first fair trade wine brand" (among other green awards). Also, the company is "one of the first farms in South Africa to enter into a stewardship contract agreement with Cape Nature to conserve the pristine habitat in perpetuity".

One of the abattoirs, situated within the town of Grabouw, primarily supply the local South African market. "We take our reputation for customer service, consumer care and producing world-class quality products very seriously." Besides the regulatory compliance, and free-range manner in which the chickens are grown, there was no other reference to water, carbon, sustainability or environmental awareness. Social upliftment is mentioned though a programme which the company supports.

As an indication of the different strategies companies may take regarding the web-based profile, a beverage company operating on the outskirts of Grabouw, does not have any information regarding water, environment, social investment or carbon on their website. The content of their website however centres on the ethos of their product, and so their corporate social or environmental investments, although potentially present, are not advertised. Another company based in Grabouw, didn't have a web presence at all.

Each company's commitment to water management, social investment, carbon and environment is summarised in Table 24.

Table 24: Private agro-processing companies web presence

	Water management	Social investment	Employment (BEE)	Carbon	Environment/ biodiversity	Market	Relative size
FP 1	X	X	X	X	X	Export	Large
FP 2		X	X		X	Export	Large
Bev 1	X	X	X	X	X	Export	Large
Bev 2		X	X		X	Export	Large
Abattoir 1		X				Local	Medium
Bev 3						Local	Medium
Abattoir 2	No website	No website	No website	No website	No website	Local	Small

There is insufficient data or analysis to draw any definite conclusions from the data portrayed in the table and extracted from the website regarding each company's ethos. However, the linkages between the size of the company and whether or not an international market with the level of CSI advertised on their website is of interest.

5.4.1 Summary of reputational risk similarities and differences

The private sector considers the catchment socio-economic profile and their relative size in the catchment as an indication of whether or not they may be at risk. They are especially concerned with their reputation with their customers and communities near their operations. The public sector considers social unrest as an indicator of a negative reputation. The public sector is especially concerned with their reputation with the electorate, and business, who they hope will invest in the region. Although in some cases this may in fact be the same population, there are differences in their relationship with civil society and business.

Both the private and public sector recognise the damaging effects of a negative reputation. In the case of SMEs, their relative size in the catchment seems to influence their view on the importance of a good reputation. For smaller companies, the additional investment required was seen as an obstacle, while larger industries widely advertise their CSI initiatives on their websites. TWK Municipality was particularly concerned with a good service delivery reputation, as this is seen to be a basic requirement for ensuring political stability with the electorate, and drawing investment into the region.

The public sector reputation is linked to their ability to provide services. They are trying to attract business to the area. An infrastructure backlog and limited human resources are not helping the municipality overcome these risks. These causes are attributed to a lack of finances due to the low tax base, unemployment and immigration of people into the region causing a growth in population. This forms a vicious cycle, forcing the municipality into subsidy dependence.

Table 25: Reputational risk summary

Reputational Indicator	Private	Public
Indicators of reputational risk	Negative media damaging to sales	Service delivery protests
Whose perception is important?	Consumers and catchment community socio-economic profile	Investors (businesses) and electorate
Positive reputation opportunity	Website/annual reports indicating sustainability or water investments. Dependant on size of company	Website and public sector documents indicate sustainability principles

5.5 Risk communication and management

Respondents were asked about the risk management plans they have for all risks as well as plans specifically about water. Other indicators useful to determining the communication of risks are the extent of information sharing within the institution as well as with other institutions. Table 26 indicates a summary of high-level risk scores related to questions regarding the communication and governance of risk within the different private and public sector stakeholders.

Table 26: Selection of water governance and communication responses and coding which was used to identify relative differences between interviews graphically

		Private Sector							Public Sector					
Type	**Questions**	Fruit Processor 1	Beverage 1	Abattoir 1	Beverage 3	Beverage 2	Abattoir 2	FP 2	TWK 3	TWK 1	TWK 5	BOCMA	TWK 2	GWUA
	Water policy, strategy or management plan	3	3	3	4	2	5	1	3	3	3	1	1	1
	Highest level of responsibility for water policy, strategy or plan	1	1	1	1	1	3	4	4	1	1	1	1	1
	Discussions of water with top management	1	1	1	1	2	2	3	1	1	1	1	1	2
	Contingency planning to respond to water risks	3	2	1	3	4	4	3	3	1	1	4	2	3
	Water related actions as operations to improve efficiency	2	2	1	1	1	4	2	3	1	1	0	2	1
	Investments related to water	2	2	2	2	2	4	2	1	1	2	2	2	1
Governance	Annual Report mentions sustainability/water	1	1	1	1	1	4	1	1	1	1	1	1	1

5.5.1 Water Risk Management Planning

The majority of companies in the case study have food and/or beverage safety plans as required by law, citing this as the main reason for the plans: *"We have food safety contingency plans which include water aspects. These are things we have to do"* (Abattoir 1). Food safety plans include water through identification of procedures in the case of a water supply cut, for example. Interestingly, the opposite was said by Abattoir 2: *"In our audits we are not required to have a water plan. We are 100% dependent on the municipality"* (Abattoir 2). This type of response again indicates that the level of investment is often closely linked with what is required through regulation, than what the actual risk may be. Across a range of questions related to risk management and water governance, Abattoir 2

responded reactively. Without a water management plan, investments such as extra water holding tanks are being made in a responsive manner to historical water shortages on the property. This indicates the low level of interest in wider catchment-based solutions to some of the water security concerns of the region.

At a municipal level there are a number of documents and processes in place to ensure the required management and planning of water and its related risks takes place. Monthly task teams investigate the municipal water statistics for each town. This is "*dealt with both technically and strategically*" (TWK, 4). However, BOCMA identified gaps in the municipal risk strategy, highlighting that *"there are two main problems. No wastewater treatment risk abatement plans and poor disaster risk management plans exist in places like Grabouw"* (BOCMA 3). This indicates differences in the expectations of what sufficient risk management includes. For example, BOCMA 2, acknowledging the necessity of risk abatement plans added that in reality *"experience in the field is how you understand risk. Encountering problems helps"* (BOCMA 2). GWUA also recognised the power of a management plan, stating that, *"Because of the Catchment Management Plan, the Palmiet has not degraded further. We are one of the only operating WUA and CMP in South Africa. Success breeds success. We are a best-case example"* (GWUA, 3). This statement also recognises the function of the WUA and CMP in ensuring the overall health of the catchment.

5.5.2 Water communication within the catchment

Most companies supplied with water from GWUA were aware and knowledgeable of their water situation, communicating on a regular basis with other stakeholders. The negatives of over-engagement were also recognised as too many meetings may cause "e*ngagement fatigue*" (GWUA 2).

Those situated in the town however do not meet often with other companies (potential competitors) over water concerns. One particular company, when asked whether the other key stakeholders dependent on water supply and quality were known had "*no idea*" who they were (Abattoir 1). Also, the understanding of the relative uses of water within the catchment was not the same for different representatives. A municipal council member did not have a very good understanding of what the relative consumption of the municipality is compared to other industries and farmers in the region (TWK 3); while the CEO of the GWUA had a much better grasp of the volumes of water being used by different sectors (GWUA 1). This indicates a potential lack of understanding of the flows within the catchment. However, it is also understandable, as those without an understanding of the wider catchment are not required by their jobs to do so and have not been required to do so.

The difference between those supplied by GWUA and the municipality was also observed: *"Within GWUA there is a good knowledge of all the stakeholders in water, but from the municipality down, there is not good knowledge"* (TWK 3). Within the water users of the municipality, there is no formal forum regarding industrial water users, and therefore respondents felt that oftentimes their

engagement was reactive to problems or issues arising in the catchment, as opposed to proactive planning against such occasions on a regular basis. This was also recognised by a local municipality representative: *"Communication between the municipality and its water users is not two-way* (TWK 3).

The following quote gives an indication of the frustration of a company supplied by municipal water regarding communication: *"They only come when something is wrong. When we call them, they do not answer their phones. Anyway, the person responsible is not an engineer. He has come through the ranks. He was a speed cop before"* (Abattoir 2). However, another company supplied by the municipality had different sentiments regarding the response of the municipality with water concerns, indicating that during water supply issues: "*We have very close communication with the municipality when this happens"* (Abattoir 1).

When companies supplied by the municipality were asked about forming their own forum to discuss water concerns, there were mixed responses. *"We can make a forum, but there is not a good relationship. The other companies don't want to talk"* (Abattoir 2). The opposite was said by Abattoir 1: *"Businesses speak regularly, especially since the recent strikes; we need to decide together on how things should be done."* They added that, *"at one stage we were looking at a community project with other industries for a combined wastewater treatment works. There were many questions. Where will it be situated? Who will get the permits to transport waste?"* (Abattoir 1). These responses indicate that perhaps the concerns were not large enough yet to warrant breaking out of their own factory fences in order to share risk mitigation strategies.

Although the GWUA forum is available to all water users of the association, some respondents felt that although results were achieved, not all stakeholders are actively engaged. *"An active forum exists, but I am not sure of the farmers' feelings"* (FP, 2). However, the overarching consensus within the GWUA members was that the multi-level platform existed and that most users were engaged and active.

From the perspective of the municipality, it was felt that more could be done about other stakeholders in the catchment (TWK, 2). In particular, respondents felt that they did not have a very good idea of the largest water users relative to the municipality itself. The GWUA was used as an example as to the level of detail the municipality would like regarding all of its own significant water users. Lack of trust was quoted as one of the contributors towards a lack of community between the public and private sector in particular. In an attempt to resolve this problem, integrated task teams were assembled, which included private and public sector representatives (TWK 3). The adoption of the workgroups was in order to use private sector expertise as well as improving communication regarding the actions taken by the municipality. This has "*helped improve multi-stakeholder communication*" (TWK 3). The benefits of being able to work together were recognised, even though

specific concerns may be different. *"With the municipality, industry and regulator; the risks are not the same. However, they can work together"* (BOCMA 2).

Another example of working together was seen within the public sector itself. *"A large risk in BOCMA is water quality. If farmers cannot irrigate, they cannot export, they cannot do agro-processing. There are no jobs"…"If the main problem is municipal discharge, there is a risk if they do not upgrade their municipal treatment works. BOCMA is a regulating agent. We do not upgrade infrastructure. But we can help look for funding. Even though it is not our mandate, we are trying to influence organs of state to help the municipality"* (BOCMA 1). This statement suggests the separation between the water services and water resources sectors. The recognition of the risks that insufficient water services management places on the water resources of the region has forced those responsible for water resources (BOCMA) to help the municipality (TWK) in managing its risks.

5.5.3 Summary of risk management plans and communication

The regulatory drive for risk management plans is evident in both the private and public sector. However, as indicated previously, risk management for water in the private sector is generally a spin-off from other regulatory requirements such as fruit export or food processing. The public sector follows an extensive risk management framework set out by national treasury. This includes a risk register that needs to be completed every quarter. Although some respondents believe this is not enough risk management from the municipality, others believe that, in fact, experience is more powerful than an in-depth risk register.

Opportunities for engagement with other water users in the catchment depend on the institution supplying the water. Companies supplied by the municipality are exposed to less opportunity to discuss issues through a forum. This is recognised as a risk by the municipality, however, due to the capacity constraints, it is assumed that trying to increase communication will further dilute precious human resources. Poor communication will form a barrier to sharing knowledge and understanding of risks. Although GWUA seems to have a functioning platform where the systems' risks may be discussed, this is not the case throughout the catchment and particularly not the case for those supplied by the local municipality.

Table 27: Risk management and communication summary

Risk management and communication indicator	Private	Public
Risk Management Plan	Industry regulation requirements. Not only water. No efficiency targets	Risk management framework based on National Treasury: risk register
Water emergency plan	Implemented if regulated	Regulatory requirement
Water discussions within institution	Range: Dependent on importance of water and level in company	Range: Dependent on type of public sector and core area
Engage with other stakeholders to manage	Yes (through GWUA), unless supplied by municipal water, then	Yes (GWUA), although do not engage sufficiently with municipal

water	reactive	users
Active forum available to engage all stakeholders	Yes (through GWUA) but not if a municipal user	Yes (through GWUA) but not if a municipal user

5.6 Critical appraisal of the interviews

There are a number of similarities and differences in the way public and private sector understand their specific water related risks. The differences between the sectors may be due to the scale at which the institution operates or the mandate of the institution (Larson et al., 2009). For example, the public sector is concerned about an array of complex factors other than water alone. This includes health, economic development, equity and redress as well as financial viability and political longevity (TWK IDP, 2012b). Service delivery protests, for example, are seen in a systemic light, linked with housing and the risk of water quality concerns in the Palmiet River. The private sector, however, recognise that water is an input to their business, without which they are unable to function optimally. As a specific problem-orientated concern, there may be alternative concerns and information sources.

Physical risks, because of their nature, are mainly informed through data or technical information. This is similar to the concept of Renn (2008a) of technical risk assessment. Sources helping to understand physical risks mentioned during the interviews include the use of metering, climate change information, water quality assessments and rainfall data. These sources of information are used as support for physical risk by both the private and public sector. Depending on the nature of the company, quality or quantity of water is more important. For the public sector, these are both of equal concern, although because the region is not climatically water scarce, the quantity of water is constrained mostly due to lack of infrastructure.

There is no single source of information that integrates all of the quantity and quality aspects with the major users in the Palmiet catchment. The catchment management plan, updated in 2010, is a report indicating flows and quality standards only at a specific time. There is no frequently updated, catchment-wide status quo. Instead, each company or institution manages only the data that is pertinent to them. The largest water users in the catchment area may be a threat to the sustainability of the catchment, while the ignorance of some stakeholders concerning water use is not helpful in managing one's own water. SAB and WWF (2009) support the concept that "to measure is to manage." The lack of integrated, catchment-wide data indicates that an integrated catchment-wide management system may be difficult to implement under the current conditions.

Through the interviews, it appears that data regarding water quantity or quality is held by specific institutions. For example, GWUA collects data regarding water use as well as quality tests. TWK Municipality test water quality, but this information is not relayed to industry, for example. Although holding a large proportion of data on the catchment, GWUA is not able to anticipate all the risks alone. Those without access to data to inform knowledge are unable to know the full scope of risks

either. A lack of knowledge and understanding through insufficient data or information is a risk (Holford, 2009).

Without an understanding of the water flows throughout the catchment, it is difficult to monitor and manage the flows together. Quality concerns are also not completely understood across the catchment. The presentation at the GWUA meeting in 2012 was the first full study of the region since the CMP in 2010. In most other interviews, quality concerns were attributed to other users without scientific support. Blaming other water polluters is not conducive to sharing within the catchment. Transparency and trust are important requirements before any sharing or participation between different stakeholders is able to take place (Pahl-Wostl et al., 2009). This is not possible with blame and without objective information indicating where the concerns are.

Regulatory risks are informed in a different way to physical water risks. Each sector, private and public, faces different regulations they are mandated to meet. These may be outside of the water sector, but affect how a company uses or discharges water. Food and safety precautions imposed by the industry and retailers (nationally or internationally) are the main groups driving compliance of different companies. The risk of not meeting these requirements may result in the company losing accreditation or business. For the public sector, the risk of not meeting these requirements could result in negative consequences for the municipality as a whole. There exists a risk aversion in the public sector due to the need to meet human rights, such as water supply (Larson et al., 2009). Penalties for not meeting the regulatory requirements are also a concern. Both sectors also mentioned the failure of institutions as an additional risk factor. Hepworth (2012) raises a concern that increased regulation is seen as a risk to the private sector, when in fact the regulation is for the best interests of society as a whole. Through interviews with the private sector, regulation itself is not the risk. The risk is the failure of not meeting the requirements, and how that may further jeopardise business. The same is true for the public sector.

Reputational risk is different to the previous two examples, as reputation is something that is dependent on actors outside of the company or institutions control. Information on physical or reputational risks can be calculated or clearly identified (Mason, 2013). Reputational risks, however, are dependent on the community or consumer, and may shift quickly. Data informing the likelihood of a reputational risk is not clear or easily understood within the catchment. Due to a lack of previous negative media experienced by the majority of the companies, this risk category was also not perceived to be a large threat. For TWK a positive reputation is one of the most important indicators of a well-functioning municipality. In lieu of the difficulty in measuring reputation, information and data regarding the welfare of the community in the catchment may be used as a proxy for understanding the potential for a bad reputation. Unequal access to services may cause unrest, as seen in the catchment previously. Alternatively, as water and electricity provision are the mandate of the

government, there may be protest action against the public sector. Disclosure of CSI or environmental stewardship may also be used as proxies for the private sector to get a better idea of the values and commitments of the company towards the greater community, as highlighted from looking at their websites. These investments indicate a level or responsibility outside of the factory fence. Recognition of regulatory risk indicates a shift in acceptance of the wider, integrated form of risk where technical and social aspects combine to form new risk concerns (Renn, 2008c).

In each risk category there are different sources of information contributing to the knowledge and understanding of water risks within the case study. In some cases the sources of information are shared between each sector. Reputational risk requires better information regarding the other (private or public) sector. For example, depending on the public sector management of water, companies are at greater or lesser risk. Reputational risk is informed by the social and economic welfare of the catchment as well as the company commitments to the wider community. These empirical findings expand upon current theory on physical, regulatory and reputational risk. Through adaptive theory, these results will further build the concept of shared water risk.

The assumption throughout this case study has been that knowledge and understanding enable better capacity to understand risk and therefore the ability to see the shared nature of risk (Holford, 2009; Pahl-Wostl et al., 2012). It is not a linear progression towards sharing (Bruns, 2003). Knowledge and understanding provide a platform for communication. Communication of risks needs to take place often within a catchment as the context and importance of risks is not stable. Sharing becomes relevant or suitable as risks develop into something more difficult to manage alone. Through monitoring and understanding the risks beforehand, the point at which sharing becomes necessary may be found more easily or quickly. This is indicative of a complex system where adaption and social learning need to take place as the context of the risk changes (Ison et al., 2007; Pahl-Wostl et al., 2009).

Communication between the sectors needs to be open and clear. The blame from one sector to the other does not help inform sharing of risks as this is not conducive to building trust and transparency necessary for sharing (Pahl-Wostl et al., 2009). This is a challenge in the South African context as the private and public sector are traditionally seen to be polarised as indicated in some of the interview responses. The ideal would be for cooperation or sharing to mitigate risk. However, this cannot happen when sectors are blaming each other. By supporting a concept where risks are first understood and known, before assuming they are shared, blame may be reduced and instead an awareness of the greater complexity of the system may be achieved.

In the case study, the realisation of shared water risk concerns is most clearly illustrated through GWUA. At quarterly meetings, representatives from all sectors come together to discuss the current state of the catchment. The impact of the municipal wastewater treatment works' failing quality

standards on irrigation quality, impacting export requirements, can be discussed and defended directly between the relevant parties. The industries supplied by the municipality are not present at these meetings. This may be one of the factors as to why they do not feel risks are adequately communicated because they are not represented at a shared forum to discuss water-related concerns (the municipality is the "user" of water and therefore the representative in the WUA). Another forum, which has the potential for sharing, is at the level of BOCMA. However, with the current changes in the setup of the CMA's in South Africa (DWA, 2013a) and the uncertainty regarding the delegation of powers from DWA there is still confusion regarding the mandate of the GWUA relative to the CMA.

The opportunities for better knowledge and understanding of the catchment as a whole will result in improved information about water transfers out of the catchment for example. Comments from BOCMA regarding the economic value of water not being sufficient alone when managing water are then able to be supported by statistics. Stronger support for rural support is gained when GWUA (or BOCMA) are able to relate the water abstraction of farmers in the region with the GDP contribution of farmers or employment more exactly than only using StatSA. In such a case, the risk of increased CoCT water transfers may be better mitigated (or supported) through improved knowledge and understanding of the water quantity and quality flows through the catchment. Although this is done in the BOCMA CMA (2011), there is potential for more in-depth analysis of what the data means for the economy of the region.

These findings, alongside the attributes identified for collaboration and risk frameworks used by the private and public sector, will be combined into a conceptual framework developed using adaptive theory in the case study context. The function of the framework and risk sharing typology is to further develop the idea of shared water risk. The framework is introduced through a process that investigates the water risks of SMEs and the public sector.

Chapter 6: Development of a water risk framework

Empirical data from the case study were used to interrogate public and private actor knowledge and understanding of water risk. The different scales of water risk were mapped to understand the scope of where water risks originated. The next step was to prioritise the public and private sector water risks into the three forms: physical, regulatory and reputational risks. The mapping of the framework aims to describe and examine the form and scope of risk. This is intentional as the thesis is based on the premise that shared risk cannot be known or understood until all actors within the catchment understand the scope and form of the wider catchment risks. The framework has been designed in relation to the development of the thesis through adaptive theory.

6.1 Water Resources Management is complex

Complexity, spatial unevenness and temporal variation are inherent characteristics of the water sector, which are compounded by the number of institutions with mandates for catchment management, water supply and waste treatment. A single company may have numerous concerns regarding their supply chains, water institutions and actual physical water supply or quality. Due to the variety of issues, it is often difficult to fully understand what is of real operational concern, and what is not. Similarly, it is not always clear what is of actual strategic risk to the business.

Figure 30 identifies priority water concerns offered by the private sector respondents during interviews. The concerns are grouped around three main clusters: water resources; the water supply; and the governance or management of the water. Companies in Grabouw have different water risk concerns depending on which institution is managing their water supply. Those supplied by the municipality were more concerned than those supplied by GWUA because GWUA does not treat the water, and therefore, the responsibility of treating both water and wastewater is the responsibility of the industry. Industry expects and requires certain water standards from the municipal supply. These expectations are not always met due to a range of issues. The majority of the issues are linked to inadequate infrastructure or management thereof. Population pressure, un-serviced areas, lack of finances and human resources all contribute to this concern. Climate change and the increasing demand for water from Cape Town were common concerns across all representatives.

This process was repeated with the public sector (Figure 31). Inputs to the figure included interviews, analysis of the municipality risk register (extract in Appendix H) and the municipal risk management framework. Concerns and risks to the municipality were clustered according to the TWK IDP (2012b) Key Performance Areas (KPAs). The factors, which may hinder the meeting of the KPAs, are identified through the risk register.

