ENHANCING ECOLOGICAL INFRASTRUCTURE IN THE UMNGENI CATCHMENT THROUGH PRIVATE SECTOR ACTION AND ENGAGEMENT

Innovative roles for collective action, stewardship, better production, finance and investment.

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December 2015

RESEARCH AND POLICY DEVELOPMENT TO ADVANCE A GREEN ECONOMY IN SOUTH AFRICA

GREEN ECONOMY RESEARCH REPORTS

REPORT #

GREEN FUND: RESEARCH AND POLICY DEVELOPMENT TO ADVANCE A GREEN ECONOMY IN SOUTH AFRICA

GREEN ECONOMY RESEARCH REPORTS

The Government of South Africa, through the Department of Environmental Affairs, has set up the Green Fund to support the transition to a low-carbon, resource-efficient and pro-employment development path. The Green Fund supports green economy initiatives, including research, which could advance South Africa's green economy transition. In February 2013, the Green Fund released a request for proposals (RFP), '*Research and Policy Development to Advance a Green Economy in South Africa'*, inviting interested parties with relevant green economy research projects to apply for research funding support. The RFP sought to strengthen the science-policy interface on the green economy by providing an opportunity for researchers in the public and private sectors to conduct research which would support green economy policy and practice in South Africa. Sixteen research and policy development grants were awarded in 2013. This peer-reviewed research report series presents the findings and policy messages emerging from the research projects.

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This report should be referenced as: Colvin. C., Cartwright, A., McKenzie. M., Dent. M., Maherry, A., Mhlongo, T. 2015. Enhancing ecological infrastructure in the uMngeni catchment through private sector action and engagement. Green Fund Research Report.

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ACKNOWLEDGEMENTS

Groundtruth Pty. Ltd. are acknowledged for their assistance with spatial data analysis and map production.

The SANBI-led, sister project team are acknowledged for their collaboration during this research, in particular Dr John Dini and Professor Graham Jewitt.

The members of the Umgeni Ecological Infrastructure Partnership (UEIP) are acknowledged for their constructive engagement in the action research process, interviews, workshops and review of the research.

The Water Research Commission, in particular Bonani Madikizela, are thanked for their active participation and chairing the research steering committees within the UEIP.

Many individuals and representatives of organisations in the finance sector nationally and in the agricultural sector in KZN, voluntarily and confidentially engaged with the project team as part of the action research in this project. Their participation and constructive engagement is gratefully acknowledged. The following individuals are acknowledged for their contributions and/ or reviews: Greg Ko, Hendrik Pfaff, Helen Gordon, Tracey Cumming, Duncan Hay, Graham Jewitt, Ian Bredin, Dave Still, Richard Clacey, Steve Gillham and Pravitha Jairam, Barbara Schreiner, Jon Duncan, Dirk Visser, Heather Jackson, Sarah McPhail.

ABBREVIATIONS

ACIP	Accelerated Community Infrastructure Programme
BEE	Black Economic Empowerment
BEPP	Built Environment Performance Plan
CEBA	Community Ecosystems Based Adaptation
CMAs	Catchment Management Agencies
CMFs	Catchment Management Forums
CUC	Capital Unit Charge
CSI	Corporate Social Investment
CSIR	Council for Scientific and Industrial Research
DBSA	Development Bank of Southern Africa
DEA	Department of Environmental Affairs
DFIs	Development Finance Institutions
DUCT	Duzi-Umngeni Conservation Trust
DWS	Department of Water and Sanitation
EKZNWildlife	Ezemvelo KwaZulu-Natal Wildlife
EPWP	Expanded Public Works Programme
ESG	Environmental Social and Governance
FIBC	Future Infrastructure Build Charge (in 2015 Water Pricing Strategy)
FSC	Forestry Stewardship Council
GDP	Gross Domestic Product
GEEF	Green Energy Efficiency Fund
GEPF	Government Employees Pension Fund
GHG	Greenhouse Gas
IDC	Industrial Development Corporation
IFC	International Finance Corporation
IIMMS	Integrated Information Management and Modelling System
IPPs	Independent Power Producers
IWRM	Integrated Water Resource Management
KZN	KwaZulu-Natal
LUI	Land User Incentive Programme
MIGs	Municipal Infrastructure Grants
MMTS	Mooi-uMngeni Transfer Scheme
MTEF	Medium Term Expenditure Framework
MWIG	Municipal Water Infrastructure Grant
NEMA	National Environmental Management Act (Act No. 107 of 1998)
NWA	National Water Act (Act No. 36 of 1988)
NWRS	National Water Resources Strategy
PIC	Public Investment Corporation
PUCMA	Proto Pongola Umzimkulu Catchment Management Agency
RBIG	Regional Bulk Infrastructure Grant
RWIG	Regional Water Infrastructure Grant
ROA	Return on Assets
TCTA	Trans Caledon Tunnel Authority
SRI	Socially Responsible Investment
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
UEIP	uMngeni Ecological Infrastructure Partnership
USDGs	Urban Settlement Development Grants
WCT	Wildlands Conservation Trust
WRC	Water Research Commission
WRM	Water Resource Management Charge
WUA	Water User Associations
WWF-SA	World Wide Fund for Nature South Africa