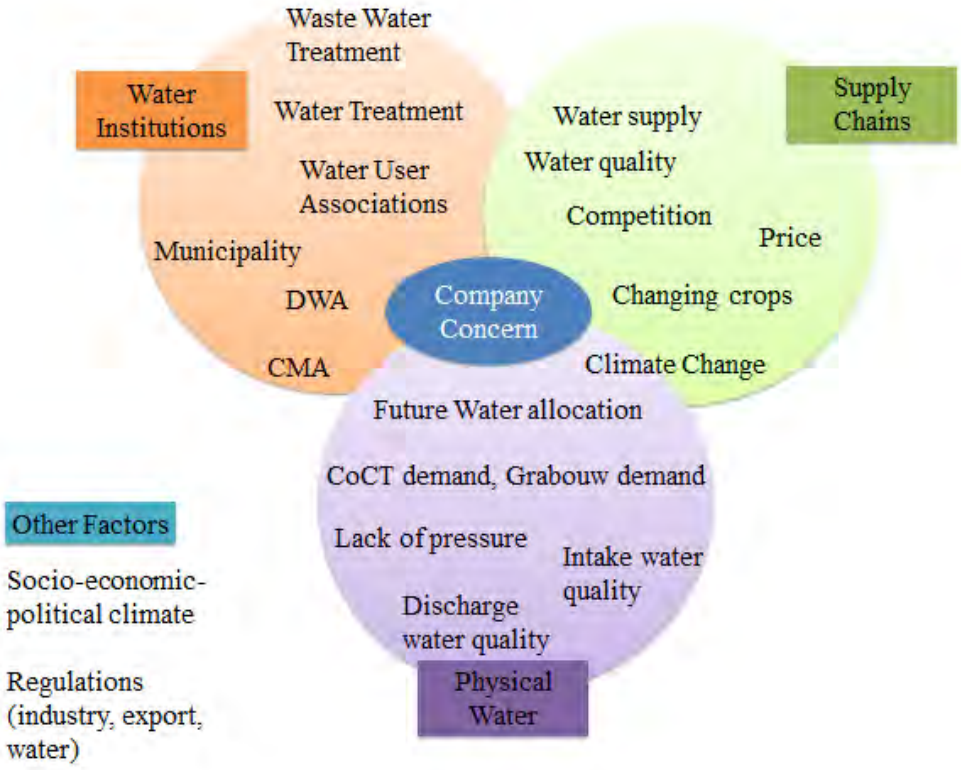

Figure 30: Water-related issues, concerns and risks facing business operations

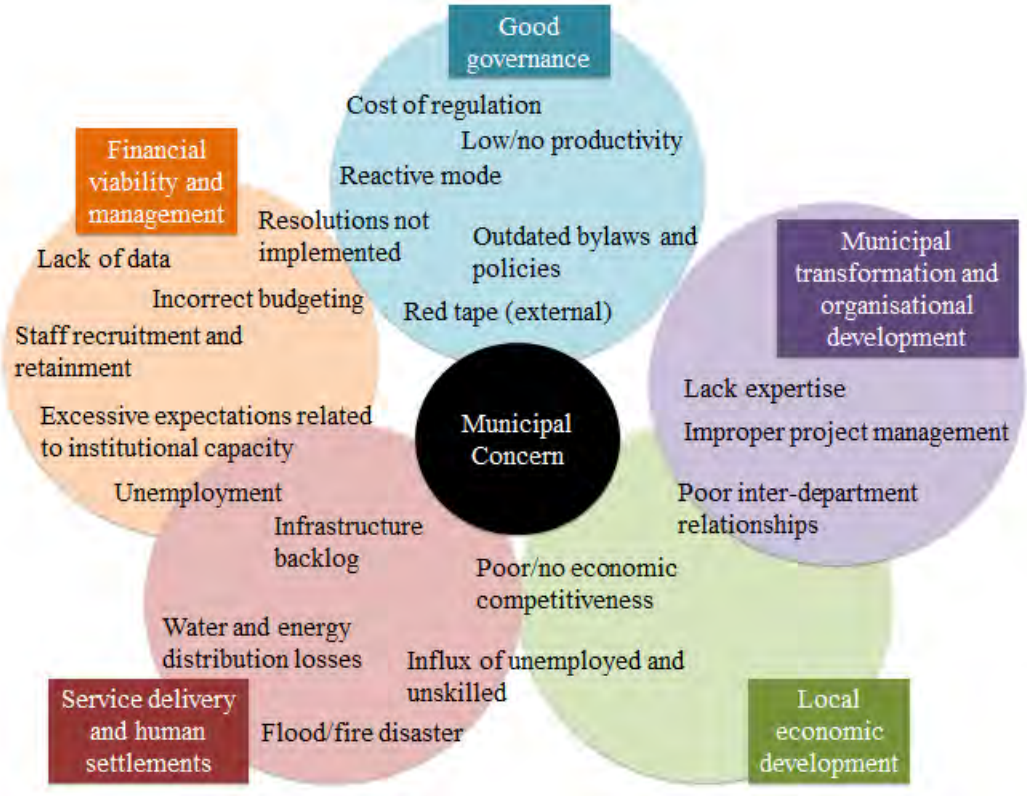

Figure 31: Issues, concerns and risks for the public sector

It must be acknowledged that water is not the focal point in the case of the public sector, but is rather a critical resource among their other complex and interdependent concerns. Concerns also include water and energy losses and the existing infrastructure backlog. The influx of unemployed and unskilled people into the municipality is also listed in the risk register, and was identified by TWK representatives on several occasions. A lack of expertise, staff recruitment and retention of staff are indicated in the TWK IDP (2012b) as one of the reasons as to why there are service delivery difficulties in the municipality. The identification and mapping of each sectors' major concerns with regards to water risk or meeting their KPAs simplified the complexity of the suite of risks facing each sector. This simplification was followed by an investigation of the different scales at which the risks may manifest.

6.2 Risk scales

Risks may occur internally, within the company or institution, or they may take place externally, as a result of wider implications related to where the company or institution is situated. It is important to distinguish between the risks that the business faces, such as water supply, quality, cost and other input concerns (specifically related to the supply chain) (Cohen and Davidson, 2011; Greenwood et al., 2012). This concept is used in the WWF Water Risk Filter (Orr et al., 2011) and WWF Water Stewardship Steps (WWF, 2013). This is depicted in Figure 32, where the risks affecting a business or institution are situated within the greater socio-economic and political context.

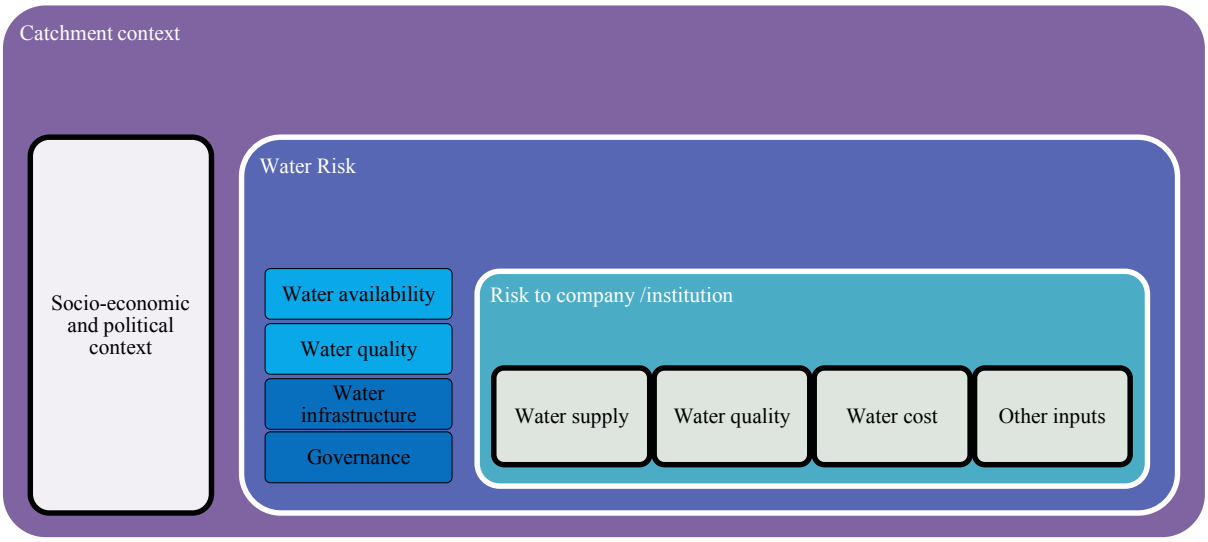

Figure 32: Company or institution water risk types and scales

A company or institution may be concerned with the supply, quality or cost of water for example. If it is part of a supply chain there may also be concerns with regards to water risks affecting inputs. These risks are also influenced by external water risks. For example, water supply may be a risk because the physical water is not available or the quality is so poor that the water cannot be used. Alternatively, the water supply may be at risk because infrastructure investments are insufficient. Therefore,

although the water is available, it is not able to be transferred to users. Finally, water supply may be at risk because the governance of water is inadequate. Where governance is poor, regulations are not followed and therefore quality or supply may be at risk. The catchment context, which includes the socio-economic, environmental and political context, may compound the water risks. For example, a weak government will be unable to monitor and regulate compliance to water quality discharge causing quality concerns to water users downstream. Each of the scales of risk is explained in more detail below:

Risk to company/ institution: A company or institution may experience water risks in a number of ways. These include lack of supply, lack of sufficient quality, high costs of water and a number of related inputs including risks through the supply chain (which may in turn be affected by water security concerns).

Water risk: The risks which a company or institution experience result from both primary and/or secondary water risks. The water risk is separated into the primary water risk factors of water quality and water quantity (shown in light blue in Figure 32). Primary water risks involve the actual resource itself being unavailable due to insufficient quality or quantity. This is mainly due to climatological factors. The secondary water risk factors including governance and infrastructure are indicated in dark blue in Figure 32. These factors may be the root for regulatory risks. Institutional failure instead of technical failure is often the cause of water security concerns in developing nations (Orr and Cartwright, 2009; Kranz, 2011; Methner, 2012).

Catchment context: The socio-political and economic risks are not one- dimensional. Risks arise from a complex interaction of the external context and internal vulnerability to risk. Factors that are traditionally seen to be outside of the realm of control or impact the catchment as a whole are included. These include the service levels of water or energy to the community or at a large scale, the economy of the region. This becomes a concern where companies are prominent, especially in small towns. In the case study, particular companies are perceived to be the major water users or polluters within the town. Regardless of whether this is true, the catchment context plays an important role in amplifying or reducing risk.

The scales of water risk embedded within the wider catchment context are simplified in Figure 33. The complexity has been removed, indicating only the major water risk concerns as primary and secondary water risks (inside the centre circle), within the wider catchment context. This is the basis of understanding private and public sector water risks in this thesis.

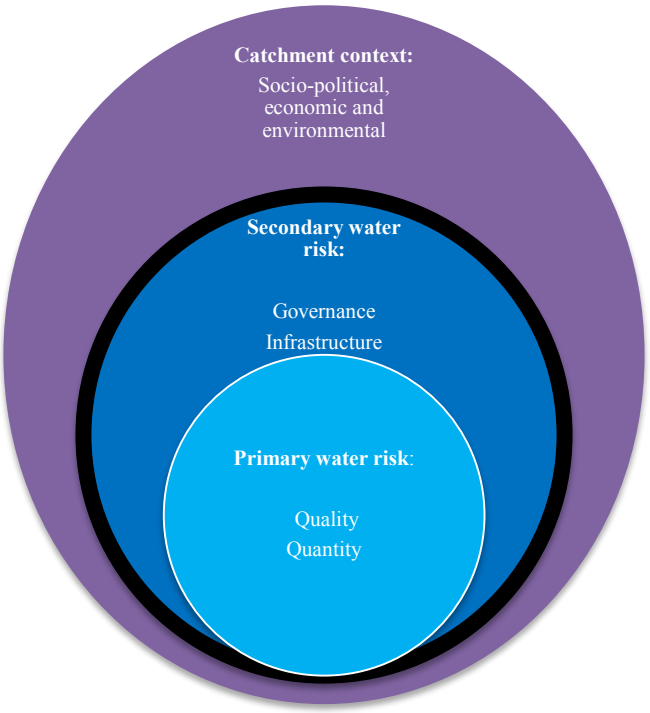

Figure 33: Simplified water risk scales

By indicating the scales at which the risks occur, identification of similarities and differences between sectors is simpler. Figure 32 and Figure 33 retain the same colour coding with regards to the scale of the risk. Therefore, physical primary risks include actual quality or quantity concerns, while secondary water risks include the infrastructure or governance required to ensure delivery of the water, as well as the physical risks of quality and quantity. In both figures the catchment represents the landscape in which the risks are embedded.

The concept of scale is also evident in boundary work research on interactions within water management and governance (Bressers and Lulofs, 2010). Contextual Interaction Theory provides a framework to understand social interaction processes and key actor characteristics (Bressers and Lulofs, 2010). Layers of contextual factors influence the actor processes and vice versa (Figure 34). Actors are influenced by the external context of the governance regime. The governance regime includes institutions as well as stable network relationships. Within this context there is an encompassing wider context which includes the political, socio-cultural, economic, technological and problem contexts (Bressers and Lulofs, 2010).

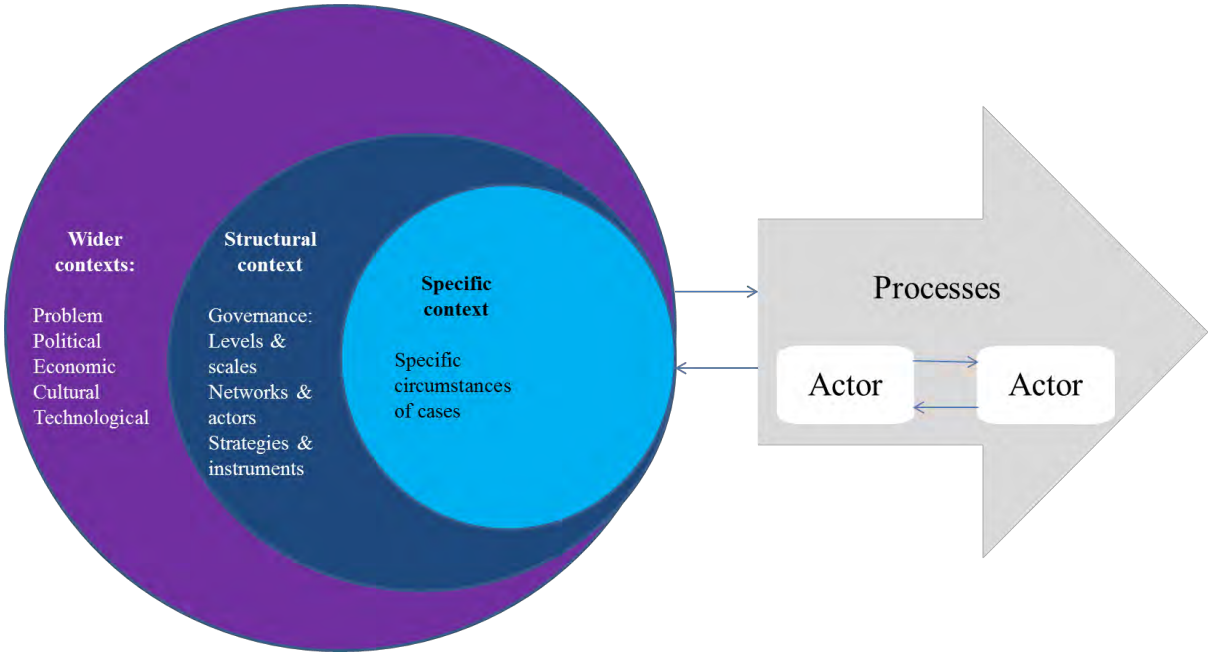

Figure 34: Layers of contextual factors for actor characteristics (Contextual Interaction Theory) (Adopted from Bressers and Lulof, 2010)

The collaborative efforts taking place between public and private actors in order to mitigate water risks is of particular interest in this research. The sharing of water risks can take place at a specific, structural or wider context level, as indicated in Figure 34. The knowledge and information required to support the sharing of water risk is sourced from all of these scales. Although actors may be situated within a single catchment, their particular risks may be distinct from each other. Private and public sector actors have differing mandates and objectives which impact their water needs substantially.

6.3 Public and private sector water risks

This thesis investigates water risks according to the physical, reputational and regulatory water risk characterisation (Orr et al., 2009; Pegram et al., 2009; DEG and WWF, 2011; Reig et al., 2013). Physical risks are generally technical, resulting in water not being available due to quality or quantity concerns. Physical risks may also include flooding. Regulatory and reputational risks are generally socially constructed risks. See Appendix E for an indication of how the adaptive theory process was used to simplify responses into the risk categories. From the outlined methods and conceptual framework building, the below selected risks have been identified and apply to this thesis:

6.3.1 Private physical

Physical risks to the private sector primarily involve the availability of sufficient quantity (not too little or too much) and good-quality water. Risks to supply or quality may result from climatic factors or inadequate infrastructure. Infrastructure may be insufficient or managed inefficiently. Based on the interviews, primary physical water risks include reduction in MAR or rainfall, increasing demand

(development or population) and climate change as indicators of water availability. The secondary factors such as infrastructure are informed by knowledge sources such as the connectivity and functioning of infrastructure or capacity within the municipality. Metering of water flows and the testing of water quality are the two standard procedures carried out by companies in order to understand water use.

6.3.2 Public physical

In the public sector, physical water risks are centred on the supply of water and ensuring environmental allocation. The supply of water has two elements: 1) the assurance of supply to the public sector; and 2) the provision of supply implemented by the local government. Quality is indicated as the second consideration in meeting compliance requirements. This factor relates to the inability of the municipality to meet the required water-quality standards. The information sources used by the public sector in understanding their physical water risks are similar to the private sector. MAR, climate change and demand requirements inform the physical availability. Quality concerns are attributed to insufficient wastewater treatment coverage in informal settlements and to a lesser extent fertiliser use. The capacity constraints within the public sector are also recognised, with financial concerns as an underlying element.

6.3.3 Private regulatory

The water use and effluent discharge regulations required by the government, as well as those stipulated by the industry association of the company, are important factors in regulatory risks. Food and beverage regulations including the Meat Safety Act (RSA, 2000b) and Eurepgap require companies to comply with SANS 241 (SABS, 2011a; 2011b) and HACCP (SABS, 2008) guidelines. In accordance with King III (2009), all companies are also bound to good governance practises. Water sector regulations including effluent discharge quality requirements were not seen to be significant until increased regulation and organisation from the public sector appears. Increased regulation, although a risk in the short term, is preferred as failing institutions and unstable policy cause greater risk and concern to companies (Sjöberg, 2002).

6.3.4 Public regulatory

Public sector regulatory risks stem mainly from regulations stipulated by national or provincial government (statutory governance). Good governance, as outlined in King III (2009), is an overriding requirement of all corporate as well as public sector activities. King III principles are incorporated into a number of regulations met by the sector, and into the risk management framework used by the municipality. The public sector representatives mentioned the considerable body of legislation and policy that have to be met, including strict financial regulations. The need to meet regulatory requirements was an overriding focus. Public representatives felt they would rather be sure of their

infrastructure capacity before being able to charge and strictly monitor effluent discharge of the private sector. This form of risk aversion is due to the regulatory requirements of the public sector.

6.3.5 Private reputational

The major concerns of private reputational risk are for companies within the communities where the supply chain is sourced or processing takes place. This is especially the case when there may be a less developed surrounding community, without access to housing or water (such as informal settlements). Customers buying the product are also important for a company's reputation. If customers perceive the company to be guilty of poor practise (regardless of whether true or not) they will communicate these concerns through their purchasing preferences. Negative media was indicated from a private sector perspective to be particularly damaging. Positive media, including being explicit about water stewardship activities through a website or annual report, was seen as a positive reputation builder.

6.3.6 Public reputational

For public sector reputations, the electorate and the investor community are important. This is equivalent to the private sector surrounding community and customers. Service delivery protests are especially harmful to their reputation both within the electorate and investor community. The investor community includes businesses that the municipality requires in order to build economic and social development in the region in order to remove dependency on subsidies. Continual reliance on subsidies will result in the municipality being unable to meet development goals.

6.4 Comparing risks: a conceptual framework

The purpose of contrasting and comparing the different water risks was not to identify which are more important, but to gain a better understanding of the risks as suggested by Failing et al. (2007). Understanding the different water risks within each sector is helpful. Deitz et al. (2003) highlight the value of information in supporting adaptive governance in complex situations. Uncertainties and values are useful knowledge alongside technical water information. Therefore, both technical and socially constructed information sources are investigated.

Larson et al. (2009) find that the public sector is sometimes more risk averse than the private sector. Rayner et al. (2005) indicate that sometimes the public sector does not follow the rational choice model, using socially constructed knowledge to make decisions. The example given by Rayner et al. (2005) is the reluctance of water resource managers to use technical climate forecasting data in their hydrological management strategies. This is due to the nature of the public sector, where trade-offs are ubiquitous (Hall et al., 2012). For example, the probability of climate forecasting being certain, resulting in water shortages, needs to be weighed against the costs of adaptation measures. Although technical data will contribute to this decision, the interests of customers, shareholders and the environment need to be taken into account (Hall et al., 2012).

The conceptual framework is based on the various scales and forms of water risk (Figure 35). Water risk is scaled according to primary and secondary risks. These are all in turn affected through the wider context in the catchment. This may be through economic, social, political or environmental factors.

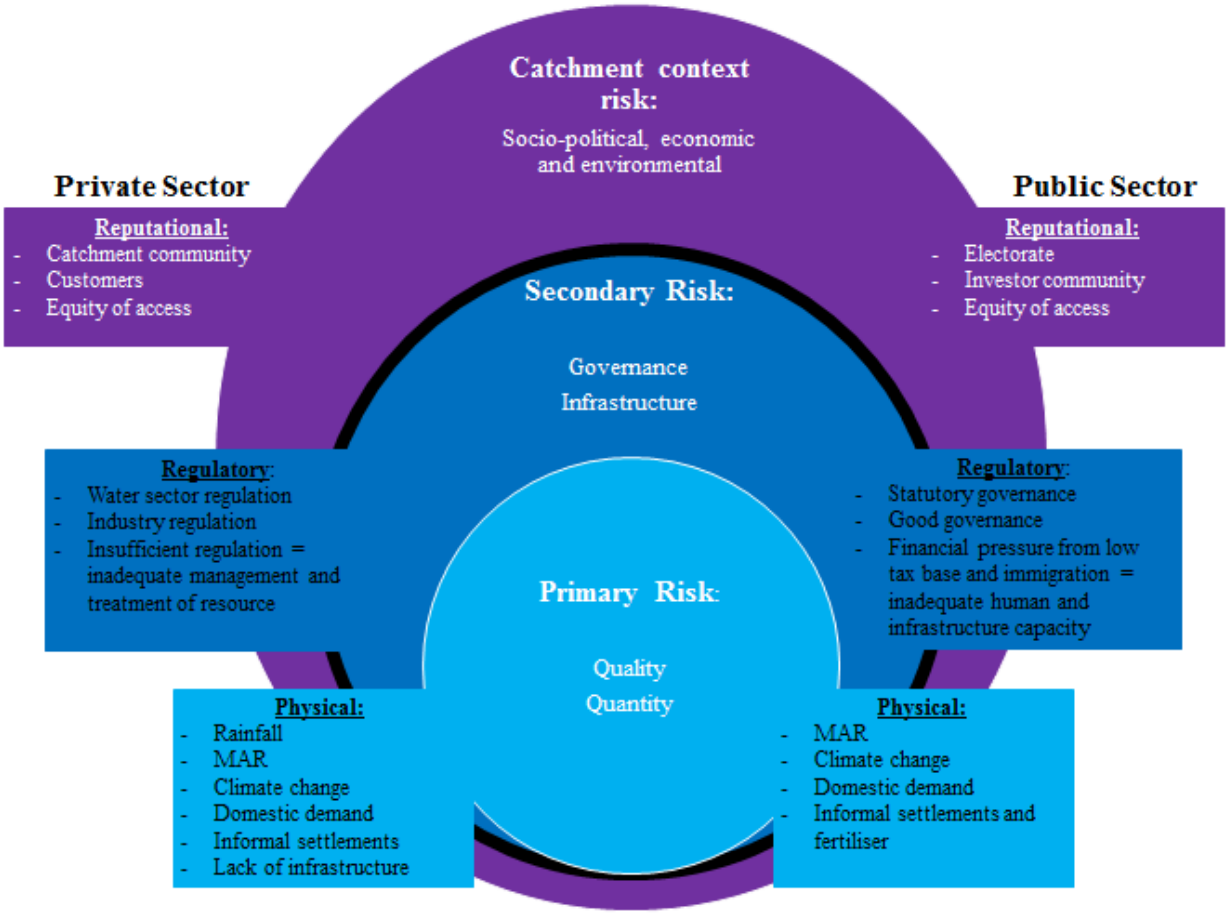

Figure 35: Private and public sector water risks conceptual framework

The dominant risk categorisation frameworks are divided into **physical, regulatory** and **reputational** risks forms. These are colour-coded and placed alongside the most relevant scale at which these risks occur. Within each category (physical, reputational and regulatory) there lies a selection of concerns which are most relevant to each sector. These are similar in many respects, but also distinct. Concerns were identified through the interviews and literature analysis of public and private water concerns.

Primary physical water risks are similar between the public and private sector. Technical sources of information mostly inform the risks each sector faces in ensuring quantity and quality of supply. Respondents felt that they are not climatically stressed. However, water supply or quality risk experiences are attributed to a lack of infrastructure (which the public sector attributes to a lack of finances). Public sector water provision needs to be of a stipulated quality. This is required by law,

and has repercussions for the municipality, including a negative reputation if this is not met. The quality of municipal water was also identified by most industries as a cause for concern.

Secondary (usually regulatory) water risks are linked to the infrastructure and governance of water. The private sector is concerned not only with the water sector regulatory regime for water quality effluent discharge or water use licences, but also with related industry-specific regulation. These industry standards often require water supply and discharge risk analyses, helping companies to identify their relationship between water and risk. Future business operations are at risk if the identification and mitigation requirements are not met. A further risk to the private sector is the inadequate regulation of industry. An example is that of wastewater discharge to the municipality, where quality standards are not enforced. This puts pressure on over-capacitated treatment works. The resulting polluted effluent discharge is a risk to irrigators and downstream water users. From the public sector perspective, regulation is seen to control why and how institutions manage their affairs. Policies, laws and regulations heavily regulate the water sector. Two key principles: statutory governance and good governance, are listed as the overarching regulatory risks facing the public sector. These regulations are for the good of the public sector so as to ensure it acts in the way that is best for society. However, the risk of not meeting these requirements becomes a concern. The financial pressures on the public sector as a result of a number of factors, including immigration and unemployment, are given as to why the public sector is not able to regulate adequately, running the risk of not meeting statutory and good governance regulatory requirements.

Finally, **catchment risks** play a role in the private and public sector reputations. The private sector reputation is mostly at risk in the catchment community in which they operate. For example, the companies operating in the Grabouw and Elgin region are at risk if there are service delivery protests, and their abstraction of water is seen to be a reason why water is not available for domestic use. Customers not situated within the catchment are important too due to their purchasing motivation. For the public sector, reputation is also important. However, in this case, the equivalent of the catchment community for the private sector is service delivery to their constituency or electorate. Where service delivery is not acceptable, the public sector may be faced with service protests. This is not only damaging to their reputation, but has the potential to overshadow the development of the region. Analysis of the large service delivery protests in 2006 and 2007 in South Africa found that continual reactive responses to service delivery protests does not help local municipalities in meeting longer term strategic goals (Atkinson, 2007). Without a positive reputation of its ability to provide the basic water and sanitation services, the public sector is unlikely to meet development goals through a lack of investment. This may force the public sector into a cycle of subsidy reliance.

To sustainably manage water resources, a coherent shared agenda for water security using a risk-based approach is suggested by Hope et al. (2012). The shared agenda is needed to stimulate reform

from a range of stakeholders while a risk-based approach is useful in managing trade-offs of delivering water securely for a number of sectors and uses (Hope et al., 2012). The conceptual framework developed in this thesis incorporates different risk scales and types, indicating the integrated nature of risk where both technical and socially constructed risks are shown (Steinberg et al., 2004; Renn, 2008b; Hope et al., 2012). The private and public sector water risks collected through interviews were indicated on separate sides of the water risk framework. This indicates that they are different sectors however they may share the resource, catchment and risk scales and categories. The private and public sector risks correspond with the most likely scale at which the risks manifest. This is done in a similar fashion by Fox (2011) and Orr et al. (2011) to identify the most likely response level to risks. The linking of risk with response is also confirmed by Pegram and Eaglin (2011) and Greenwood et al. (2012). This framework is the first to link the scale at which risks manifest with the form of risk; while comparing private and public sector perspectives.

In some interviews, blame is apportioned to the other sector regarding the roots of the risk (another reason for being on opposite sides of the framework). For example, the municipality is blamed for poor quality in the catchment when in fact industries admit to either not meeting quality requirements or not knowing whether or not they are compliant with regulations. This is not conducive to the promotion of sharing risks. The blame and transfer of responsibility of risks to other industries or sectors does not support communication or co-operation. Since risks are technically and socially constructed, the knowledge and understanding of risks needs to be informed by the context as well as with data from the wider catchment. Communication of the risks to others in the catchment is able to take place once risks are known and understood. Communication and a full understanding by the public and private sector of the entire system of risks, including the primary, secondary and catchment context risks are important.

The risks between the public and private sector in the Palmiet catchment are not equal. The public sector has a wider range of complexities, dealing with the environmental, social and economic welfare of the entire municipality. However, in some cases, the risks are related, and in other cases they may have the same root causes. For example, the lack of taxes and dependence on subsidies in the municipality is contributing to the reason why the wastewater treatment facility is operating over capacity. This is also indirectly linked to the Eurepgap or Meat Safety Act compliance risks. Regardless of whether or not the risks are the same, the knowledge and understanding informing the risks is of importance. Risk responses need to consider the risk being experienced, as well as the sector capacity or interest in engaging outside of their direct circle of influence.

An important outcome of the framework is that sharing of risks cannot be assumed or taken for granted. Before any sharing can take place, knowledge and understanding of risks is required. Data supporting the perceived risks is helpful to communicate the concerns between sectors. A forum

where stakeholders are able to come together in an unthreatening manner is helpful in stimulating discussion between the sectors. Through appropriate communication regarding the understanding and knowledge of risks, the systemic nature of risk may be explored and potentially reduced.

6.5 Testing, validation and refinement of the shared water risk framework

Phase II questions regarding the shared water risk framework first interrogated the different scales of water risk (primary, secondary and catchment) followed by the different forms of water risk (physical, regulatory and reputational). In many cases the interviews helped to affirm the particular risks being faced by each sector. Interviewees were probed for elements which could be deemed missing from the framework.

6.5.1 Insights from the shared water risk framework

Financial risk was not explicitly included in the framework figure, but became important following Phase II interviews (Public Sector 1, BOCMA). A municipal representative expanded upon the importance of financial risk, saying that this is a larger systemic problem which is due to the entire governance structure of South Africa, including changes in legislation in 1994 regarding financing municipalities, forcing them to become dependent on grants and rate payers alone: "*We get just enough to survive, but not enough to fix the problem*" (Public Sector 4; TWK 2). Orr et al. (2009: 29) specify financial risk alongside physical, regulatory and reputational risk as "water shortages translate into higher energy prices, higher insurance and credit costs, and lower investor confidence, all of which further undermine business profitability." In the 2013 CDP Global Report on Water, companies have anticipated financial impacts as high as US$1 billion as a result of water risks to business (CDP, 2013). Therefore, financial risk was added as an overarching impact of water risks for both the private and the public sector. The risk of environmental decline through the loss of ecosystem function through pollution for example was also not mentioned. Ecological awareness, aside from the direct functional needs of the public and private sector, was not identified as a key risk. This either indicates that loss of ecosystem function is not a high concern because of a well-functioning ecosystem, or it indicates that companies, municipality and water users association are focussed purely on meeting their targets, without wider consideration of the catchment risks. Interview bias, for example not explicitly asking about environmental health or biodiversity, may also be a consideration.

The lack of clarification on how risks are calculated using hazard and frequency is another insight. This issue was raised by the municipal engineer, who is exposed to technical concepts of risk at a municipal level (TWK 2). He suggested the development of an organised management plan by identifying a range of risks according to likelihood and impact, focussing on major risks only. For the purposes of this research, a less 'technical' understanding of risk was used as the involvement of the private sector in water risk management is still in its infancy. Therefore, knowledge and understanding of the hazard and frequency of risks is less understood. The complications of

identifying a metric to calculate risk were further exacerbated due to the lack of definition for risk (Flint and Luloff, 2006; Thywissen, 2006; Holford, 2009). The concept of water risk in this thesis is aligned with the methodology of both the WWF Water Risk Filter and the CDP 2014 Water Risk Assessment, where risks are ranked according to a Likert system instead of exact quantification according to risk and impact (Orr et al., 2011; CDP, 2014; WWF and DEG, n.d.).

6.5.2 Risk Scales: primary, secondary and catchment

Table 28 below highlights particular comments captured from Phase II interviews which support or challenge particular aspects of the risks scales in the shared water risk framework.

Table 28: Selection of Phase II responses on the scales of the shared water risk framework

Risk Scale	Public Sector		Private Sector
	TWK Local municipality	**GWUA and BOCMA**	
Primary	*"There is incoming water and then there is also discharge water which can be polluted."*	*"This scale must include surface water and ground water."*	*"The quality of water discharged is also a risk for us."*
Secondary	*"Good governance is a must. Whether municipality is empowered to do it is the other issue."*	*"Quality and quantity are important, but they are not risks without human intervention."* *"It is important to have functioning institutions. They are critical for effective WRM. "*	*"Quality is a risk because the municipality are not able to treat [water]adequately"* *"The infrastructure of the WWTW is a concern. But in terms of governance, BOCMA are doing a good job. They are involved in lots in the area. Newsletters and meetings are being held. Maybe if one stands closer, you might see problems, but from this distance, I can see nothing wrong. "*
Catchment	*"Yes, we are all part of a larger system."*	*"The catchment is core. The framework needs to show the interaction between primary, secondary and catchment more. "*	*"We are influencing the quality of the water in the catchment. If we do not act with transparency or follow legislation, we may pollute. This is a cycle however, as then water quality we receive is affected. The growing population of Grabouw, already 5x more than the planned capacity is a risk as it put pressure on the resources available."*

Physical risks are defined as “too little water (scarcity), too much water (flooding) or water that is unfit for use (pollution), each of which is associated with the management of a water resource” (Orr et al., 2009: 27). Through the additional interviews, interviewees pointed out that at a primary risk scale, the framework needed to be explicit not only about quality and quantity of water, but also surface and ground water (Public sector 1, 3). Incoming water supply and outgoing water effluent also need to be

considered (Private sector 1, 2). The expansion of the characteristics of physical water risk is illustrated in the refinement of the shared water risk framework.

Orr et al. (2009) highlight the dual nature of regulation as "most businesses thrive in a stable regulatory regime, however, when regulation is unpredictable, this can be a serious problem." The secondary water risk including institutional governance and infrastructure was confirmed through comments such as: "*quality concerns are as a result of inadequate municipal treatment*" (Private sector 1) and "*it is important to have institutions. They are critical for effective WRM*" (Public Sector 2). Private Sector 2 mentioned that because of newsletters and frequent meetings, the institutional governance of BOCMA was ensuring they are aware of upcoming concerns. Therefore, regulation is both an opportunity and a risk. When managed appropriately, good governance can ensure that water is managed efficiently. However, when water resources become stressed in a catchment, the response from the public sector is often to impose further legislation, risking future water supply to the company (Pegram et al., 2009).

Risks at a catchment scale consider the socio-economic context of the catchment. Technical and social aspects of risk need to be considered within the context of the catchment where a facility or municipality is situated (Renn, 1998; Flint and Luloff, 2006). A major socio-economic risk mentioned by both private and public sector is the influx of people to Grabouw, leading to a large informal settlement in the area: "*The growing population of Grabouw, already 5x more than the planned capacity is a risk as it put pressure on the resources available*" (Private Sector 1). "*The Groenland Water Users Association, representing the water users in the catchment is particularly concerned about poor water quality impacting export regulations. As a result, they are working together with BOCMA and the Theewaterskloof Municipality to keep the informal settlements from polluting the water supply* (Public Sector 3)." The informal settlement was not the only entity to blame for poor water quality, as one facility in particular recognised the relationship between users within a catchment: "*We are influencing the quality of the water in the catchment. If we do not act with transparency or follow legislation, we may pollute. This is a cycle however, as then water quality we receive is affected* (Private Sector 1).

6.5.3 Risk Forms: physical, regulatory and reputational

Comments on the risk forms (physical, regulatory and reputational) added further nuance regarding the major concerns within each sector. Extracts from the interviews are indicated in Table 29.

Table 29: Selection of Phase II interview responses on the risk forms of the shared water risk framework

Risk Type	Sector		Interviewee Response
Physical	**Public Sector**	**TWK Local Municipality**	*"Take out informal settlements in isolation, there are others which pollute too. And it is probably not a physical, but catchment level risk? It should be all pollutants, from agriculture, industry and informal settlements. "*

Risk Type	Sector		Interviewee Response
		GWUA and BOCMA	*"Yes, the degradation of rivers has a negative impact on ecosystems. This is not good for the aesthetics of the river, which are important too."* *"Climate change is not a problem as the rainfall is shifting east to west. Therefore Elgin valley is not at risk"* *"Flood damage is not a risk, because of the topography. The slopes are too steep, so water cannot accumulate."* *"Domestic demand has been dealt with by the municipality, and the informal settlements are being dealt with."* *"Fertiliser is so expensive it is not overused anymore, as it is not subsidised anymore."*
	Private Sector		*"It depends where you are situated, what is a concern" "We don't get polluted water as there are no settlements above the (Eikenhof) dam. The water has a low pH, therefore we apply pH correction, but aside from the tannins in the water, the overall quality is fine. "*
Regulatory	**Public Sector**	**TWK Local Municipality**	*"There appears to be a lack of awareness from the private sector if they are concerned about a lack of regulation. They could be concerned about ineffective implementation – this could be a risk. For example, not enforced – but the regulation is one of the best in the world. Should be seen as an opportunity rather."* *"From the public sector side, statutory governance is just something we need to live with. The alternative is not an option. Good governance is a must. Whether the municipality is empowered to do it is the other issue. We need to embrace the legislation we are governed by, and see that it is assisting us. Yes, the Public Finance Management Act is seen to be restrictive. But not everyone was playing the game properly before. Unfortunately due to the bad enforcement of regulation, we still get fraud and corruption. Financial pressures and capacity issues are certainly a large risk. "*
		GWUA and BOCMA	*"A particular risk for regulation is where the decision-making process is not clear. It is not always clear who is making the decisions, and this is a risk. "* *"Altering the Water Act is a risk. Another risk is that the dam belongs to the farmers. Financed and built by farmers only. No government money. As the law is now, DWA owns all the water, so now we are not sure who the owner of the dam is. But we are getting counselling on this. "*
	Private Sector		*"Legislation is a huge barrier for us, but it is also a help in making us ensure certain standards too." "Laws and regulations need to remain stable, or this is a risk."*
Reputational	**Public Sector**	**TWK Local Municipality**	*Yes, reputational risk is important for the municipality. Equity of access is the incorrect term. It is larger than this. In terms of the Water Act, we have to supply everyone with a minimum amount of water. Population influx puts pressure on the municipality. But in terms of access, this is something non-negotiable.*
		GWUA and BOCMA	*"Social cohesion is important in this case. Where it is affected, there is great instability."* *"These [reputational risks] are more complex and harder to explain. They are all connected."* *"There is a financial risk missing. If the public sector is at*

Risk Type	Sector		Interviewee Response
			risk, this will affect the tax payer."
		Private Sector	"*We are influencing the quality of the water in the catchment. If we do not act with transparency or follow legislation, we may pollute. This is a cycle however, as then water quality we receive is affected* (Private Sector 1).

As indicated in the table above, a selection of risks, highlighted during the Phase I interviews are not believed to be of concern. For example, at the physical risk level, climate change is not a large concern if current projections are correct regarding the increase in rainfall predicted for the region (Public Sector 3). One representative from the public sector highlighted the fact that informal settlements cannot always be blamed for water pollution concerns. Agriculture and industry also pollute, and therefore instead of informal settlements, the line should read 'all pollutants' (TWK 2). These comments indicate the shifting importance of particular risks between public and private actors over time.

Regulatory risks expanded upon during the interviews include the fact that an unclear understanding of how decisions are made regarding regulation is a risk to the private and public sector. Promulgation of the National Water Act (NWA) in 1998 and changing the ownership of water to the DWA has resulted in uncertainty for farmers who invested in building the Eikenhof Dam (Public Sector 3). One municipal representative was alarmed that 'regulation' itself was being seen as a risk. Inadequate implementation of regulation is clearly a risk, but the regulation and legislation of the National Water Act is lauded as some of the best in the world (TWK 2). From a public sector perspective, statutory governance requirements are the reality in which the municipality exists. Although restrictive, measures such as the PFMA are necessary to reduce fraud and corruption. There was overall agreement that financial pressures and capacity issues are the largest concern from a municipal perspective. These comments echo the debates regarding the necessity of good governance to ensure sustainable water management, but also the risks of inadequate regulatory implementation of Hepworth (2012), Labina and Hall (2012), Merrey and Cook (2012) and Mason (2013).

Reputational risk was acknowledged as complex and interconnected. In literature, reputational risks are especially pertinent in large multi-national corporations (CDP, 2009; 2010; Pegram and Eaglin, 2011; Sojamo and Larson, 2012). This is in part due to consumer perceptions of the company and requirements of King III (2009). However, reputational risk in smaller enterprises and local government is also important, albeit in a different manner (Public Sector 3). Equity of access to water, one of the reputational risk forms, was believed to be misleading, as this is not a risk, but a legislative requirement of government. What is a risk, however, is the difficulty in meeting equity of supply access due to a lack of financial support and capacity. To adequately supply to all informal settlements under current financial and capacity constraints is a challenge, which, if not met, is likely to become a reputational risk for government. Orr et al. (2009) highlight how companies are

concerned about how the value chain is perceived by the wider public, while local government is concerned about how the wider municipal community views their performance.

Following the revisions and comments mentioned above, the refined framework is indicated below in Figure 36. The following changes were noted:

- The dotted boundaries between primary, secondary and catchment risk as they are all inter-related and linked. For example a particular physical water risk may result in reputational concerns to a company or public sector institution.
- The addition of financial risk which is a concern particularly for the public sector, but private sector too.
- The removal of informal settlements alone as a physical risk for the public sector to a general inclusion of all pollutants.
- Changes for the public sector under regulatory risks to more general concerns voiced by interviewees.
- The removal of climate change as a public sector water risk.
- Supply to informal settlements instead of equity of access under the public sector risks.

The changes have helped to refine the framework, ensuring that all aspects of private and public sector risk perceptions have been added. More importantly, the framework has been verified by the respondents from previous interviews, to test whether or not such a tool would be useful in their water risk management practises on a day-to-day basis. The commentary and suggestions made regarding the construction of the framework are an indication of how important water risk concerns are to the various stakeholders. The value of finding simple and clear ways of communicating water risk concerns across sectors was recognised and supported, especially at forums such as the GWUA.

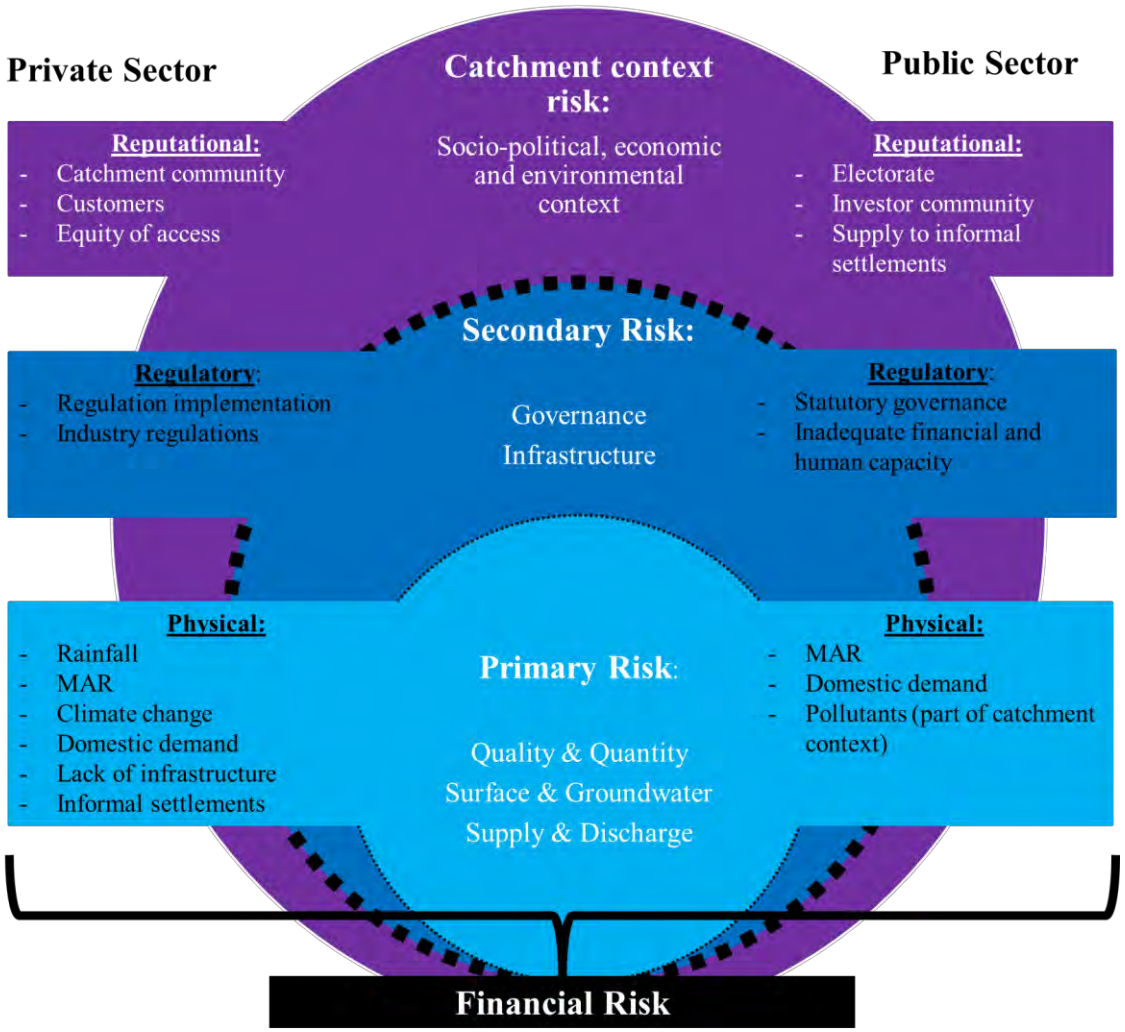

Figure 36: Refined private and public sector water risks conceptual framework

There are a number of critical insights regarding this framework, (including limitations), and how the framework contributes to the thesis. One particular limitation is the 'static' sense of the risks. In reality, risks are not present only at one scale, or even only one risk type. Also, risks may differ in impact and probability, which is not indicated in the current framework. However, regardless of these limitations, the practise of delineating, and trying to make sense of the root cause of particular risks is an important step in recognising the knowledge and understanding of different sectors' risks. The practise of carrying out this exercise among a multi-stakeholder group is useful in identifying how risks are similar or different between different sectors. This is a fundamental step towards understanding shared water risks within a catchment in a simple and accessible manner from representatives from different sectors.