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1 INTRODUCTION

1.1 Project Context

The Green Fund is a national fund that seeks to support green initiatives to assist South Africa's transition to a low carbon, resource efficient and climate resilient development-path delivering high impact economic, environmental and social benefits. The Fund is managed by the Development of Bank of South Africa (DBSA) on behalf of Department of Environmental Affairs. This research project was awarded in 2014 under the "Research and Policy Development to Advance a Green Economy in South Africa" programme that aimed to strengthen the science-policy interface in the green economy.

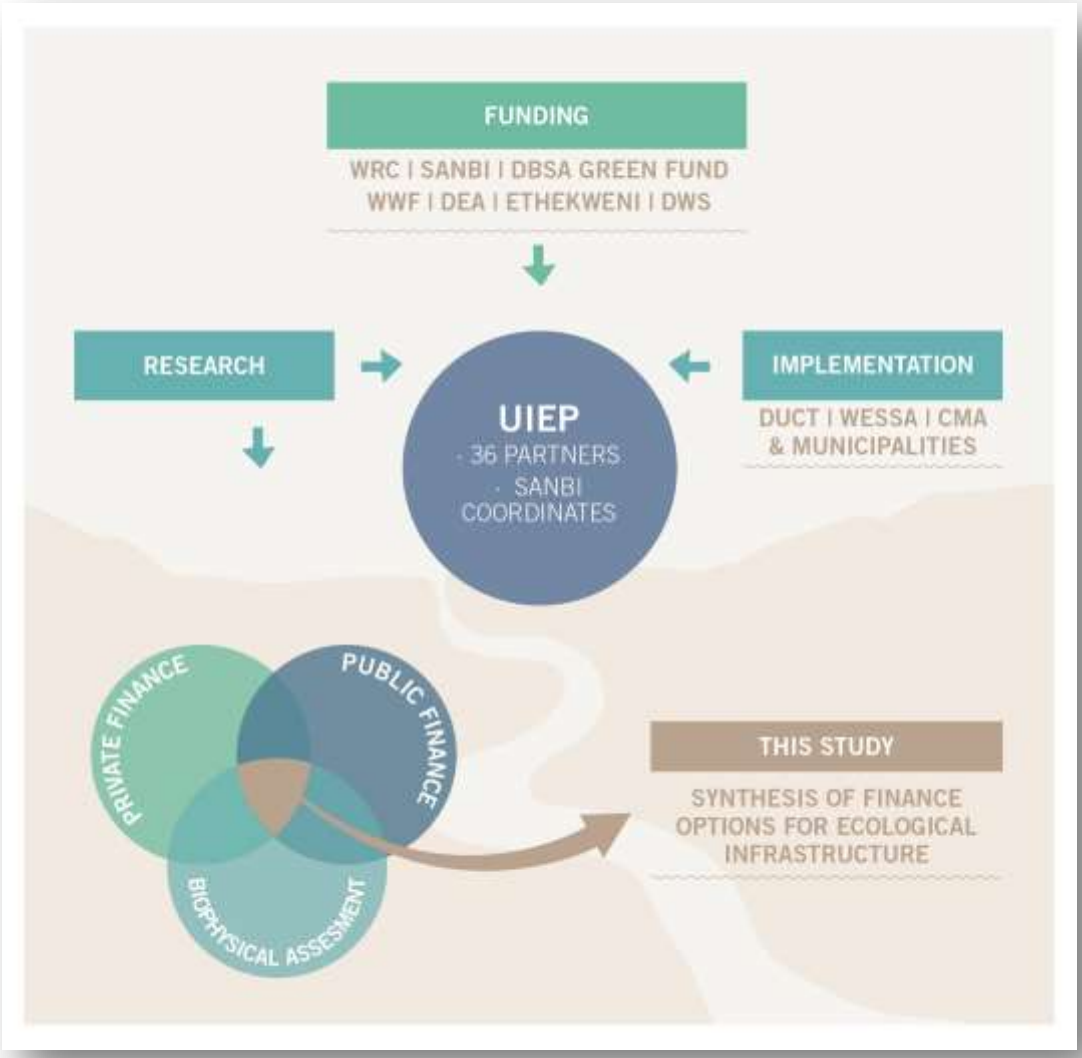


Figure 1.1: The contextualisation of this study in the broader Umgeni Ecological Infrastructure Partnership

The project was awarded in conjunction with a research project awarded to the South African National Biodiversity Institute (SANBI) which also focussed on investment in Ecological Infrastructure in the same area, the uMngeni catchment. The terms of reference (TOR) for the two projects were

consolidated; the SANBI project focussed more on the biophysical assessment of ecological infrastructure and the role of public institutions; and this WWF-SA project focussed more on the role of private finance and the private sector. The projects were carried out and reviewed in close cooperation with the newly formed uMgeni Ecological Infrastructure Partnership (UEIP) which represents 36 organisations in the greater catchment area aiming to protect and enhance the state of ecological infrastructure and therefore water security.

The technical report from the sister SANBI project is entitled: Jewitt, et al., "*Investing in ecological infrastructure to enhance water security in the uMngeni River catchment."* 2015.

1.2 Statement of the Research Problem

Almost all challenges related to the governance of natural resources are, at a fundamental level, related to the 'tragedy of the commons'. Why do different stakeholders rarely collaborate to promote the health of the common resource on which they all depend? Any strategy seeking to promote a green economy needs to address this fundamental question.