Chapter 7: Water risk sharing or shared water risk?

This thesis seeks to understand how actors in the catchment may share water risk. Inductive reasoning through adaptive theory was used to expand upon the concept of shared water risk. Empirical data from interviews and technical analysis of the case study contributed towards building upon the idea of shared water risk which is not well developed in theoretical literature. Literature and additional frameworks or concepts related to risk, water resources management and sharing were incorporated to inform risk sharing between public and private actors. This was further developed through empirical data. Once collective risks have been identified, the process of building partnerships to share the common challenge is necessary. This research has identified that one of the earliest stages of risk sharing is first to generate information and data to inform knowledge and understanding of each sectors' water risks.

7.1 Responding to water-related risks

When exposed to a specific water risk (for example water quality), there are a number of actions that may be taken to mitigate the risk. The particular risk appetite and vulnerabilities, which form part of the organisational culture of the institution, may help guide the response (Layder et al., 2009). For example, some industries, when faced with water quality concerns, have opted for an internal response, building their own treatment facility. In other cases, companies have invested in the municipality in order to help build infrastructure to manage the water quality concerns (see Appendix I (4) for the example of Sasol and eMalahleni Local Municipality). In the case of Grabouw, companies have primarily chosen internal risk mitigation strategies indicated by Abattoir 1 and Abattoir 2 (in Chapter Five), independently investigating effluent treatment systems in order to meet discharge regulatory requirements from the municipality. For the public sector however, there is recognition that water resources management requires collaboration across a range of institutions, *"We do not have an option not to share. In terms of the shared water risk framework, the community, industry or organised agriculture have a choice. However as government, we have to work together. It is a must. The biggest value of this work and effort would be to publish in the right place. Need to make people aware of this; 95% of people don't even think about this"* (TWK 2).

External responses to risk need to be based on knowledge and understanding of the risk. This is similar to the concept of Bruns (2003) and Greenwood et al. (2012) where information is collected and communicated before public participation collaboration or collective action. Technical information through water accounting of some form is needed before trying to work outside of the factory fence (Orr et al., 2009; Greenwood et al., 2012). See Appendix I (2) for a case study on Anglo American in the Olifants River Catchment for an example of how risks are informed through communication between stakeholders. In the case study, there is no catchment-wide information

sharing between the public and private sector, although some information sharing takes place during GWUA and BOCMA forums.

Hopet al. (2012: 11) identify four "substantive areas of collaboration" including "basins under pressure, infrastructure investment, sustainable cost recovery for water services, global data monitoring and analysis". These areas are listed among "priority actions to reduce water risks". The four factors supporting collaboration listed by Hope et al. (2012) are compared with the case study of this thesis. Firstly, concerning the basin being under pressure, the case study basin is not perceived to be under physical water stress. This is evident through the responses in the interviews regarding water security in the catchment and the surplus in the catchment water balance (Paxton and Ractliffe, 2010). Secondly, although investments have been made in infrastructure, these have all been internal, without multi-sector investment. For example, Abattoir 1 and 2 were each considering effluent treatment systems separately in order to meet future regulatory requirements. The public sector has also made investments in infrastructure without private sector support. There was no collaboration or 'sharing' between the Theewaterskloof Local Municipality and private companies in Grabouw during the expansion of the Grabouw Wastewater Treatment Works. In this case, an investment was made in order to meet the high effluent load being received; however, companies within Grabouw continue to discharge effluent which is higher than the regulatory requirements. Thirdly, sustainable cost recovery for water services is planned, but not currently implemented across the municipality. The Theewaterskloof Local Municipality respondents feel they are not able to focus on cost recovery or regulation of industrial wastewater discharge until the required infrastructure for supply is put in place, ensuring they can justifiably charge for a service (TWK 1, 3). Lastly, monitoring and analysis does not cover the entire catchment. Instead, each company or institution measures their own data that is of relevance to them, without sharing this across the catchment (unless within GWUA or BOCMA). Therefore, Grabouw and the surrounding Elgin Valley do not currently show any of the elements identified by Hope et al. (2012) as conducive for collaboration, one of the phases of sharing knowledge and understanding. This is with the exception of GWUA and BOCMA, who currently represent elements of water risk sharing at different levels, but not at the entire catchment scale.

7.2 Sharing knowledge and understanding

Holford (2009: 462), using the concepts of Giddens (1990) and Beck (1999) and the 'risk society', suggests that "risk is created where there is a lack or gap in knowledge". Therefore, before a response to risk is possible, whether internal or external, the risk needs to be understood (Allan, 1999). "Risk identification requires intimate knowledge of the organisation, the market in which it operates, the legal, social, political and cultural environment in which it exists as well as an understanding of the strategic and operational objectives" (ARM, AIRMIC, ALARM, 2010: 20). The way and form in which water information is commonly collected in a catchment is not conducive to adaptive management as social information is often not included (Pahl-Wostl et al., 2008). Pahl-Wostl (2007a)

supports the inclusion of factual (technical knowledge) as well as 'soft' subjective (social knowledge) perceptions. As information production needs to be through, "mutual dialogue and not as a one-directional transfer of expert knowledge," public and private sector knowledge and understanding of risk is required (Pahl-Wostl et al., 2008). Both technical and social information are important sources of knowledge (Corburn, 2007), as the consideration of social as well as technical knowledge and information enables one to fully investigate how stakeholders in the catchment act (Allan, 1999; Pahl-Wostl, 2007b). This is supportive of Renn (2008c) combining technical and social elements of risk into an integrated risk framework.

Adaptive management indicates a system where learning through communication and feedback takes place alongside trying to improve the system. Adaptive management can be defined as "learning to manage by managing to learn" (Pahl-Wostl, 2007b). In water management, this is critical as the uncertainties and risks are always changing. The management of water is continually able to shift according to the new knowledge acquired. The management of water should shift and adapt to what is most prudent at the time (Huitema et al., 2009; Pahl-Wostl et al., 2009; Ostrom, 2010; Hope et al., 2012), allowing management of water risks and trade-offs between different sectors of the economy and water users (Hope et al., 2012).

The function of having an adaptive water management system is to respond rather than react to undesirable impacts of change. The pro-active form of management is based on an understanding of the basin (Pahl-Wostl, 2007b). "New information must be available to the system and the system must be able to process this information" (Pahl-Wostl, 2007b). In this thesis, the context of risks being faced is informed by technical information regarding the actual quantity and quality of water available in the catchment. This is categorised as physical risk. Regulatory and reputational risks represent the governance structure, actors and institutional factors influencing the social aspects of the context.

The 'process' aspect of social learning and adaptive management is comparable to the process of public and private sector identifying their knowledge and understanding of risk. The risk is informed by problems being faced in the catchment in addition to the social or relational issues that magnify or feedback into the problem. In the case of Grabouw, this is seen through the case of the local municipality that is faced with the problem of inadequate water supply provision. The social issues compounding this include continued immigration into the region, increasing the gap in service provision further for example.

The 'outcomes' identified by Pahl-Wostl (2007b) are both technical and social. The 'outcomes' are fed back as information for the 'context' for social learning to take place. This is core to the adaptive management process where new information is integrated in order to adapt the process as required. The building up of a 'shared problem perception' and communication of different points of view are important elements of social learning within water management (Pahl-Wostl, 2007a). In terms of the

case study, the outcomes of identifying public and private sector water risks include both a technical understanding of the risks through information and data as well as socially orientated knowledge and understanding.

7.3 A sharing typology

The function of risk sharing is not for public and private sector mandates to change, but for the public sector to provide a secure backdrop against which the private sector is able to manage risks in a collective manner (Hacker and O'Leary, 2012). Partnerships may be with other private sector organisations or with a local municipality, CMA or WUA, for example.

Hope et al. (2012: 10) suggest a mechanism "for sustained engagement and productive outcomes for policy, enterprise and research communities". Based on the empirical evidence from the case study and literature, this thesis introduces a sharing typology as a mechanism to indicate the range of sharing which may take place in an effort to manage water resources. As indicated by Bruns (2003) and Greenwood et al. (2012) sharing may take a number of forms. This is specific to the context at hand. This thesis recognises that although water may be shared within a catchment, it does not necessarily mean that the actual risks are shared, or that the mitigation should be shared between the institutions. As with collective action, there may be different levels of 'sharing' which may vary over time and space. A typology of shared risk in the context of water resource management is shown in Table 30. Evidence of each level in the typology is critically investigated with empirical evidence from the case study. Note however, that in reality, the indicated stages of sharing in the typology are not mutually exclusive, and may merge into each other at different times and under different circumstances.

Table 30: Typology of risk sharing in the context of water resources management

No.	Characteristic features of sharing	Description	Support in literature
7	Co-management of water risks	Mitigation of the risk takes place through joining of efforts or finances in a centralised manner	Bruns (2003); Greenwood et al. (2012)
6	Co-operation and agreement	Common concerns are expressed and a strategy from each sector is identified in order to mitigate the same risk or source of risk	Bruns (2003); Greenwood et al. (2012)
5	Willingness/preparedness to meet others to discuss joint or mutual water risks (collaboration stage)	Monthly, quarterly or yearly meetings to discuss concerns within the catchment	Potapchuck (1991); BOCMA CMS (2011)
4	Communication of risk information and knowledge	Information in the form of data and analysis that is presented on the internet or in forums, committees of interest etc.	Pahl-Wostl et al. (2009; 2011); Huitema et al. (2009); Frewer (2004)
3	Information and knowledge of water risk other face in the same catchment	Acquired through catchment management plans, catchment-wide data, common issues or concerns	Greenwood et al. (2012); Bressers and Lulofs, (2010)
2	Information, knowledge and understanding of own water risk	Acquired through data collection, perceptions, company/institution audits, footprint assessments	Bruns (2003); Orr et al. (2009); Greenwood et al. (2012); CDP (2014)
1	Awareness of the risk	Awareness of individual entity risk and/or those facing other users in the catchment generally	Beck (1999); Allan (1999); Holford (2009)

The risk sharing typology (Table 30) identifies a number of phases towards risk sharing. **Awareness of the risk** is a base requirement. In the case of Grabouw, all respondents recognised that they face water risk. The majority are not at risk of physical quantity due to high rainfall in the area, but respondents did recognise water quality as a concern.

Information, knowledge and understanding of one's own risk are necessary before being able to understand the risks being faced by other stakeholders within a catchment. "Corporations need to 'know their basin' and understand the impact they have upon it. Only then can appropriate action be established" (CDP, 2014: 10). This is also suggested in the WWF Water Risk Filter (WWF and DEG, n.d.). Evidence supporting this stage of the typology is seen in the case of Abattoir 2 where optimisation of water use within the company is required first in order to better understand their own risk before being able to communicate with other companies in the catchment.

Information and knowledge of the risks others face in the same catchment begins a conversation. It helps identify whether or not there are relevant risks that could be shared. This forms part of social learning and adaptive management of water resources. Without basin-wide information and knowledge ensuring a full understanding of the quality changes, it is difficult to identify the sources of concern (Bressers and Lulofs, 2010). This is suggested by Hope et al. (2012) as a factor that stalls risk sharing. Awareness of the risks other stakeholders face within the case study was uneven. This is supported through responses such as, "within GWUA there is a good knowledge of all the stakeholders in water, but from the municipality down, there is not good knowledge" (TWK 3).

Communication of risk information and knowledge has been shown to be useful in risk mitigation. How the risk is communicated is also important (Frewer, 2004). "Information sharing can equalize partners and groups whereas unequal access to knowledge exacerbates in-group and out-group dynamics, facilitating either vicious or virtuous cycles of engagement and shaping the way in which actors are able, or unable, to cooperate with one another" (Goldin, 2010: 204). Through informed knowledge of the wider catchment, better understanding of the root causes and potential feedback loops of risks become known. Scientific knowledge must be produced through interaction with existing social context of the actors to improve the chances that knowledge is used effectively (Bressers and Lulofs, 2010). Hence technical information in addition to communication across a range of sector actors is necessary. CDP (2012: 11) have found that through the public disclosure of water related information from companies, there is potential "to create value and mitigate operational, regulatory and reputational risks". The same was found with the CDP climate change work, where business value was created once companies began to disclose carbon and climate related information. In the case study, communication of risk information and knowledge does not take place in a centralised form. These is no single data or information source with both quality and quantity information on the entire catchment. From the perspective of the private sector, public sector monitoring of data was seen to be inconsistent and irregular (FP1, FP2, Bev 1, Bev 2). GWUA meter and measure their stakeholders' water consumption. However, GWUA does not know the water usage statistics within the municipality as it is not part of their mandate. Therefore, although each public sector institution is metering water use, there is no single, centralised data repository for the catchment. This indicates an opportunity for sharing information, so that actual water flows within the catchment may be understood in greater depth.

A willingness/preparedness to meet others to discuss joint or mutual risk represents the collaboration or consultation stages of Bruns (2003) and Greenwood et al. (2012). Evidence of the importance to meet and discuss can be found in Appendix I – 2. This stage of the typology is achieved through monthly, quarterly or yearly meetings to discuss concerns with the catchment. This form of the typology is seen in the GWUA quarterly meetings where concerns concerning water within the catchment are raised. These are noted in the minutes and disseminated to the wider catchment users.

The dissemination of this information indicates a willingness to incorporate a range of stakeholders in the knowledge and understanding of the risk.

Co-operation and agreements in the catchment concerning water management indicate a realisation that resources may be managed with participation from multiple stakeholders. In the Palmiet Catchment, there are a number of agreements between the local municipality, GWUA and BOCMA. The purpose of the CMA is to coordinate government, sector partners and stakeholders (Mazibuko and Pegram, 2006). Evidence of co-operation for example is through the support from BOCMA to the local municipality in finding funding for infrastructure upgrades. The BOCMA representative indicated that by supporting the municipality in an effort to better treat their effluent, the water quality risks in the wider catchment may be reduced (BOCMA 1).

The final stage of the typology, the co-management of risk, as discussed in Bruns (2003) and Greenwood et al. (2012), includes the most advanced forms of participation or collective action. At this stage, the water risks need to be large enough that they may not be managed by a single stakeholder alone, as there are additional risks associated with more integrated forms of sharing (Pegram et al. 2011). In some cases, a catalyst is required, which allows the realisation that the private and public sector are unable to mitigate water risks alone. This is evident through the case study of Nestlé in the Southern Cape in Appendix I. The most developed example of co-management within the case study is between GWUA, BOCMA and the local municipality. Within the private sector, there are bilateral examples of co-management however these are based on technical infrastructure, and not necessarily on water resources governance. More advanced forms of sharing between the private and public sectors may not have taken place because, as suggested by Hope et al. (2012), the necessary factors supporting the sharing of risks are not present. These include large enough water stress, investments in water infrastructure, full cost recovery of water services or catchment-wide information and data on the resource. In the case of the Palmiet Catchment, water resources are not believed to be under significant stress, water infrastructure is largely adequate for private sector users, water is not charged at the full cost recovery and in some areas there is limited information on the catchment.

Government and industry working together are suited to solving contemporary challenges while attempting to avoid future ones (WBCSD, 2006; Hecht et al., 2012). Pahl-Wostl et al. (2009) and Naime and Andrey (2012), indicate that due to the systemic nature of water, government and the private sector are incapable of managing water separately and need to work together. Partnerships can "achieve their objectives more effectively and efficiently by pooling resources and sharing risks and rewards" (Hamann et al., 2011: 10). Optimising efficiency within factory operations is not able to mitigate external risks as a result of water regulations for example. The same may be said for the broader public sector institutions, where better policies and stronger institutions are unable to solve

water risks without stakeholder engagement (Sjöberg, 2002; Morrison et al., 2010; CDP, 2012). Therefore, the CEO Water Mandate Guide to Responsible Business Engagement with Water Policy advocates not only for better public policy and stronger institutions to reduce water risks, but also for inclusive and meaningful stakeholder involvement in decision-making (Morrison et al., 2010).

Although each sector recognises the strengths they may bring to a partnership, regulation is a priority concern (Hepworth, 2012; Labina and Hall, 2012; Merrey and Cook, 2012; Mason, 2013). Regulation is important in reducing risks such as corporate capture, where private sector objectives begin to control the public good (water). Hepworth (2012) identifies the power that companies have as they may have greater resources and knowledge compared to "other stakeholders and the public sector". This may become a danger to the catchment, as private companies may sway management according to their needs. Lack of response in the form of a robust framework from the public sector on how businesses may engage in water management is an indicator of the risk. The CDP (2012) urges that collective action does not become a substitute for a robust water strategy. Companies should still act independently, and establish their own concrete targets and goals. "At its best, collective action can lead to a strong sense of shared interests, shared responsibility, and shared benefits" (CDP, 2012: 23). However, at its worst there may be unintended consequences for the public good. Understanding the shared nature of risks within a catchment does not mean that the two sectors need to start working together in all instances (Hacker and O'Leary, 2012). First improved knowledge and understanding of the individual sectors' water risks is needed. This then needs to be communicated between all stakeholders, indicating where there are similar or collaborative elements. Finally, should the nature of the risk require, the mitigation thereof could be shared.

7.4 Refining the sharing typology

Refinement of the sharing typology took place through additional interviews with stakeholders within the case study region. Interviews added nuance regarding their understanding and experiences of water risk sharing. The selection of testimonials highlights some of the respondents' reactions to the sharing typology, as indicated in Table 31. These are elaborated further in the text, indicating how the responses link to different stages within the risk sharing typology below.

Table 31: Phase II interview comments linked to the typology of risk sharing in the context of water resources management

No.	Stages of sharing	Testimonial
7	Co-management of water risks	*"We are at many levels including co – management. We are involved with the municipality, together in many areas, for example cleaning up informal settlements, beautifying the village and cleaning out the river."* *"From a municipal prospective we at the stage of co-management of water risk with GWUA. There is some joining of efforts, sharing of financial burdens and resources with regards to water quality monitoring as well as river rehabilitation."*
6	Co-operation and agreement	*"There is a fair amount of cooperation and agreement between the different levels of decision makers and the different parties. Elandskloof irrigation board and GWUA for example, are all fairly well aware of the risks that Theewaterskloof Local Municipality has to manage, and are cooperative in managing them."*
5	Willingness/preparedness to meet others to discuss joint or mutual water risks (collaboration stage)	*"The municipality is represented on the GWUA board which builds trust and strengthens relations. GWUA also attends all the river rehabilitation work group meetings facilitated by the municipality."*
4	Communication of risk information and knowledge	*"Water quality monitoring is done by GWUA at certain points and information is shared with the municipality to address risk through an integrated approach."*
3	Information and knowledge of water risk other face in the same catchment	*"Newsletters and meetings are being held by GWUA and BOCMA. This is how we know what is going on."* *"…the end should be a user manual. So that the municipality and GWUA know what to do and how to share."*
2	Information, knowledge and understanding of own water risk	*We need to make people aware of their risks. 95% of people don't even think about this."*
1	Awareness of the risk	*"The biggest risk is the level of awareness to realise what the risk is."*

Private sector 1, supplied by water from the municipality, concurred with the idea of risk sharing stating that "*we share risks with other users in the catchment, because we all have the same supply*

and we share the risk of poor quality water if the municipality is unable to treat it appropriately."…*"The examples in the typology cover this idea of sharing fully. But there are always problems, as it takes time; sometimes more than a year. But in the end it is solved. Collecting information is key to supporting activities."*

The knowledge and information building in a step-wise progression towards risk sharing was commended as close to what happens in reality. Private sector respondents could share experiences of information sharing and co-management of infrastructure (Private sector 1, 2). Depending on the risk being faced, different partnerships are needed (Private sector 2): "*There are different partnerships that are at different stages. They also change in time. Sometimes we need to share information. The next time we need to work on a project. It all depends."* However, there was also recognition that sharing is not always necessary, and should not be rushed: "*Sharing has not yet happened concretely. We are still in the planning stages. It takes time because it is complex."*

From a municipal level perspective, co-management is one of the perceived stages of sharing with the GWUA (TWK 1, 2, Public Sector 3). This is supported by the following quotes: *"We are at many levels including co–management. We are involved with the municipality, together in many areas, for example cleaning up informal settlements, beautifying the village and cleaning out the river,"* and *"from a municipal prospective we at the stage of co-management of water risk with GWUA. There is some joining of efforts, sharing of financial burdens and resources with regards to water quality monitoring as well as river rehabilitation."* Co-management is supported by a large amount of information flow and meetings which take place between a range of government institutions in the district (Public Sector 4; TWK 2): "*Water quality monitoring is done by GWUA at certain points and information is shared with the municipality to address risk through an integrated approach. The municipality is represented on the GWUA board which builds trust and strengthens relations. GWUA also attends all the river rehabilitation work group meetings facilitated by the municipality."*

Collaboration around the management of water resources is not always straightforward, as indicated by this quote: "*There is a fair amount of cooperation and agreement between the different levels of decision makers and the different parties. Elandskloof irrigation board and GWUA for example, are all fairly well aware of the risks that Theewaterskloof Local Municipality has to manage, and are cooperative in managing them. The party we battle the most with is the DWA who have a very rigid approach."*

Regardless of the typology and the framework, one public sector representative mentioned the need for a catalyst before sharing takes place. This is of great importance, resulting in Step 1 of the typology -awareness of the risk in the first place- being the most critical in establishing the driver for risk sharing: "*The typology makes sense. But like in all of these things, we need a driver to work together. The biggest risk is the level of awareness to realise what the risk is. We need to have enough*

drive and enthusiasm to act. If there was a large accident and we lost the [Eikenhof] dam wall – then there would be chaos. The likelihood is minimal, but the impact is huge. If have more critical risks, and organise them appropriately, then can put together a management plan. We do not have that at the moment (GWUA 1)."

Converting the concept of the sharing typology and the shared water risk framework into a manual or set of guidelines which the public and private sector could consider when faced with water challenges within a catchment was suggested. It was felt that catchments which are faced with more extreme water stress may find the process especially helpful (Public sector 3): *"...the end should be a user manual. So that the municipality and GWUA know what to do and how to share."*

7.4.1 Insights into the concept of shared water risk

In addition to the Phase II interviews regarding the shared water risk framework and risk sharing typology, respondents were asked about their perceptions of shared water risk in general. These comments were used to gain a general understanding of the value of the shared water risk idea in mitigating water security concerns.

Private Sector 2, which was not supplied by water from the municipality but by GWUA, indicated that their risks are shared with others users from the Eikenhof Dam. For example, if the dam level drops or if allocation from the dam changes, they are all at risk. However, as an industry drawing raw water from the Eikenhof Dam, they are not susceptible to the risks posed by inadequate municipal treatment.

The GWUA itself did not recognise itself as 'sharing' water risks, but being ultimately responsible for the supply of water to a range of users. Noting the complexity of water resources within a catchment, the GWUA representative highlighted that the municipality are part owners of the Eikenhof Dam, and therefore responsible for the management of the dam too: "*Others might be at risk, but GWUA is managed so well, our users are not really at risk*" (Public 2). Adequate supply of water as a result of population expansion or rainfall is the primary risk facing the WUA. However, the respondent did acknowledge that businesses receiving water from within the jurisdiction of the municipality may not receive water due to a management problem.

At the public sector level, the acknowledgement of the shared nature of water risks was more explicit, and mentioned on separate occasions by a range of public sector representatives: "*In my opinion 'shared water risk' entails the acknowledgement that the risk associated with the supply, treatment, distribution is not limited to one organisation whether it be the state, provincial government, local authority, Water Board or Water Users Association. It is in fact the responsibility of every citizen and therefore becomes a concerted effort between all affected parties to identify, evaluate and manage any inherent risks in the water balance system*" (TWK Municipality 2) "*Risk is shared through multi-*

stakeholder partnerships between the local community, public sector and private sector to mitigate and find solutions tailored for this area and community" (TWK Municipality 1). Risks are especially seen to be shared among different public sector institutions, as indicated by the following quote from a municipal representative: "*Risk regarding investigating and responding to public complaints and concerns regarding water quality are shared with the Overberg District Municipality Health Inspectorate, BOCMA and GWUA*" (TWK 1).

Private sector opportunities regarding sharing water risks included mostly cost saving (Private Sector 1; Private Sector 2) and symbiotic partnerships where one industries' waste is another industries' inputs (e.g. effluent from Private Sector 1 used in a biogas digester by a neighbouring industry). From the public sector perspective, a wider range of opportunities were mentioned including those mentioned by the private sector. These include making water management more effective and improved problem solving from more perspectives. Municipal capacity was mentioned (TWK 1 and 2) as a driving factor for increased input from a wider range of stakeholders: "*With more eyes on the ground*" and good communication channels, risks can be mitigated earlier (TWK 1).

A major challenge for water risk sharing mentioned by the private sector is the capacity of the municipality. One example is the irregular capturing of water quality data by the municipality, which makes the sharing of information problematic between the different institutions. Inadequate public sector finance was also mentioned as a challenge, as the public sector "*wait for us to do something to reduce the risk first*" (Private Sector 2). An additional challenge mentioned is the larger distances between industries or the municipality in a rural area which makes physical infrastructure sharing difficult.

From a public sector perspective, the distinct objectives of the private sector (profit maximisation) and public sector (social welfare) were mentioned as barriers to working together. In addition, the shorter return on investment timeframes of the private sector makes it difficult for industry and government to invest in risk mitigation together (BOCMA, Public Sector 1). From the public sector perspective, "*there is a lack of awareness and acknowledgement in the community that risks need to be identified, prevented, avoided, minimized and removed in a proactive manner in order to protect all interests and the asset*" (TWK 1). Within the public sector itself, unrelated to the private sector objectives, challenges to working with businesses include the Municipal Finance Management Act (MFMA) and the 'silo' structure of municipal departments.

Chapter 8: Implications and conclusions

Shared water risk has primarily focussed on the private sector at a large multi-national scale (Wharton, 2011; Hepworth, 2012; Sojamo and Larson, 2012). In this thesis, the idea has been explored empirically both within small-medium sized agro-processing private sector companies and the public sector represented by the local municipality, WUA and CMA. Interviews were conducted within a local catchment in South Africa to determine the understanding of water risks within and between private and public actors. Risks were mapped to examine the idea of shared water risk involving both collaborative governance and risk management. Collaborative governance involves trust, built partly on an understanding and knowledge of water risks facing each sector. In answering the research questions laid out in this thesis, there are implications both for theory, policy and practise.

8.1 Research questions

In the Palmiet Catchment the knowledge and understanding of risks is dependent on the nature of the institution, and what their target and mandate is. This has an impact answering the first research question of this thesis, "*what is the knowledge and understanding of water risks within and between the public and private sector within a single catchment?"* The scale and form of risk is dependent not only on the context of the water risk, but also the perceptions of the private or public sector actors. Actors which are part of a larger forum, such as the GWUA, are far more aware of the risks of the wider catchment due to the information sharing which takes place. On the contrary, businesses which are not part of the WUA feel more threatened by water risks such as disruption in supply or inadequate water quality.

Knowledge and understanding of water risk within the case study catchment is informed by both technical and social sources of information. Both are required due to the nature of water management. Technical data sources include metering and water quality testing which in particular inform physical water risks. Social sources of information include the socio-economic status of the catchment as well as the regulatory environment of the sectors. These are more closely linked with regulatory or reputational risks. Through consideration of physical, regulatory and reputational concerns, a wider range of water-related risks are considered, beyond that of purely quantity and quality.

The conceptual framework supports the identification of each sector's water risk concerns as physical, reputational or regulatory risks, placing them onto the possible scales at which these risks manifest. The process of building the conceptual framework enables a comparison and exchange of risk concerns, without being imposing or threatening. The conceptual framework also considers the communication and framing of risk for each sector, which helps to identify forums where risks can be communicated among different sectors. With an informed understanding and knowledge of water risk,

social learning and adaptive management is supported. Through communication, necessary in adaptive management and collaborative governance, sectors are better able to identify where there may be symbiotic sharing of risks in order to optimise mitigation efforts.

The second research question of this thesis is: "*how does the knowledge and understanding of public and private sector water risks help to map and understand shared water risks in a catchment?"* Mapping the scale and form of specific private and public sector water risks on a single framework is helpful in making comparisons between the different sectors. Even within a single sector, understanding the linkages between physical, regulatory and reputational risks is helpful in determining the root of concern. The academic contribution of this thesis lies in the analysis of knowledge and understanding of risk within the public and private sectors and the potential to develop a systemic understanding of the field and the position of stakeholders in the public and private sector. The ultimate challenge was to develop an empirically-based understanding of the emerging idea of shared water risk, which was achieved through comparing and contrasting private and public sector water risks.

The concept of sharing was investigated both in literature and through the interview data. A key attribute identified through the interviews, before actual risk sharing or integration of goals may take place, is the sharing of knowledge and understanding of risks through communication. This needs to be in a non-threatening environment, where blame and pressures of regulation do not cloud the process of understanding the full system. For risks to be informed by knowledge, not only does it require that each sector understands and identifies what their respective risks are, but they also need to communicate these risks to others within the catchment. The need for clear and effective communication between different sectors engaged in water management is clear. However, because the private and public sector have traditionally been kept separate without in-depth conversation and collaboration, the communication is often misunderstood. In the Palmiet Catchment, the GWUA offers an opportunity for sectors to communicate and collaborate.

The GWUA is categorised as a public sector institution. However, it is in fact made up of private sector representatives. In this case study, overlap was found between the private and GWUA risks. Considerations such as the export requirements of fruit in particular were linked. Therefore, an additional factor as to why risks may differ is because of the interaction and communication groups may have with each other. In the catchment, farmers and agro-processing companies have greater interaction with the WUA than with the municipality, for example. This is especially the case if supplied from GWUA water as opposed to municipal water. Therefore, although risks themselves may be different, the knowledge and information informing the risks is often similar. Through communication, sharing knowledge and understanding between parties, risks may become better

understood between the distinctive parties. Whether sharing is required or not in order to mitigate the risks is dependent on the context.

The third research question was, "how do the public and private sectors respond to shared water risk?" Interviews with private and public sector actors regarding shared water risk resulted in a mixture of responses. Although actors acknowledge that sharing risk is an effective way to reduce particular water concerns, it was also highlighted that this is not always possible considering the other constraints faced by each sector. Barriers range from capacity or regulatory constraints in the public sector, to financial or regulatory constraints in the private sector.

The level of 'sharing' between actors is relative to the context of the risk. Like the extended ladder of participation (Bruns, 2003) or collective action (Greenwood et al., 2012), there may be different forms of sharing relevant to each situation. These are suggested in the risk sharing typology. Instead of purely supporting the concept of sharing public and private responsibilities within water resources management, this thesis recommends first exploring what the different risk concerns are before assuming they are shared. Secondly, this thesis recommends the use of an adaptive management approach, sharing risks only when required. A critical requirement in adaptive management is social learning through communication of risks that need to be informed by knowledge and understanding. This needs to be communicated across sectors to ensure full understanding of the complexity of risks within the catchment.

In summary, an informed knowledge and understanding of water risk enables the public and private sector to jointly map and understand shared water risks within a catchment. However, before assuming risks are shared, the informed knowledge and understanding promotes adaptive management through social learning and communication. Therefore, if necessary, the risk can be shared, whether only through information or mitigation as indicated through the risk sharing typology.

8.2 Implications for theory

This thesis contributes to the theory of water resources management in a number of ways. Collaboration, collective action, risk sharing and partnership are all strategies suggested for improved water resources management. This thesis investigates how risk sharing may be better understood through introducing the following elements: 1) the use of risk as a framework through which to communicate water-related concerns, 2) the acknowledgement that risks are not necessarily the same; 3) investigating the differences between public and private sector water risks, and 4) a typology for risk-sharing identifying the different forms the sharing of risks may take.

By attempting to understand the complexity of water resources management, improved management through the sharing of common risks (where applicable) may follow. Where risks are not shared, the process of investigating the knowledge and understanding of risks helps to identify the complexity of

the system, perhaps helping identify other solutions to the concerns. Contributions of this thesis include the use of risk as a common language to help bring together diverse sectors. This is especially necessary when participatory decision-making is required. A further contribution of this thesis in using a broad definition of risk is the ability to consider not only the technical aspects of water supply and sanitation, but the wider social and environmental factors too. Understanding water security as a risk enables a wider and more diverse stakeholder group.

In this thesis risks are not the same between individuals, and especially not the same between different sectors. However, risks may be shared through common root causes for example. Acknowledgment of this allows this thesis to move towards identifying what the different risks may entail. It is only through investigation of the different concerns each sector has regarding water risk that sustainable solutions that meet the requirements of the whole are found. The growing use of enterprise risk in the public sector indicates an appetite for engaging in a wider risk framework at different spatial and temporal scales. Enterprise Risk Management (ERM) is also used by the private sector.

The investigation of the current growing discourse of private sector engagement in water policy is novel, in addition to trying to investigate the theoretical underpinning and role of SMEs. However, the real contribution is that of trying to compare and contrast the public sector understanding and response to increasing water risk concerns and the private sector engagement in what is traditionally a public sector mandate. Tools and matrices helping to investigate water risks are numerous. The majority are targeted towards investors or the private sector. Few have been developed with the public sector as a specific target. With increasing support for private sector engagement, it is imperative that the public sector prepare for where they may or may not need private sector intervention. The conceptual framework developed in thesis helps to identify the scales and categories of water risks, and levels of engagement relevant to both the private and public sector.

The framework is clear, novel and builds further on existing frameworks. It highlights different water risks and maps where these security risks are most relevant. It helps to consider the challenge of water resources management in a new light, without assuming that risks are shared, but that there may be elements of sharing which may be explored once the wider risk context is understood.

The thesis also recognises that sharing does not occur in a single form. A risk sharing typology has been developed, indicating the different forms of sharing which may take place between the public and private sectors. These concepts are linked with that of the social learning and adaptive management framework of Pahl-Wostl et al. (2011) and Huitema et al. (2012). This is of importance, as before sharing can take place, the risks of the system need to be adequately known, communicated and managed through adaptive responses.

8.3 Implications for policy and practice

Investigating risk concerns and placing them in comparison to the other stakeholders involved, has a number of practical applications for the private and public sector alike.

8.3.1 Private sector managers

All businesses experience risk. Water risks may be dealt with internally through optimisation of processes or construction of internal infrastructure. However, depending on the nature or scale of the water concern, the public sector may be able to help in reducing the common risk. Through the process of understanding the institutional roles and scope, the private sector may be better equipped in identifying the public sector institution of relevance, potentially streamlining the risk mitigation process. The risk sharing typology as well as the conceptual framework is useful in this case.

8.3.2 Public sector representatives

The value of water risk conceptualisation for the public sector is two-fold. Firstly, it allows for improved communication with the private sector, as now risks are conceived similarly. Secondly, the inclusion of water risks in a wider context identifies how the different risk concerns for the municipality are related. At times the fragmentation of the public sector into separate silos or ministries, departments and offices hides the systemic nature of the public sector mandate. Social and economic development, while remaining a custodian of the environment, is a challenging task.

Seeing the complexity of the water risks narrowed into actionable areas is something that this thesis recommends as particularly useful. An added bonus is the ability to see where the private sector is able to help legitimately in mitigating the risks without hindering the public sector mandate. Considering the technical as well as social elements of water risk will help avoid the concerns raised where the TWK IDP, for example, only focuses on water services and supply without considering the resources available. The risk sharing typology offers guidance on how to best begin the process of knowing and understanding the risks associated with water.

8.4 Further research

Understanding water risks is only the starting point. Further research in this field calls for additional case studies to understand how risk, for example, is informed outside of the agro-processing sector. In addition, public sector risk is possibly very different when investigating district or metropolitan municipalities. In regions where there is no functioning CMA or WUA, the risks may also be different. Future scope for widening the knowledge and understanding of risks within different private and public sector contexts, by considering other case studies, is as follows:

- Additional case studies are required to expand upon the range of knowledge and understanding informing water risks in each sector.

- An informed knowledge and understanding of water risk enables the public and private sector to better understand how water resources and the associated risks thereof are shared within a catchment. Further investigation is required to analyse whether or not increased knowledge and understanding will result in collaboration in this context.
- Furthermore, research is required to investigate whether or not collective action, established through recognition of shared water risks, results in mitigation or reduction of water risks.
- Finally, the public sector response to the increased interest from the private sector needs to be interrogated further. As indicated in this thesis, there are risks associated with 'sharing.' A policy response from the public sector is necessary to ensure water management remains in the best interests of society as a whole. This needs to be investigated further.

8.5 Conclusions

Increasing water risks have resulted in private-sector interest in water resources management. The manner in which water resources are managed is also changing as multi-stakeholder participation increases. This is as a result of a number of factors, including increased interest from the private sector. An example of increasing participation in water management is the narrative of shared water risk, primarily stemming from literature from the private sector. However, increased participation and collaboration in WRM and governance poses both challenges and benefits.

Water risks are not the same across different actors. In the private sector, businesses consider risk according to the effect on profit margins or viability of business. These risks may be physical, regulatory or reputational in nature. Risks are often judged in a short timeframe in relation to profit margins. There has been a shift, however, as businesses increasingly consider their long-term business sustainability within a wider context. The public sector considers their water risks in a more technical sense (through municipal engineers), as well as within the wider civil society needs. Long-term social welfare and development of the community are the time frames most considered for the public sector, although shorter-term political office also impacts the timeframes of risk.

The case study considered agro-processing industries in the region of Grabouw, South Africa and water management institutions such as the CMA, WUA and local municipality. Although historically not a water scarce area, water quality is a concern. The demand of competing users including Cape Town is increasingly also becoming a concern. Empirical results from the interviews show a diverse understanding of water risk, with some similarities and some differences.

In the water risk framework developed, water risks are characterised both by their scale and form. The scale of water risks from both the private and public sector perspective includes primary risks associated with direct water supply (quality or quantity); secondary water risks associated with infrastructure or governance/management of water resources; and tertiary (contextual) level risk

including the socio-economic and environmental or political context of the catchment. The forms of water risk include physical water risks relating more to the primary water risks; regulatory water risks linked to the secondary water risk scale of governance and regulation; and reputational water risks linked to the contextual scale of the catchment, where the reputation of the public or private sector is impacted by others in the catchment.

The scale and form of public and private sector water risks were dependent on the context of each actor within the catchment. For example, companies supplied by water from the municipality felt more at risk than those supplied by the GWUA. This is due to a number of reasons including the perception of inadequate capacity compounded by experience of water shortages or poor water quality in Grabouw. Another contributor to their water risk is the added level of management or governance to consider. Also, unlike the WUA, businesses receiving water from the municipality do not have a platform to share their concerns upon. The risks perceived and experienced by the small- to medium-sized companies is also distinct to those more widely published by large MNCs. The major distinction between the two is the inability of smaller companies to manage significant water risks alone due to the financial burden thereof.

Water risk sharing does not happen in all cases of water risk within a catchment. Sharing most often takes place where the risk is too large to manage alone, or the capacity of one actor is not sufficient to deal with the challenge individually. Development of sharing begins with smaller steps, by understanding your own challenges being faced, followed by understanding the wider concerns of the catchment. Following a general understanding of the context, communication and collaboration around the risks being faced can potentially begin. The actors may then decide to integrate or share the financial or management burden of a water risk mitigation strategy. Information regarding the water risks and communication thereof is critical for the development of a shared understanding of the challenge.

The challenge of collaborative partnerships between private and public sectors, with different perceptions of water risk is a potential constraint towards adaptive water resources management together. However, as discussed in this thesis, evidence of information sharing, and in some cases the risks themselves, gives an indication that the different mandates and perceptions of the actors can be overcome. The GWUA and the CMA are an indication of a platform supporting the sharing of information between the private and public sector. Industries represented at the platform felt more at ease with the security of water supply than those supplied by the municipality alone, where such a forum does not exist. In addition, a number of projects have developed from the GWUA, where both the private and public sector have invested their resources. Forums such as these are the foundation for water risk sharing between public and private sector actors.

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Appendices

A. Confidentiality agreement

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Confidentiality agreement

Purpose: to obtain permission from facility to use data or information collected during the interview.

These questions form part of the researcher's PhD research. Before any publication of results or sharing of findings, you will be consulted to review the information to be shared. There are a number of ways the data may be converted into information and therefore shared as knowledge. The options are shown as below, and will be carried out as you determine. Please indicate (Y/N) whether or not the following may be shared. If you would like to first revise the findings before making a decision, please indicate with a "D."

Facility Information	**Yes (Y) or No (N) or Depends upon revision (D)**
Facility Name	
Facility Type (municipal treatment works or private food and beverage company)	
Facility Data (m3)	
Facility situation (town or region)	
Facility footprint	
Facility risk profile	

Personal Information	**Yes (Y) or No (N) or Depends upon revision (D)**
Name	
Position (management, operations etc.)	
Personal beliefs (not attached to company)	

Signed:

_____ Hannah Baleta _____ Date

_____ Participant _____ Date

B. CEO Water Mandate 5 Principles for Business engagement in water policy

- Principle 1: Advance sustainable water management. The engagement in water policy must be motivated by a genuine interest in furthering efficient, equitable, and ecologically sustainable water management.
- Principle 2: Respect public and private roles. Responsible corporate engagement in water policy entails ensuring that activities do not infringe upon, but rather support, the government's mandate and responsibilities to develop and implement water policy. Acting consistently with this principle includes a commitment to work within a well-regulated (and enforced) environment.
- Principle 3: Strive for inclusiveness and partnerships. Responsible engagement in water policy promotes inclusiveness and equitable, genuine, and meaningful partnerships across a wide range of interests.
- Principle 4: Be pragmatic and consider integrated engagement. Responsible engagement in water policy proceeds in a coherent manner that recognizes the interconnectedness between water and many other policy arenas. It is a proactive approach, rather than one responsive to events, and it is cognizant of, and sensitive to, the environmental, social, cultural, and political contexts within which it takes place.
- Principle 5: Be accountable and transparent. Companies engaged in responsible water policy are fully transparent and accountable for their role in a way that ensures alignment with sustainable water management and promotes trust among stakeholders.

C. Water Risk Tools

Tools considered are indicated in Figure 377 according to the categories outlined.

- Company targeted tools for water accounting
    - Water Footprint Network
    - Water GAP
- Company targeted tools for water risk disclosure
    - Global Reporting Initiative
- Company targeted water risk filters
    - World Business Council for Sustainable Development Global Water Tool
    - Veolia Water Impact Index
    - RepRisk
    - Global Environmental Management Initiative (GEMI) Collecting the Drops: A water sustainability planner
    - Global Environmental Management Initiative (GEMI) Connecting the Drops: A water sustainability tool
    - ASPIRE
    - CERES Aqua Gauge
- Financial Institution targeted disclosure tools
    - Carbon Disclosure Project (CDP): Water Disclosure
- Financial Institution targeted risk filters
    - WRI Water Index/Aqueduct
    - WWF-DEG Water Risk Filter
- Basin/Country level water risk tools
    - United Nations System of Environmental-Economic Accounting for Water (SEEA-W)
    - Veolia Growing Blue
    - WRG 2030 Water Supply and Demand Cost Curves

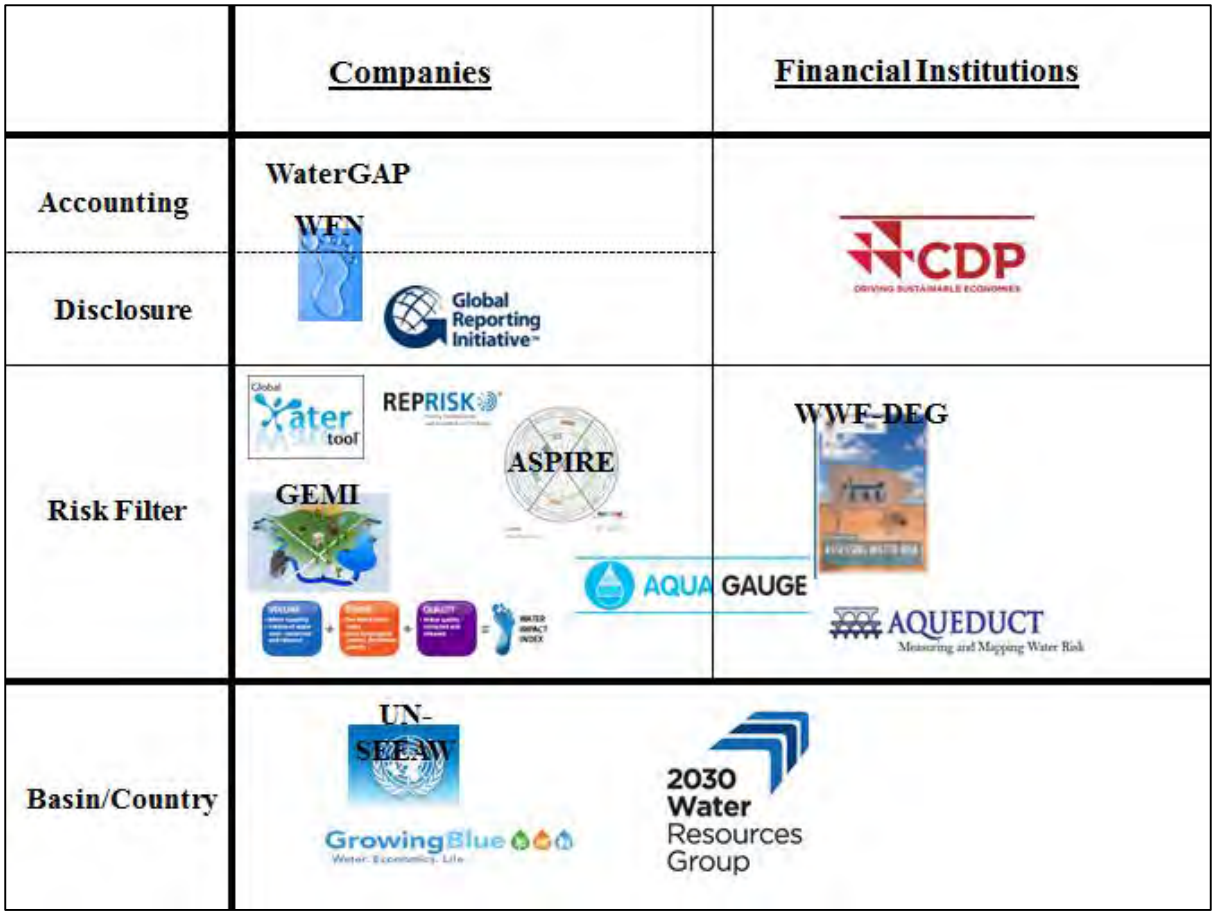


Figure 37: Water risk tools

The basis of water accounting is to understand the abstraction and discharge of an entity within a catchment. The most used tool for water accounting is that of the Water Footprint Network (Hoekstra et al., 2011). The information gathered through foot printing cannot be used to support corporate image alone. Action, following a deeper understanding of the companies' relationship with water, to manage water use, is the true measure of the footprints importance (Jeswani and Azapagic, 2011; Wharton, 2011). Water accounting tools may also be used for investor disclosure purposes. Organisations driving disclosure include the Global Reporting Initiative (GRI; n.d.) and The Carbon Disclosure Project (CDP), a UK-based, non-profit organisation, launched a new investor-driven water disclosure initiative in 2009. Companies are sent questionnaires, requesting disclosure of water use and discharge metrics. Exposure to both operational and supply chain risks is characterised. This effort is being supported by a number of European financial institutions (Jensen and Namazie, 2007; Pegram, 2010; Orr et al., 2011). Collective and sector-specific water risks, impacts, opportunities and management performance is gained through the completion of the water risk survey by companies (Barton, 2010; CDP South Africa, 2012).