In this research we seek to understand *how different private sector companies operating within the uMngeni catchment, can collaborate to enhance the health of the shared ecological infrastructure on which they depend.* The research will focus especially on understanding the role of private sector finance institutions, which are embedded widely across 'the commons' and thus face systemic risk related to the health of the catchment.

> *"Until mother nature sets up a back office with an invoice system, behaviour won't change and natural resources can be used indiscriminately….putting a price on… externalities is the only answer."* Chris Brett, global head of sustainability at Olam International, August 2015.

The DWS estimates that over the next decade nearly R700 billion will be required to upgrade engineered infrastructure to meet our water and sanitation needs in the future. It is expected that more than half that finance will have to come from the private sector. This quantum does not account for the synchronous investment in ecological infrastructure that will be necessary in order to maintain healthy water yields from our catchments.

1.3 Aims and Objectives

No green economy research strategy can be considered complete without seeking to innovatively address the fundamental issue of the 'tragedy of the commons'. Multi-stakeholder environmental certification schemes for commodities provide a means for stakeholders within a sector (or commodity) to drive collective action for the improvement of the environmental commons. However, these schemes have not been utilised in a concerted manner to drive change within a geographically defined ecosystem, such as a catchment. Furthermore, the potential of private finance (lending, investment and insurance) to shape positive behaviour towards the environmental commons has not been appreciated to date.

The key aims of this project are:

- To determine how different market mechanisms can be co-ordinated into collective action for the enhancement of ecological infrastructure at a catchment scale;
- To evaluate the role of private finance in catalysing systemic change and collective action in the production supply chains within which they are invested;
- To determine the best governance mechanisms by which different market mechanisms and private finance institutions can co-operate to deliver large scale change at a landscape level.