Building onto water accounting, information gathered may be contextualised within the location of the study or company. This layer of complexity enables a filtering of risk whereby 'hotspots' can be

identified according to the level of risk present. Risk filters targeted towards companies include the World Business Council Global Water Tool and the Veolia Water Impact Index. These tools use water accounting, overlaid with the company and catchment contexts to understand different risk profiles. Tools in this category may also include planning frameworks which help companies build water management strategies to reduce water risk. GEMI Connecting the Drops (GEMI, n.d.a), GEMI Collecting the Drops (GEMI, n.d.b.) and GEMI Local Water Tool (GEMI, n.d.c) are such tools. The most widely used water risk tools include the WWF-DEG Water Risk Filter (Orr et al., 2011) and the WRI Aqueduct tool (Reig et al., 2013; WRI, n.d.). Both of these tools are continuously being improved on and widened in scope. They are used by financial institutions and by corporate companies, contributing important catchment or country level information.

The final category of tools has been developed for use at a national or company scale specifically. These include the UN System of Environmental – Economic Accounting for Water (UN SEEAW; UN DESA, 2012), The Veolia Growing Blue Tool (Growing Blue, 2013) and the Water Resources Group (WRG) 2030 cost curves (WRG 2030; 2009). The WRG 2030 cost curves are introduced in "Charting our Water Future" (2009). The report is sponsored, written and supported by a group of private sector companies and institutions which have recognised the economic threat water scarcity may present (WRG 2030, 2009). The curves have been criticised for their economics and infrastructure-centred view of water resources management without considering the social or environment sufficiently, lack of transparency and proprietary clauses (Hepworth, 2012; Newborne and Mason, 2012; Mason, 2013).

D. Risk Identification Interview frameworks

Pegram (2010)

Pegram (2010) indicated how most companies begin to engage with water-related risks through the following process:

1) Attempt to understand and quantify the nature of the water risk being faced. It is important to note that risks are not static, and this responses need to be adaptive to changing risk climates.
2) Focus of where response is required depends on the nature of the risk. Agro-processing companies may be more concerned with their water usage within the supply chain, while the mining sector may be more concerned with their in-house operations.
3) Companies may decide to engage on a number of levels. These include internal company processes and supply decision through to local or catchment governance, national or even global policy discourse.
4) An increasing number of companies have begun to mainstream water risks into their corporate operational risk mitigation strategy through operational budget funding. This marks a shift from the previous corporate social responsibility focus water played in a business.
5) Political, institutional and social conditions between developed and developing countries heavily impact the risks companies are exposed to. As a result, companies tend to respond differently. Developing countries are characterised by environmental reputation and regulatory negotiation while developing country risk management tends to require social and institutional interventions.

Morrison et al. (2009)

Morrison et al. (2009) identify a number of steps company executives and directors should take in order to better understand water risks. To evaluate and effectively address water risks, companies should take the following actions:

1. Measure the company's water footprint (i.e. water use and wastewater discharge) throughout its entire value chain, including suppliers and product use.
2. Assess physical, regulatory and reputational risks associated with its water footprint, and seek to align the evaluation with the company's energy and climate risk assessments.
3. Integrate water issues into strategic business planning and governance structures.
4. Engage key stakeholders (for example, local communities, non-governmental organizations, government bodies, suppliers, and employees) as part of a water risk assessment, long-term planning and implementation activities.
5. Disclose and communicate water performance and associated risks.

Similarly, investors should pursue the following steps to better understand potential water-related exposure in their portfolio companies:

1. Independently assess companies' water risk exposure.
2. Demand more meaningful corporate water disclosure.
3. Encourage companies to incorporate water issues into their climate change strategies.
4. Emphasise the business opportunity side of the water challenge.

Morrison and Gleick (2004)

Framework developed in Morrison and Gleick: Freshwater Resources – Managing Risks Facing the Private Sector outlines the ten key components of water risk management:

1. Measure Current Water Use.
2. Assess Water Landscape and Water Risks
3. Consult and Engage Stakeholders.
4. Engage the Supply Chain.
5. Establish a water policy and set corollary goals and targets.
6. Implement best available technology.
7. Factor water risk into relevant business decisions.
8. Measure and report performance.
9. Form strategic partnerships.
10. Commit to continuous improvement.

E. Interview data summary and adaptive theory process

Questions outline

The following table is an outline of the questions asked per topic or risk form. Questions were open ended where appropriate to ensure interviewees shared their own insights. The questions were based on a range of water risk assessment tools including the WWF Water Risk Filter (WWF and DEG, n.d. and Orr et al., 2009), WRI Aquduct Tool (Reig et al., 2013) and the CDP Water Questionnaire (CDP, 2011; CDP, 2012).

Type	Question number	Question outline
Governance	1	Do you have a water policy, strategy or management plan?
	2	What is the highest level of responsibility for water policy, strategy or plan?
	3	How often are there discussions of water with top management
	4	Contingency planning to respond to water risks
	5	Water related actions as operations to improve efficiency
	6	Investments related to water

	7	Annual Report mentions sustainability/water
Physical	8	Water stressed region?
	9	Inputs from water stressed region?
	10	Importance of water for operations
	11	History of water problems?
	12	Flexibility to change water supply?
	13	Flexibility to change inputs?
	14	Quality concerns?
	15	Physical concerns?
Regulatory	16	Discharge compliance?
	17	History of regulatory penalties or fees?
	18	Future regulatory changes?
	19	Strong enforcements of current regulations?
	20	Strong concern over HACCP or SANS type regulations
	21	Other industry regulatory bodies (i.e. Woolworths?)
Reputational	22	Exposure to media (positive or negative)
	23	Knowledge of other stakeholders in catchment
	24	Importance of consumer relative to other users
	25	Engagement with other stakeholders in catchment?
	26	Active forum engaging all stakeholders?
	27	Involvement in water disputes with other stakeholders
	28	Media - sustainability mentioned in website
	29	Media - water mentioned in website

Response summary with scoring on the Lickert Scale (very high, high, average, low, very low):

The following figures indicate the scores given to respondents per topic or risk form. Although this method is not statistically significant, the graphics help to identify significantly different responses (i.e. very high risk or very low risk relative to others).

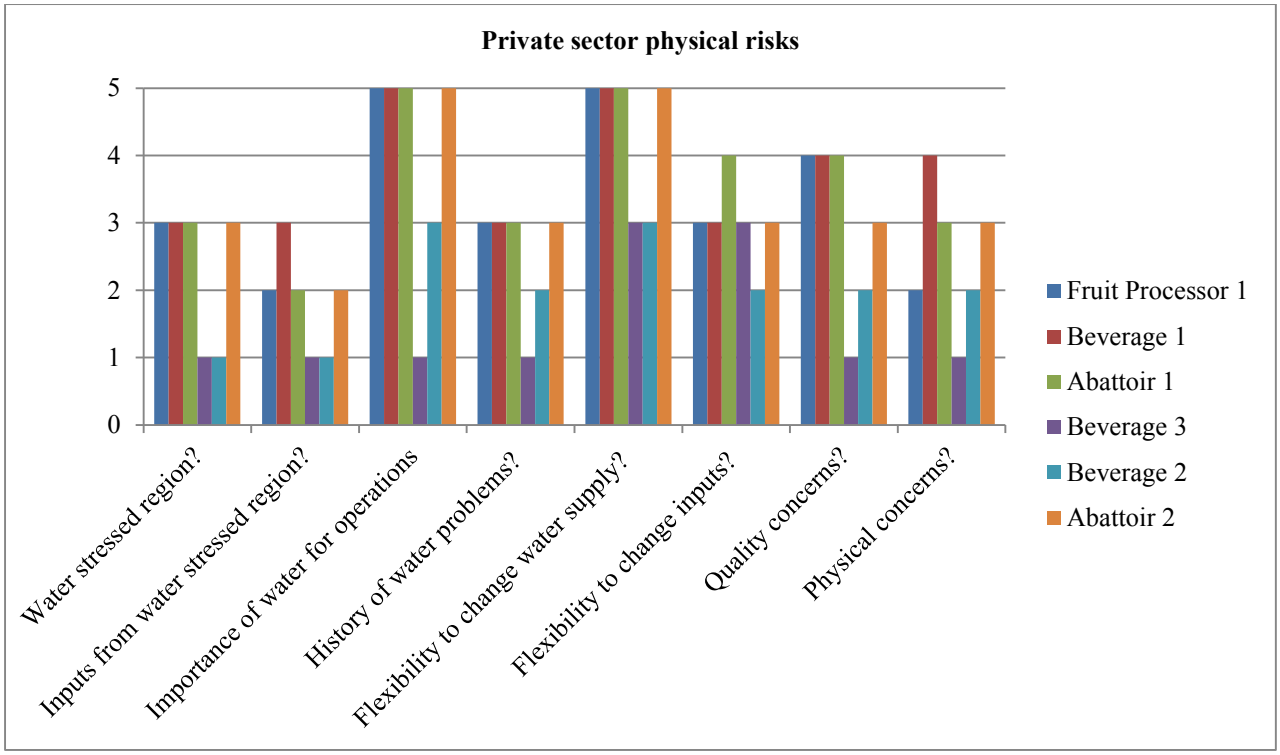


Figure 38: Private sector physical risks response summary

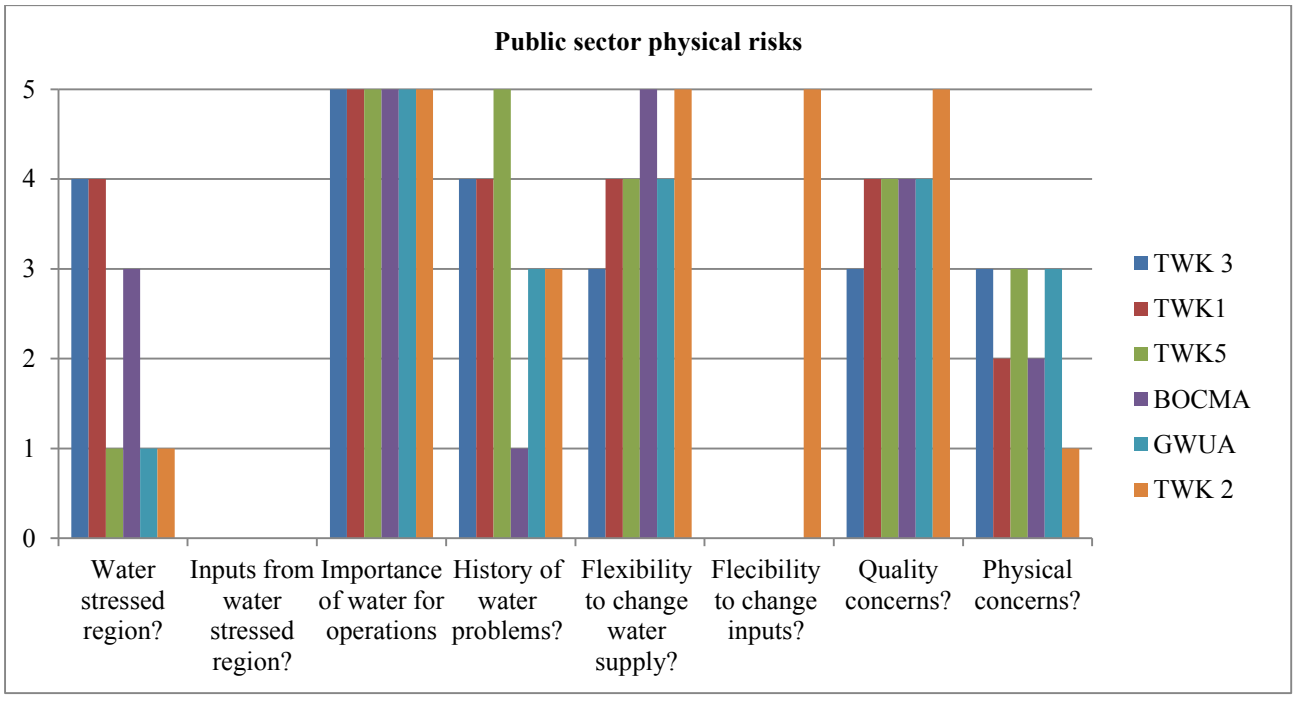


Figure 39: Public sector physical risks response summary

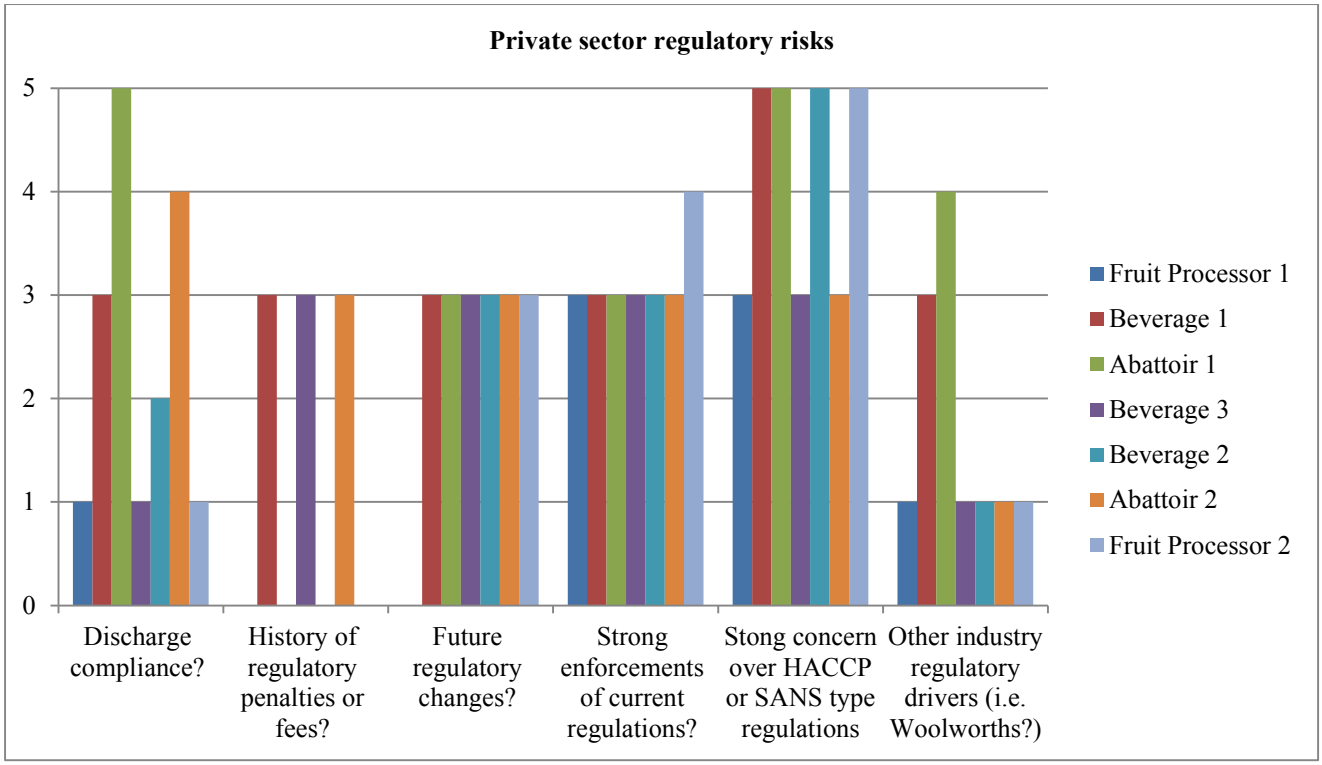


Figure 40: Private sector regulatory risks response summary

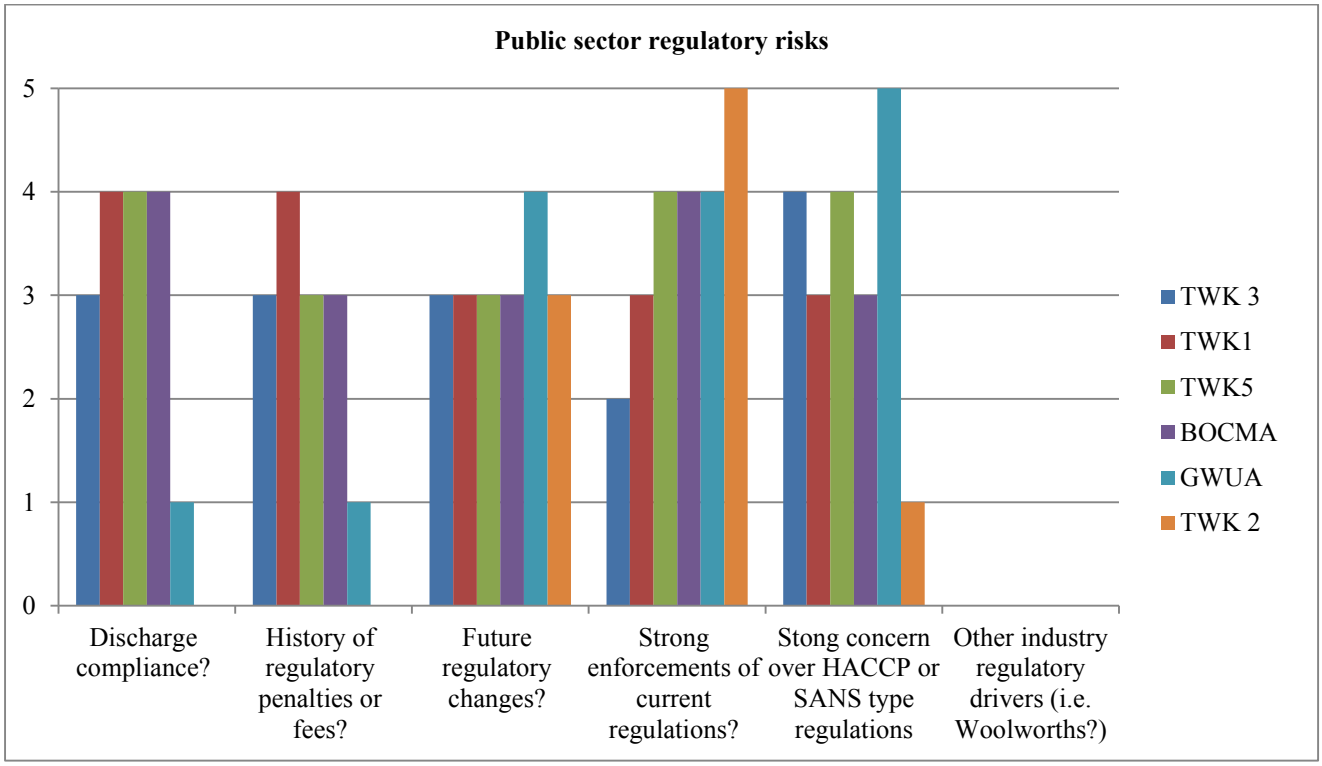


Figure 41: Public sector regulatory risks response summary

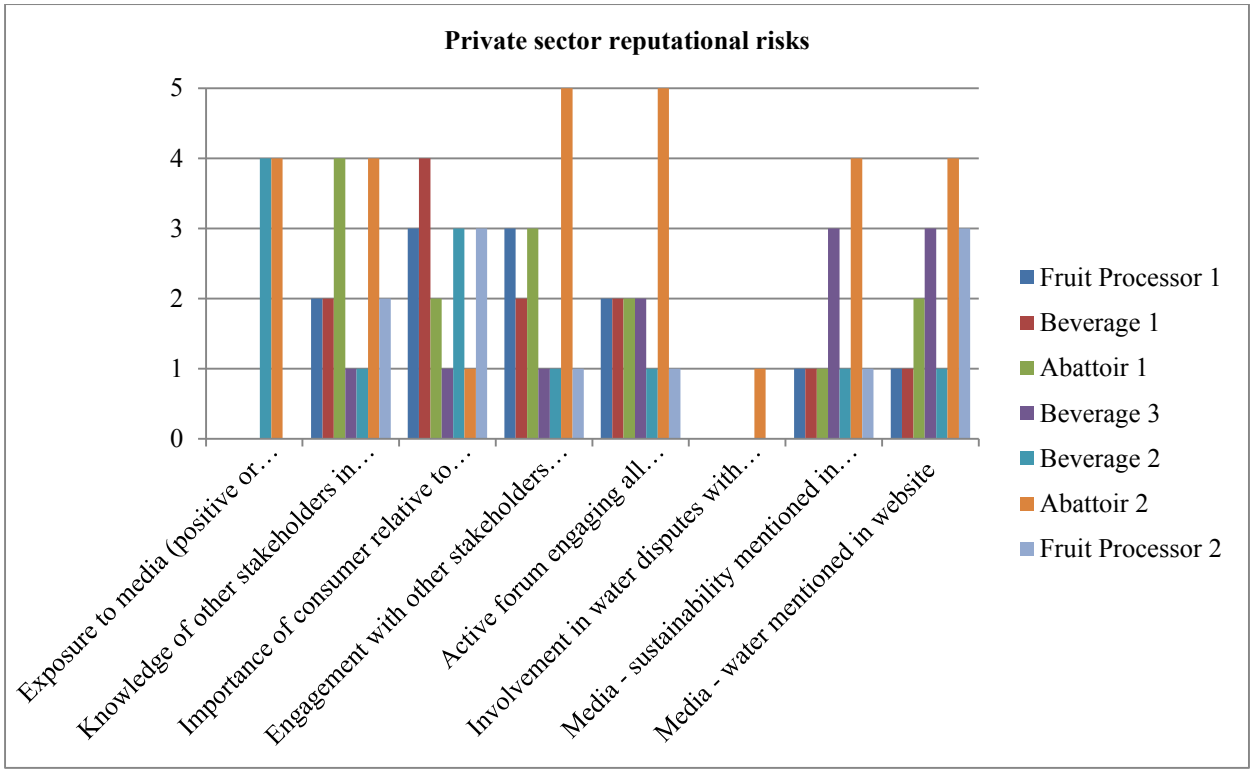


Figure 42: Private sector reputational risks response summary

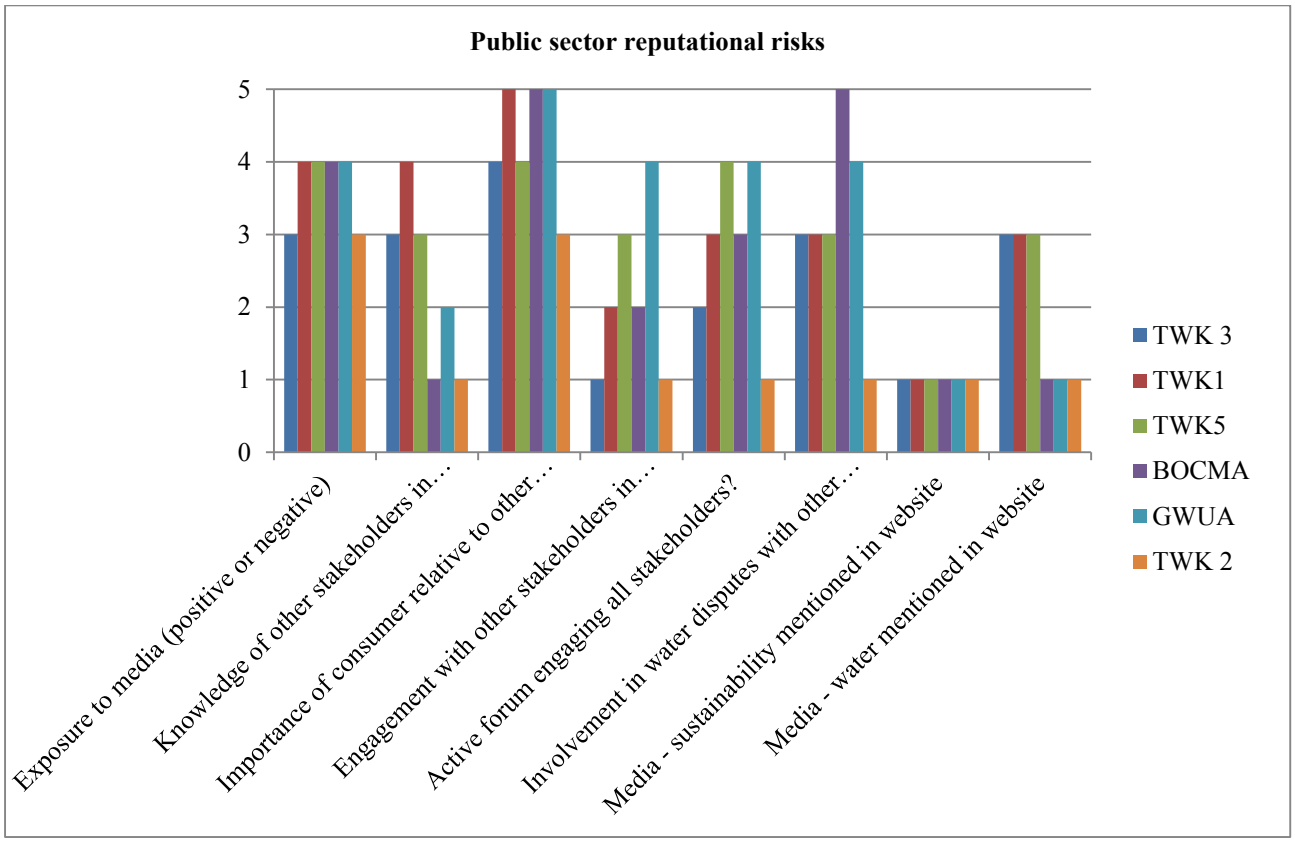


Figure 43: Public sector reputational risks response summary

Adaptive Theory Process Overview

The following appendix gives an overview of the adaptive theory process. Interview responses indicated in the previous appendix were collated in order to identify similar phrases or terms regarding water risk concerns. Significant differences were also collected.

PART ONE
Collecting key words from interviews

Ordering of responses:
Private:
FP 1
Beverage 1
Abattoir 1
Beverage 3
Beverage 2
Abattoir 2
FP 2

Public
TWK 3
TWK 1
TWK 4
BOCMA
TWK 2
GWUA

Physical Risk

Water stressed region?

Private

- No, but anticipate problems in the future
- No, but anticipate issues
- Not quantity stressed, perhaps in some ways quality stressed (high alum in the water from municipality)
- No, never run out of water.
- No (vs. Hemel en Aarde Valley)
- No, but maybe in future. Some winters are dry, not as much snow as before.
- Not now, but may become one, especially with discussions with BOCMA re: water for Cape Town

Public

- Yes, not always physical, management too
- Yes, not physically, but infrastructural. Potential for water stress in future however.
- No
- Yes - if take into considerations CT
- No
- No

Inputs from water stressed region

Private

- not at the moment
- Sometimes
- Not really, but because farms, do not have security of municipality, and so may be at risk in the future.
- No

- No
- Not as bad as Karoo. Farmers always complain about rain - too much or too little. Golden mile between Caledon and Bredasdorp gets better rain than near Botrivier.
- No

Public

- n/a
- n/a
- n/a
- n/a
- n/a
- No

Importance of freshwater for operations

Private

- Vital
- Vital
- Vital
- Not important at all (very small amount)
- Not overly important (irrigable quality for farm, and cellar quality is important, but a very small amount comparatively)
- Vital
- Vital for pack house and refrigeration

Public

- Vital
- Vital
- Vital
- Vital
- Vital
- Vital

Operations water problems in past

Private

- quality problems with high cl in water – Eurepgap accreditation and dislike from consumers
- Yes, pipeline burst
- Once in a blue moon (1 case last year – quality bad) very close communication with municipality. Pressure also a problem as need a certain amount for machinery.
- No
- No (2 years)
- Yes, once a quarter.
- No
- Yes, but recent massive upgrades have been done. Should be stable for the next five years.

Public

- Yes, technical barriers. Not stressed in terms of bulk supply; nor are there quality problems. However, administrative issues and therefore don't meet Blue Drops.
- Yes
- No
- Yes, no critical
- none, anticipate in future

Flexibility to change suppliers

Private

- Water: not flexible as current main supplier is the only feasible option
- Water: not flexible as main supplier the only feasible one
- Water: some flexibility to change supplier (GWUA, municipality, borehole)
- Water: Eikenhof, borehole
- Not flexible
- Yes, i.e. borehole or rainwater harvesting. BUT – if Eikenhof is dry, likely the alternatives will be dry too

Public

- Some flexibility – Wesselsgat Dam or boreholes
- Wesselsgat = alternative supply, however, very small pipe and from same raw water source as Eikenhof.
- Slight – have two pipelines from Dam and Wesselsgat
- No
- Yes, Wesselsgat
- Not flexible

Flexibility to change suppliers: Inputs

Private

- owned by supplying stakeholders
- reasonably flexible
- Chickens: not flexible – five-year contract, and takes at least two years to develop a chicken farm. Wine: no reason to change.
- Flexibility to change main suppliers exists (grapes and apples)
- Can change, but will cost more
- Not flexible, have annual programmes.

Public

- n/a
- n/a
- n/a
- n/a
- Not flexible

Quality concern

Private

- Yes
- Own treatment – but critical for product
- Yes
- No
- From own dams in mountains
- Yes
- Eurepgap

Public

- Yes
- Large issue
- Yes, high FE requires high Alum
- Yes pollution through informal settlement and fertiliser and WWTW
- Large
- Huge, Eurepgap

Physical concern

Private

- Not as important
- High

- Pressure is important
- No
- Perhaps
- Yes
- Not as critical

Public

- Yes
- Not as important
- Infrastructure mainly
- Not as critical
- Medium
- Not a concern

Regulatory Risk

Discharge compliance

Private

- yes
- Yes, although have been problems
- No legal requirements at the moment. Would fail (17000/15000)
- Meets all standards
- Yes, have to.
- Legal requirements will be installed in the next five years
- Facility meets all requirements At times, problems in past

Public

- In Grabouw there have been process problems with low pH needing high amounts of alum. Unable to floc all of the alum out effectively. Change in SANS241 standards from high risk to low risk. Perceptions of risks have changed.
- Problems before, now compliant
- Others not complying with BOCMA requirements
- Yes
- n/a

Penalties or fees for discharge regulations

Private

- No
- Yes, discharge once
- No
- Yes, one small fine
- No
- Facility has been under investigation in the past.
- No

Public

- Yes
- Have not been regulating industrial effluent correctly. Only SAB paying for effluent in Caledon. Opportunity cost, as regardless of what companies put down pipes or pay, still have to treat it. Making companies pay a fine does not make the problem go away. Also, then have the expectancy to treat effectively if charge for service. First therefore get infrastructure in to deal with the problem.
- Yes
- Yes
- No
- n/a

Exposed to regulatory changes - planned or potential

Private

- no
- Yes, DWA quality compliance getting stricter
- Yes, changes in water effluent quality standards being discussed.
- Yes, depends on government's timing
- Yes, in the next five years.
- Yes

Public

- Yes, changes are being discussed
- Likely But who decides on price for example? GWUA? BOCMA? Not only regulatory change, but there is a lack of awareness of companies responsibilities.
- Yes
- Yes
- Yes
- yes, water rights may change in the next five years – i.e. CoCT taking water from GWUA - domestic>agri

Strong enforcement of regulations in area of operations

Private

- some irregular enforcement
- Irregular
- Irregular
- Irregular
- Irregular (John Roberts of DWA, can see everything somehow)
- Irregular
- Stronger enforcement planned in the next few years

Public

- Previously weak, however, recent development in integrated task team has improved water regulation etc.
- No, getting there.
- Yes
- Yes
- Yes
- strong in whole basin

Strong concern over HACCP or SANS type regulations

Private

- Yes
- VERY
- VERY
- Yes
- VERY
- Not as large a concern
- Yes, Eurepgap etc.
- Yes, good governance regulations

Public

- Yes
- Yes, all municipal actions regulated.
- Yes, although BOCMA act more as regulators.
- Yes, good governance.
- Risk management act.

- No

Supply to Woolworths - mentioned Woolworths regulations as a driver

Private

- No
- Yes
- Yes
- No
- No
- No
- No

Public

- No
- No
- n/a
- n/a
- n/a
- n/a

Reputational Risk

Exposure of facility to local/national media (criticizing or positive for water issue)

Private

- never
- never
- never
- never
- Positive exposure as the winery wastewater setup is one of the first sustainable solutions in the country.
- Frequently
- never

Public

- Occasionally positive and negative
- Frequent – reputation most critical risk
- Frequent
- A lot of media – one of only two CMAs in country.
- Yes – municipality always first
- occasionally – Grabouw WWT quality

Does facility know other key stakeholders?

Private

- yes
- Yes
- no
- Yes, all other key stakeholders
- Yes, especially downstream, as farmer informs PC of changes in water flow etc.
- Limited knowledge of other stakeholders
- yes

Public

- Yes, although communication not good with all.
- Yes, all. Note people ARE the municipality. Also note disjuncture WITHIN the municipality BETWEEN sectors.
- Somewhat

- Yes
- Yes
- Yes, all

Importance of facility as a consumer compared to other stakeholders

Private

- large user
- Major
- one of the many large
- one of the smallest users in terms of industry
- One of the many large users
- smaller users
- one of the many large

Public

- Major user, but not sure how large in comparison to other industries or farms
- One of the largest
- Important
- Critical to functioning of catchment
- Critical, second after environment
- major user (association)

Involvement in water disputes with other stakeholders

Private

- no disputes
- no
- no
- no
- no
- No, but have problems communicating
- no

Public

- Yes, continual. Not only the municipality. Often larger. I.e. - GWUA with DWA etc.
- Yes.
- Yes
- Yes
- Yes
- none (1 local on winter tariffs, and potential for dispute with DWA and CoCT with water payments)

Sustainability mentioned in website

Private

- Yes
- Yes
- Yes
- No
- Yes
- No website
- Yes

Public

- Yes - 2030
- Yes - 2030
- TWK 2030 plan
- Yes

- Yes
- No

Risk management and communication

Water policy, strategy or management plan

Private

- High level with no measurement targets
- High level
- High level
- No – always done just what is best
- Yes – Cape Nature Environmental Management Plan
- No
- Yes, environmental management plan

Public

- Yes: risk register
- Yes: risk register
- Yes: risk register
- Yes
- Yes: risk register
- Yes

Highest level of responsibility for water policy, strategy or plan

Private

- CEO, Board Directors
- CEO
- Technical manager and GM
- GM and Director daily discuss water
- Production Manager
- Plant manager
- CEO or board

Public

- Operational – technical manager.
- Strategic – council
- Risk Owners are the directors of each of the municipal services. Discussed at council and strategic committee meetings.
- Risk owner
- All
- All
- CEO and Board

Discussions of water with top management

Private

- Monthly
- Monthly, daily
- Monthly financial meeting - discuss water because it is a large portion of their costs.
- Water usage report daily to senior managers
- daily and weekly
- In summer, irrigation - daily and weekly. Wastewater – rarely – unless investment happening, or a problem.
- Once a quarter at board meetings
- Once per year

Public

- Monthly at task team meetings
- Monthly
- Monthly
- Daily
- Daily
- once per quarter

Contingency planning to respond to water risks

Private

- yes, high level
- Yes, reservoir etc.
- Food safety related contingency plans - what to do if the water supplies stops - required by regulation. not in a plan, but in terms of water source, can use Eikenhof or borehole or municipality
- Not yet, but planned - in response to required regulation. In theory, have enough water, but have a borehole as a backup plan.
- Planning some contingency measures
- high level for some scenarios

Public

- contingency planning to respond to water risks
- Ask technical management or look at the IDP for details
- There are a number of plans. Depends on what the risk is
- Yes, it is required by regulation
- Yes, but not sufficient (BOCMA)
- Yes, each person is the risk owner
- Yes, the business plan has measures (GWUA)

Water related actions as operations to improve efficiency

Private

- consumption and discharge metering
- Numerous
- Extensive abstraction and discharge monitoring of quantity, need for quality of effluent.
- extensive metering and efficiency measures
- Soil moisture irrigation. Metering. Check for measures within cellars.
- Planning water related actions – COD chemicals
- extensive – installed meters, put toilets in GIB water

Public

- ask Rose or see IDP
- Yes, including upgrade of WWTW, etc.
- continual
- n/a
- Yes; start with critical first
- extensive metering and quality monitoring

Investments related to water

Private

- yes, planned
- Numerous
- yes, significant investments planned
- Yes, significant investments planned – want to use effluent water in the boiler – but in the meantime continuous improvements made to the effluent dam.
- Yes, significant investments planned. Plans to make the one dam bigger, but unnecessary with the water saving measures with respect to irrigating on soil moisture.

- Minor investments – if extensive investments, will close down. Looking into water tanks for during water disruptions.
- Process of being implemented: sand filter instead of high chemical input etc.

Public

- Recent upgrading
- Upgrade of Grabouw WWTW
- yes
- Yes
- Yes; as required by TWK
- Yes, significant currently being implemented

Annual Report mentions sustainability/water

Private

- Yes
- Yes
- Yes
- Yes
- Yes
- No (N/A)
- Yes

Public

- Yes
- Yes
- Yes
- Yes
- Yes; TWK 2030
- Yes

Engagement with other stakeholders to manage water

Private

- yes, reactive engagement
- Yes
- Facility reactively engages with municipality when there is a problem.
- actively engaging on a multilevel platform (GWUA)
- Actively engaged with all stakeholders in a multi-lateral platform
- No
- yes, actively engaged on a multi-level platform

Public

- Yes – numerous for GWUA; integrated town renewal plan with local government and work groups with public and private sector
- Yes - Reactive
- Yes
- Small issues in contacting other businesses
- Yes, all, multi-level

Active forum engaging all stakeholders

Private

- yes, results achieved, but not all engaged
- Yes
- Forum exists, but not all stakeholders engaged.
- Forum exists, not all stakeholders are engaged
- Yes, forum exists, actively engaging all stakeholders (GWUA)

- No forum exists yet
- yes, all stakeholders actively manage

Public

- Yes, although perhaps not ALL
- Yes, however, large amount of mistrust between the private and public sector. Therefore not as good as it could be.
- Not at town level
- Yes
- Reactive
- Yes

PART TWO

Second level coding

The second level coding followed from the previous process, whereby common terms identified in the interviews were listed. In addition, significantly different terms were noted. These terms are listed in an effort to reduce the complexity gathered from the interviews, without losing the nuance of the private and public sector responses.

Physical Risk

Water stressed region?

Private

- No
- Anticipate problems in the future
- Quality not quantity
- Compared to others

Public

- 3 Yes, 3 No
- Yes = management, infrastructure lacking, CT demand

Inputs from water stressed region

Private

- NO
- Future
- Farmers more at risk

Public

- n/a

Importance of freshwater for operations

Private

- Vital
- No = compared to farmers
- No = not in processing, only cooling

Public

- Vital

Operations water problems in past

Private

- No and Yes
- Yes = quality, high CL – Eurepgap
- Yes = burst municipal pipeline
- Yes, but have upgraded, so no more in future (5 years)

Public

- Yes administration a problem

- Yes, infrastructure a problem
- Anticipate in future

Flexibility to change suppliers

Private

- Flexible for other sources, but doesn't matter. All same climate

Public

- Flexible for other sources, but doesn't matter. All same climate

Flexibility to change suppliers: Inputs

Private

- owned by supplying stakeholders
- reasonably flexible
- Chickens: not flexible – five-year contract, and takes at least two years to develop a chicken farm. Wine: no reason to change.
- Flexibility to change main suppliers exists (grapes and apples)
- Can change, but will cost more
- Not flexible, have annual programmes.

Public

- n/a

Quality concern

Private

- Yes, regulatory requirement. No if not in product.

Public

- Yes, FE, regulatory requirements

Physical concern

Private

- Not as important

Public

- Not as important, mainly due to infrastructure

<u>Regulatory Risk</u>

Discharge compliance

Private

- Legal requirement = compliance
- Not required yet = non compliance

Public

- Problems, but now compliant
- Others not compliant with municipal requirements, but municipality not enforcing

Penalties or fees for discharge regulations

Private

- 3 = yes, but all small
- 4 = no

Public

- Yes, but not enforcing well on others

Exposed to regulatory changes – planned or potential

Private

- Yes, public sector getting more organised

Public

- Yes, future

Strong enforcement of regulations in area of operations

Private

- Currently irregular

Public

- Was weak, now better

Strong concern over HACCP or SANS type regulations

Private

- Yes, very

Public

- Yes, everything regulated

Supply to Woolworths - mentioned Woolworths regulations as a driver

Private

- 2 = yes

Public

- n/a

<u>Reputational Risk</u>

Exposure of facility to local/national media (criticizing or positive for water issue)

Private

- 1 yes (negative)
- 1 yes (positive)

Public

- Frequent, largest risk.
- Always in news

Does facility know other key stakeholders?

Private

- No = municipal supply
- Rest = yes

Public

- Yes, although not good within municipality

Importance of facility as a consumer compared to other stakeholders

Private

- Various
- Not sure in comparison to others (1)

Public

- Major, but not sure in comparison to others (3)

Involvement in water disputes with other stakeholders

Private

- No

Public

- Yes, continual, various public sector "discussions"

Sustainability mentioned in website

Private

- 2 = no

- Yes = rest

Public

- GWUA = no
- Municipality and BOCMA = yes

Risk management and communication

Water policy, strategy or management plan

Private

- 3 = high level plan, 2 with measurement targets
- 2 = environmental management plan
- 2 = no

Public

- Yes, risk register, business plan, CMA

Highest level of responsibility for water policy, strategy or plan

Private

- Various: CEO, Board Directors, GM, technical manager, plant manager, production manager

Public

- Various: Strategic = council; Operational = technical manager.
- ALL = risk owners
- GWUA = CEO/Board

Discussions of water with top management

Private

- Various: daily, monthly, quarterly, yearly – depends on level
- Only when problem arises (wastewater)

Public

- Various: Monthly, daily, quarterly – depends on level

Contingency planning to respond to water risks

Private

- Yes, mostly being planned in response to future regulations, so currently not sufficient

Public

- Yes, various. Some don't see it as sufficient

Water related actions as operations to improve efficiency

Private

- Consumption and discharge metering; quality of product water; effluent less common, only where strictly regulated

Public

- Yes, start with most important first, adequate infrastructure, and then move onto efficiency etc.

Investments related to water

Private

- Yes, mostly planned in response to more regulation

Public

- Yes, most recent in response to regulatory requirements. Otherwise on-going.

Annual Report mentions sustainability/water

Private

- 1 = no

Public

- Yes

Engagement with other stakeholders to manage water

Private

- Yes, except for within municipality.
- Municipal = reactive

Public

- Yes
- Within municipality lacking

Active forum engaging all stakeholders

Private

- Yes. Results are achieved, but not ALL engaged.

Public

- Yes, but not as well as it could be. Especially within the municipality

PART THREE

The third phase of the adaptive theory process was to consult theoretical frameworks on this topic, and to identify how the empirical data gathered through the interviews, and summarised in part two, may be a useful development from the theoretical frameworks already in existence. In accordance with the distinction between physical, regulatory and reputational risks, these are indicated in separate figures. The inner ring indicates responses which are primary risk factors, while the outer ring includes drivers or secondary risk factors of relevance.