The overall research question for this project is: *How can private finance and market mechanisms most strategically deliver collective action for the enhancement of ecological infrastructure within the uMngeni catchment?*

The uMngeni catchment, provides a unique opportunity to explore these ideas. in 2013, high level stakeholders, led by the eThekwini Municipality, SANBI, DWA and WWF-SA, initiated a process of improving the health of the shared ecological infrastructure through collective action. The uMngeni Ecological Infrastructure Partnership (UEIP) was formed to enable interested, impacted and influential organisations harmonise their efforts to achieve greater water security through enhanced ecological infrastructure.

1.4 Background

The uMngeni catchment supports around 10% of the South African economy (ca. R300 Billion in 2010), and yet faces significant challenges related to water as a key constraint to economic well-being. The eThekwini Metropole, the economic hub of KwaZulu Natal and final recipient of water from the uMngeni catchment, is acutely aware of these risks and has recognised the role that ecological infrastructure plays in water security.

To this end key organisations (led by eThekwini Municipality, SANBI, DWA and WWF) are spearheading an alliance aimed at enhancing the ecological infrastructure of the uMngeni catchment with a view to reducing water risks related to water quality and quantity. This group has been formalised within an MoU for the uMngeni Ecological Infrastructure Partnership (UEIP) which currently has 36 signatory members.

1.4.1 Ecological Infrastructure

The term ecological infrastructure has emerged in the last 3 years as a new way to frame physical landscapes which provide critical services to people, and on which our engineered infrastructure depends. Water is one of the most direct and important services delivered to society and the economy from landscapes. Therefore, focussing on catchments and the hydrological functioning of landscapes is a useful lens. Ecological components, such as wetlands, flood plains, and riparian zones, provide essential water services – such as water provisioning and purification, sediment filtration, and flood attenuation.

Ecological Infrastructure (EI) is defined as **functioning ecosystems that produce and deliver valuable services to people** (SANBI 2014)

Headwater areas, riparian zones, wetlands, groundwater recharge zones and rivers are all critical components of EI for water. The healthy functioning of these landscape elements is essential for engineered infrastructure (such as dams, reticulations systems, water treatment works) to operate optimally. Together they can be viewed as 'green' or 'soft' (ecological) and 'grey' or 'hard' (engineered) infrastructure. The figure below shows how they interlink and are considered together in national government planning with engineered infrastructure as a focus for the 18th Strategic Integrated Project (SIP18) and ecological infrastructure as the focus of the proposed SIP19.

Ecological Infrastructure occurs on private land, state land, communal land, protected land and in urban areas. Common approaches to its protection and restoration are therefore complex. The sister SANBI project addresses issues of formal government and coordinated budgeting, planning, spending and implementation between relevant departments (such as Dept of Water and Sanitation and Dept of Environmental Affairs). This project focuses on the role that the private sector can play, via markets, land-owners and private finance, in influencing impacts and restoration of riparian zones, headwaters and high yielding catchments.