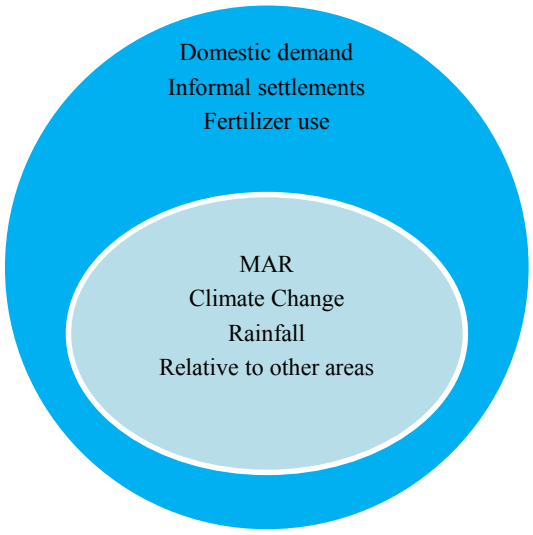


Figure 44: Physical water risk elements and drivers collated from the interviews

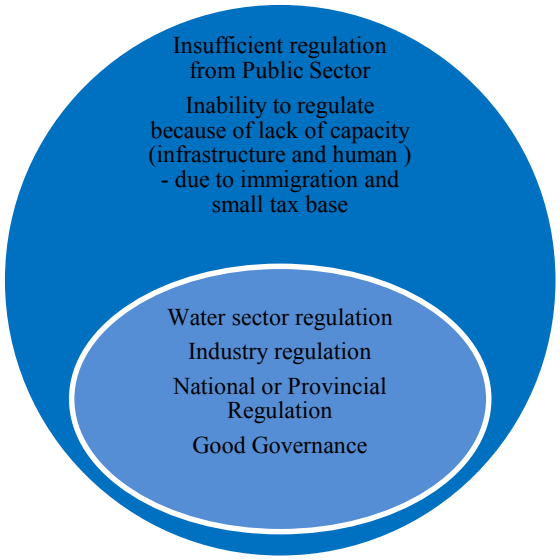


Figure 45: Regulatory water risk elements and drivers collated from the interviews

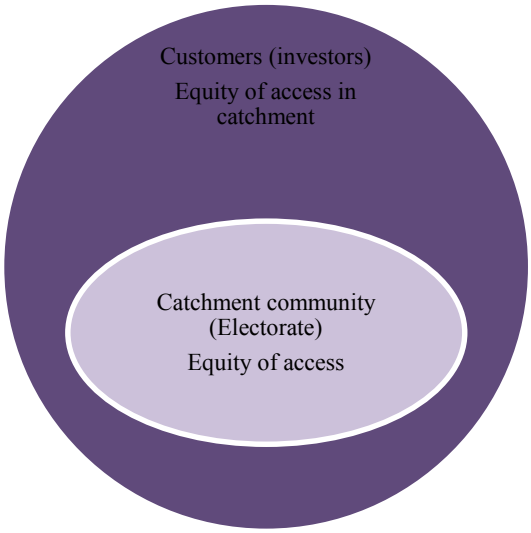
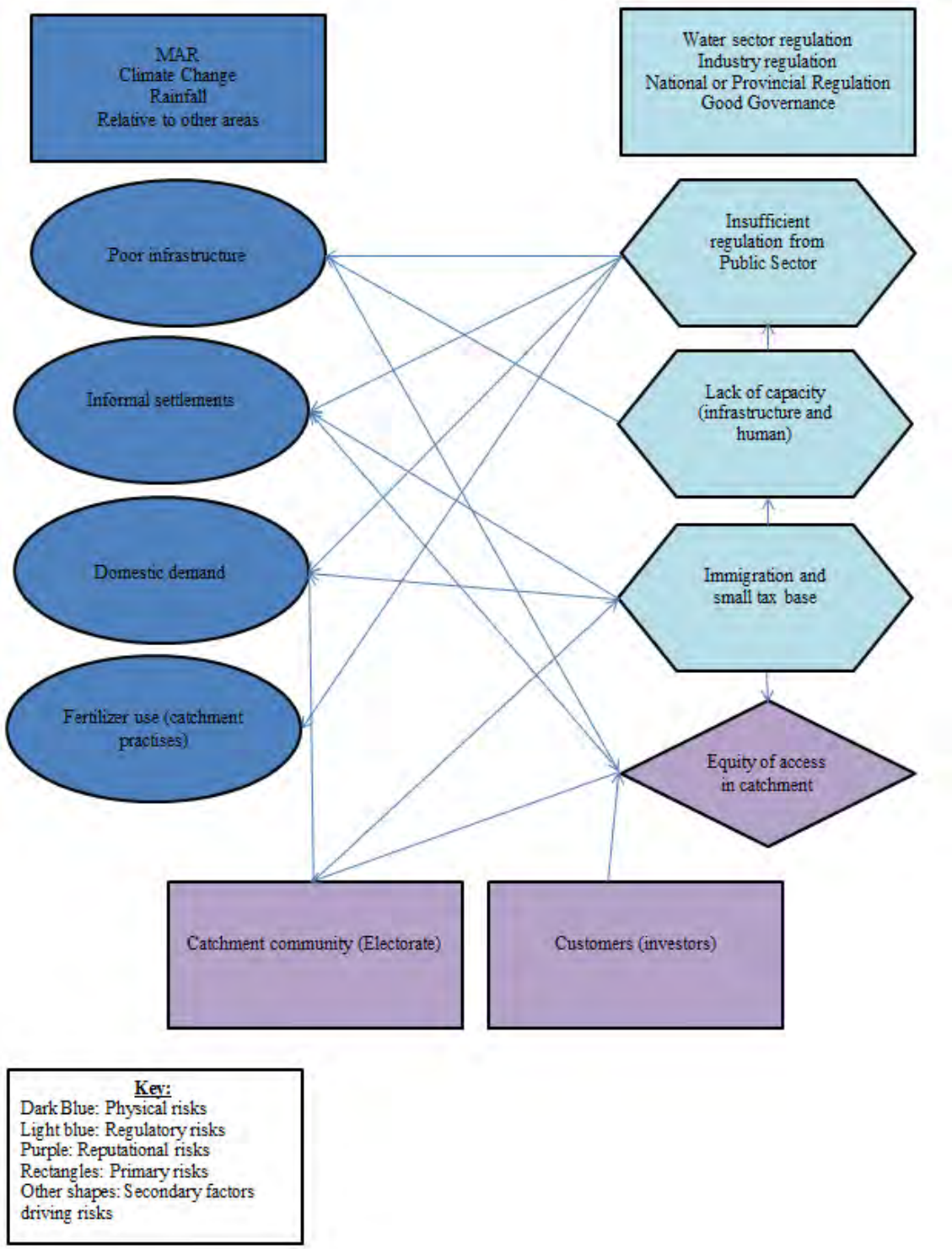


Figure 46: Reputational water risk elements and drivers collated from the interviews

PART FOUR

Part four of the adaptive theory process indicates the linking of risks and their different factors. The intention of the method was to further investigate the root causes of particular risks, and to identify risks which have the same, or similar root causes between the private and public sector.



F. Interview respondents

Public Sector:

Theewaterskloof Local Municipality:

- Director
- Management Office Representative
- Corporate Representative
- Town Manager
- Technical Officer

Breede – Overberg Catchment Management Agency:

- Executive
- Water manager
- Water specialist
- Relations Manager

Water Users Association:

- Executive
- Committee Member 1 (farmer)
- Committee Member 2 (farmer)
- Attendance of a number of the WUA AGM's and quarterly meetings where ad hoc meetings were held with additional different GWUA committee representatives

Private Sector (within case study region):

Beverage 1

- Project Manager
- Data Manager

Beverage 2

- Production manager

Beverage 3

- Production Manager

Abattoir 1

- General Manager
- Technical manager

Abattoir 2

- General Manager

Fruit processing 1

- Engineering Manager

Fruit processing 2

- Engineering Manager

Private Sector (outside case study region):

Beverage 4

- Director
- Hops Breeder

Beverage 5

- Director

Fabric care 1 (

- Numerous

Fruit processing 3

- Manager
- Engineer

Fruit processing 4

- Director

Energy 1

- Advisor

Mining 1

- Manager

Consulting engineers 1

- Engineer

Consulting engineers 2

- Engineer

Public Sector (outside of case study region):

Local Municipality 1 (George)

- Director

Local Municipality 2 (Mossel Bay)

- Manager

Cape Town Metropolitan Municipality:

- Numerous

Other stakeholders and interested parties (within case study region):

Eskom: Palmiet Pumped Storage Scheme

- Manager

Other stakeholders and interested parties (outside case study region):

G. Palmiet River Catchment water quality changes

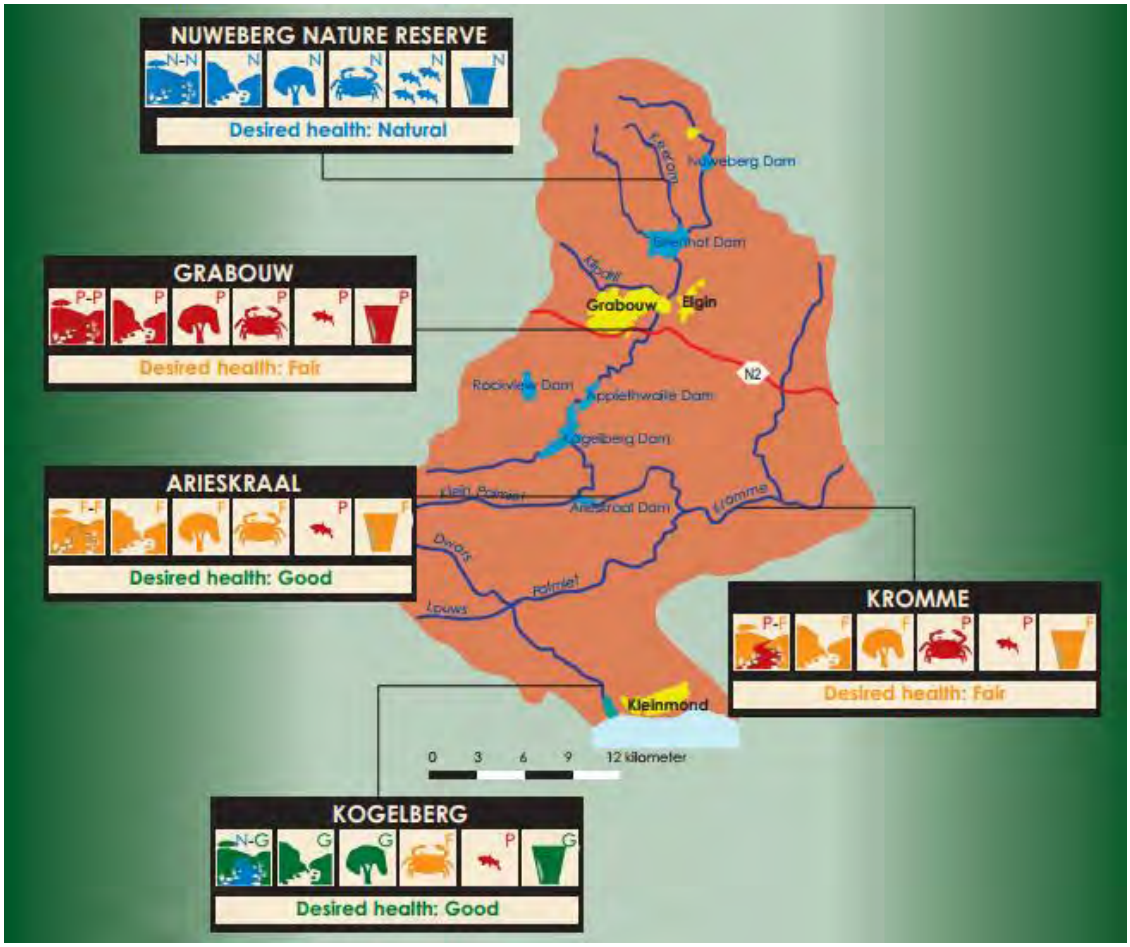


Figure 47: Palmiet catchment quality changes (River Health Program, 2003)

H. Theewaterskloof Risk Register Extracts

The following table illustrates the particular water risks in the Theewaterskloof Local Municipality risk register, and how these impact the ability of the municipality in meeting particular Integrated Development Plan (IDP) Objectives and Key Performance Areas (KPA).

Integrated Development Plan (IDP)	IDP Objectives / SDBIP	Risk Description
3.5.2 KPA: financial viability and management	(LED)Strategic objective 6	Influx of Unemployed, skilled and Homeless people
3.5.5 KPA: good governance	(GG)Strategic objective 8	Cost of Regulation and Compliance Requirements
3.5.2KPA: financial viability and management	(FV)Strategic Objective 5	Slow or No Recovery of Potential Revenue
3.5.2 KPA: financial viability and management	(FV)Strategic Objective 5	Lack of Accurate Data/(Accuracy of Bill)
3.5.2 KPA: financial viability and management	(FV)Strategic Objective 5	Incorrect Budgeting (Activity Based Costing / Zero Based Budgeting)
3.5.4 KPA: municipal transformation and organisational development	(MTOD)Strategic objective 7	Managing Talent (Recruiting and Retaining staff)
3.5.5 KPA: good governance	(MTOD)Strategic objective 7	Potential Low or No Productivity
3.5.5 KPA: good governance	(GG) Strategic objective 9	Out-dated Bylaws and Corporate Policies
3.5.4 KPA: municipal transformation and organisational development	(MTOD)Strategic objective 7	No Available High Level Expertise (Can existing staff take TWK to the next level)
3.5.3 KPA: local economic development	(LED)Strategic objective 6	Influx of unemployment, unskilled and homeless people
3.5.3 KPA: local economic development	(LED)Strategic objective 6	Poor or No Economic Competitiveness
3.5.1 KPA: service delivery and human settlements	(SD)Strategic objective 1	Backlog in Infrastructure
3.5.1 KPA: service delivery and human settlements	(SD)Strategic objective 1	Disasters (Floods / Fires)
3.5.1 KPA: service delivery and human settlements	(FV)Strategic Objective 5	Distribution losses
3.5.1 KPA: service delivery and human settlements	(SD)Strategic objective 4	Excessive Expectations in relation to Institutional capacity
3.5.5 KPA: good governance	(GG)Strategic objective 8	Red Tape (External in context of provincial Departments)
3.5.5 KPA: good governance	(GG)Strategic objective 8	Resolutions not Implemented
3.5.4 KPA: municipal transformation and organisational development	(MTOD)Strategic objective 7	Improper or No Project Management
3.5.5 KPA: good governance	(GG) Strategic objective 8	Crises that TWK step in a reactive mode
3.5.4 KPA: municipal transformation and organisational development	(GG)Strategic objective 8	Poor or No Interdepartmental Relations

I. Building the conceptual framework: complexity thinking and enterprise risk management

The following elements were used in building the shared water risk conceptual framework. Case studies of corporate interest in water resources management, whether through collective action or water risk data disclosure are used to support or illustrate the particular concept used.

Complexity thinking

Each stage in the development of the conceptual framework is grounded in different sources of literature. In the first step of the conceptual framework building process, the full variety of risks facing the private and public sector use complexity theory literature, where uncertainties, nonlinearities and unpredictable aspects of a system are embraced (Goulding, 2005; Westley et al., 2006; Anfara and Mertz, 2006). The risks facing the sector in the wider context of the environment were considered (Gharajedaghi, 2011). The importance of systems thinking is taken from the following quote by Senge, in Dent (2010), "We cannot know what it is to be human by looking at a list of body parts and their functions. When it comes to organ-isations rather than organ-isms, our systems thinking often lets us down." This is the case in water too, where the sector is made up of a number of composite elements, all of which are related (Mollinga, 2008), and need to be considered in full.

An example of where considering the full complexity of the system has supported the public and private sector in working together is the case of Anglo Thermal Coal in eMalahleni. Consideration of the entire catchment, and the different stakeholders within, was the solution to identify working together with the municipality. Anglo in the Olifants is also given as a case example.

1. Anglo Thermal Coal in eMalahleni Local Municipality

Anglo Thermal Coal set up a partnership together with neighbouring mines in the local municipality of eMalahleni, where the water from the mines is treated to an environmentally acceptable level (SWPN, 2012; Anglo American, n.d.a.). This is then transferred to the already water-stressed local municipality who treat the water to a potable standard. Analysis of the wider catchment, including other stakeholders was a necessary requirement. Previously the mines were focused only on trying to get rid of the 'problematic' water, without considering where it may actually be useful in the wider system (Anglo, water manager). Another important aspect of this case is that the mines are not responsible for treating the water to a potable level. Therefore, they are not taking over responsibility of the public sector mandate. Instead, the mine treats the water only to the regulated level required before discharge into the environment (Anglo, water manager). This is of importance with regards to regulatory risk and removing perceived corporate capture. The operation does not supply water to the municipality for free.

2. Anglo and the Olifants River Catchment

Anglo has been involved at a basin level in the Olifants River Catchment, Limpopo Province. The catchment is home to all three of the company's commodity business units: Kumba Iron Ore, Anglo American Thermal Coal and Anglo American Platinum (Greenwood et al., 2012). Other businesses in the region were contacted when it was realised that water constrained future growth and social development in the catchment. It was recognised that all of the catchment was facing water security concerns, and not Anglo alone (Anglo American, n.d.b.). The Olifants Water Resources Strategy Forum was set up by the stakeholders within the catchment in order to discuss their water risk concerns under a non-threatening and non-binding environment (Anglo, water manager). The sharing of information and communication with other stakeholders enabled the parties to "get on the same page" in order to move towards a common water secure goal (Greenwood et al., 2012). Through the forum, the more formalised and legally binding Lebalelo Water Users Association was set up to ensure water is appropriately managed in close collaboration with the DWA. Fifty % of the project is funded through the DWA, while the second half is sourced from businesses in the region. Fifty % of the water allocation is apportioned to industry, while the second half is for surrounding communities in the catchment for domestic use (Greenwood et al., 2012). The collaboration was made possible by first having an informal forum where stakeholders could get together and discuss before signing any contractual agreements (Anglo, water manager).

In the case study, the complexity of the catchment is indicated through a number of ways. Firstly, the range of different institutions involved in water management may be difficult to navigate. The complex separation of water resources and water services into separate institutions is mentioned in the Water for Growth and Development Framework as a potential risk (DWA, 2009). The range of concerns and opinions throughout the catchment regarding water is an additional indicator of the complexity. Also, the systemic manner in which the small tax base and growing population have put pressure on the management of the municipal infrastructure causing the water and wastewater treatment facilities to become over capacitated. This has in turn caused concerns about water quality for the catchment as a whole, especially for those companies where potentially polluted water is being used on fruit for export or in their product. An additional factor is that due to the poor human resources capacity at the municipality, they are unable to enforce industrial effluent requirements and are as a result, treating effluent with very high loading.

In order to simplify the complexity, it is valuable to know the actual volumes of water used at each point of the process or step within the chain. This is highlighted through the large amount of work SABMiller have done in water footprinting in order to first measure before being able to manage water security concerns.

3. *SABMiller and Water Footprinting*

SABMiller recognise business planning and decision-making areas informed through a water footprint analysis. They use technical data from water footprinting analyses to inform the documentation and quantification of water risks in their business (SAB and WWF, 2009). First, a water footprint analysis indicates the amount and location of water use, giving an overview of water use in the value chain. Second, a footprint may provide strategic information in order to assess physical, reputational and regulatory water risks. The assessment of these risks may inform operations and supply chain business models. Lastly, a footprint analysis contributes a knowledge set which equips managers with information to engage outside of their factory fence. The information may support the establishment of partnerships "to address problems outside of SABMiller's breweries that are likely ultimately to provide benefits for its operations" (SAB and WWF, 2009). Understanding the status quo through footprinting has introduced various technological and managerial interventions to improve efficiencies to reduce their water footprint (SAB and WWF, 2009; Morrison and Schulte, 2009; The Coca-Cola Company and the Nature Conservancy, 2010; Hoekstra et al., 2011).

Another useful step in the effort to understand the complexity is to identify all of the different water institutions. Water resources are managed, at different scales and through different particular functions between the DWA, BOCMA and GWUA. Identifying and acknowledging the boundaries and linkages between these institutions is helpful to identify different risk scales. From the water services perspective, the Theewaterskloof Local Municipality are responsible. The identification of the risks helps to identify that Theewaterskloof has exactly the same water source as GWAU (Eikenhof Dam), yet those supplied by each institution have different perspectives on what their water risks are.

Enterprise Risk Management (ERM) and scale

Risks may manifest at different scales. Morrison et al. (2010) and Orr et al. (2011) introduce the concept of company risk distinct to that of the catchment risk, while the identification of the actual water risks embedded in the wider context mirrors the concept of ERM (AIRMIC, ALARM, IRM; 2010). A similar figure to that of the conceptual framework indicating water risks embedded within the wider context can be found in the Theewaterskloof Risk Framework, which is also based on ERM (TWK Risk Policy, 2011). Consideration of the wider context in which risks exist includes the institutional factors, and not physical context alone. This is supported by Merrey and Cook (2012), who identify knowledge of the institutional relationships, as one of the largest knowledge gaps in water resources management. Hence the case study analysis investigates hydrology as well as administrative scales by considering physical as well as regulatory and reputational risks.

An example of where the wider and longer-term strategic risks were considered alongside operational risks is that of Sasol in Emfuleni. Instead of investing heavily in operational level water efficiency measures, Sasol identified far larger water savings that could be made through optimising local municipality reticulation. Through a strategic and catchment-wide view of risk, a solution to water stress was found though public and private sector partnership.

4. Sasol and Emfuleni Municipality

Sasol have been involved with the Emfuleni Municipality, South Africa, co-funding and partnering with the local municipality and GIZ in an attempt to save unaccounted for water losses through the municipal infrastructure (Greenwood et al., 2012, Sasol, 2013). Sasol is a large water user in the Vaal River Catchment (4 %). They recognised that the catchment is stressed and wanted to reduce their demand for water. However, efficiency savings made in their facilities was expensive. Instead, they recognised that the Emfuleni Municipality had up to 40 % unaccounted for water through leakage. The savings made on water demand by fixing the leaks were more cost effective than those made by optimising Sasol processing plants. The core requirement in this form of engagement included a capacitated local municipality (Sasol, water manager). In addition, the process had a defined contract indicating exactly how it was to be managed. Strict timelines and financial ring-fencing made the intervention less risky from the private sector perspective. The project was not done on a philanthropic basis, but with a definite business case recognising the opportunity costs of efficiency savings in the local municipality reticulation compared to Sasol processing plants (SWPN, 2012). Another element in this collaboration was the involvement from a third party funder (GIZ) (Sasol, 2013).

Linking the scales of risk in a similar manner to that of the Enterprise Risk Management Framework is useful in this risk framework. This is because the local municipality actively use the ERM framework, making it simpler to communicate the different levels and scales water risks manifest, and the relation to the private sector. Differentiating between operational risks (physical water risks) and longer-term strategic risks (reputation risks) is also useful for the private sector representatives. Agro-processing facilities all acknowledge risks that they are facing in the short term (i.e. Abattoir 1 pressure concerns or FP 1 water quality concerns). In anticipation they are making measures to mitigate the future risks (i.e. the anticipated regulatory changes, or increased demand from CT). By using a common framework, it may be simpler for each sector to understand each other. Therefore, the linking of risks to the different scales, similar to that of ERM is helpful in improving the understanding and communication of the risks.

A catalyst

Some form of catalyst is required which allows the realisation that the private and public sector are unable to mitigate water risks alone. This is evident through the case study of Nestlé in the Southern Cape.

5. Nestlé and the Southern Cape

The Southern Cape, where there has been a drought, has indicated a level of 'sharing' in risk mitigation responses. Nestlé have illustrated engagement at an operations and supply chain level in Mossel Bay in the Southern Cape following a drought in 2008 - 2010. A driver of their intervention was the drought, forcing higher efficiency measures (SIWI, 2012). Nestlé's municipal water consumption was reduced by 50 % through the implementation of a number of water saving techniques including a major investment into a milk condensate recovery and re-use process (SWPN, 2012; Nestlé Mossel Bay, plant manager). Data is needed to support the investments made for water saving. In addition to efficiency measures 'in-house' Nestlé gave support to the farmers in their supply chain too. Through redefinition of their value chains towards 'creating shared value', they are "acting as a steward for essential natural resources, driving economic and social development while improving the quality, quantity, cost and reliability of inputs and distribution" (Nestlé, 2011; Bockstette and Stamp, 2012; SWPN, 2012). This has been carried out at varying degrees relative to their "extent of risk, the reputation of the company, impact of operations and corporate resources available" (Pegram and Eaglin, 2011: 4). Education or efficiency measures within the factory fence were also implemented (Nestlé, 2011).