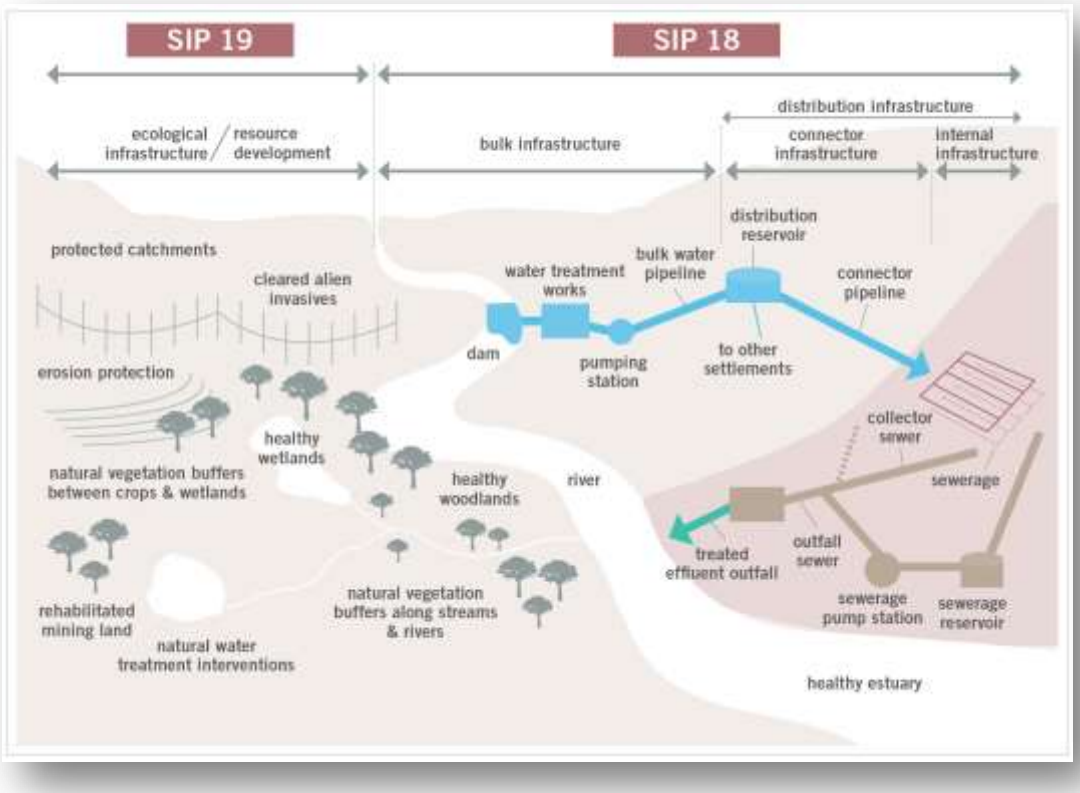


Figure 1.2: Interdependencies between ecological and engineered infrastructure for water security as addressed in SIP18 and the proposed SIP19 (DEA, 2014)1.4.2. Envisaged Role of Finance and Markets

There is a growing understanding of the link between the degradation of ecological infrastructure and risks to business (Pegram *et al.* 2009). Nel *et al.* (2011a) showed how degrading catchments were affecting risk to the production of hops – a key ingredient to one of South Africa's largest private sector corporations, South African Breweries Ltd. Nel *et al.* (2011a) also demonstrated the cost-effectiveness of the rehabilitation of ecological infrastructure as a means of reducing business risk. However, if companies are to effectively contribute towards enhancement of ecological infrastructure at a catchment scale they will need to move beyond seeking to address their risk at an individual scale and start acting as a collective (CEO Water Mandate 2012).

Porter & Kramer (2011) coined the concept of 'shared value creation' which advised that businesses could advance their competitive advantage through collaboration with other stakeholders to grow the shared pool of value within which they participated. However, Porter & Kramer (2011) stopped short of providing the practical advice on how such stakeholders could be identified or how they could be engaged. Mitchell *et al.* (1997), in an exhaustive review of the stakeholder literature, suggested that stakeholders should be prioritised according to three attributes: power, legitimacy and urgency. Ostrom (2000) emphasises the need to analyse contextual information about participants. Holley *et al.* (2012) provide more practical advice with reference to collaborative environmental governance, citing ten design principles for such arrangements. More recently, Petersen *et al.* (2014) suggest four fundamental attributes may determine the nature of such collaborations, including awareness of connectedness, motivation to change, access to pathways of change and pay-offs (or rewards) for engaging in such collaborations.
Within this context the finance sector is seen to be positioned particularly strategically. Due to its wide investment into landscapes and supply chains it is particularly vulnerable to systemic risks, but also very strategically positioned to leverage collective action (Mulder & Clements-Hunt, 2010).

The role of market-base mechanisms in driving more sustainable environmental practices is increasingly recognised. Global multi-stakeholder certification schemes (e.g. the Forestry Stewardship Council, Marine Stewardship Council, Bonsucro, Roundtable on Sustainable Palm Oil, Better Cotton Initiative) enable buyers and consumers to drive market positive change along a supply chain. However, these certification schemes have been applied within a single sector and largely in complete isolation of each other. Different market-based mechanisms have not been applied in a strategically co-ordinated manner to leverage cohesive environmental change within a defined geographical landscape.

Furthermore, existing market-based mechanisms have traditionally viewed the supply-chain as stretching from the producer, through a processor, a retailer, and ultimately to a consumer (Figure 1.3).

Figure 1.3: Traditional view of the food & fibre supply chain

More recently the importance of private finance in supply chains has become clearer. On the one side, almost all producers will need to access capital to produce raw products. This capital is provided to individual farmers as working capital loans, whilst larger producers (e.g. forestry and farming companies) will raise equity from investors. On the other side of the supply chain, almost all middle class consumers will carry some form of short term insurance to ensure their continued economic viability in increasingly volatile times. These insurance companies will in turn use investment vehicles to gain returns on the premiums from these clients. Much of these investments are likely to be invested back in production supply chain, completing the financial cycle (see Figure 1.4).

A recent international review of market based instruments (MBI) review those that have been tried and tested in other regions with an assessment of how well they have been shown to support integrated water resource management (IWRM) and water stewardship (Hepworth et al, 2015). The instruments include water trading, payment for ecosystem goods and services, water credits, offsets and investment bonds and funds. Offsets have not been deemed to deliver well into IWRM and are not supported by our current water policies in South Africa. Other MBIs offer opportunities and are discussed more fully in section 4.

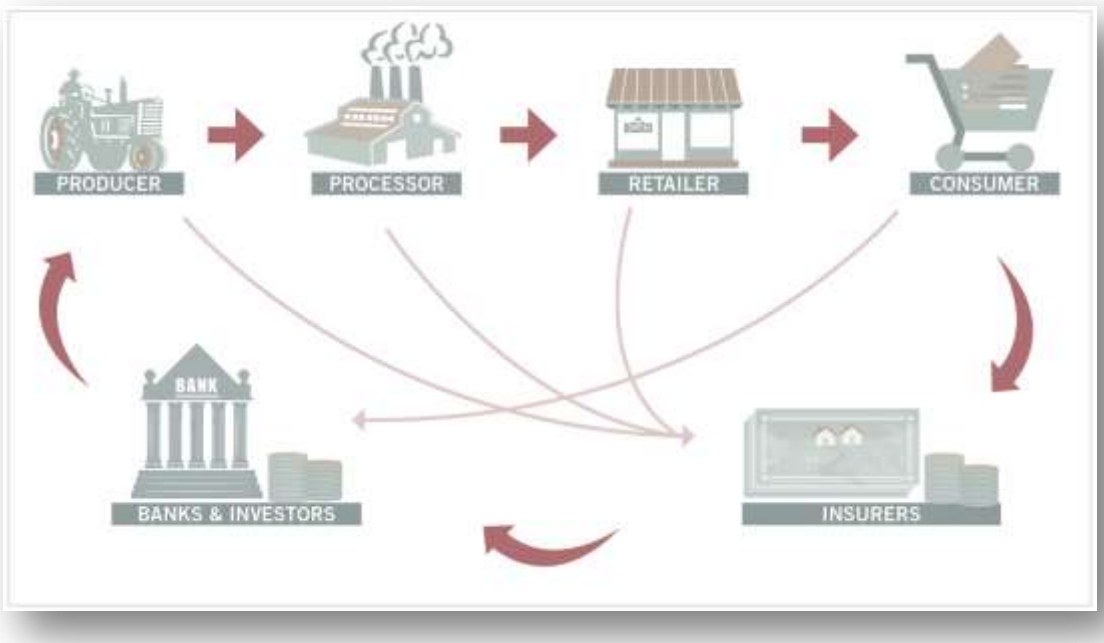


Figure 1.4: The role of private finance in sustaining supply chains

Table 1.1: A typology of Market Based Instruments for water resource management summarising examples, opportunities, risks and implications for water security and stewardship (adapted from Hepworth et al, 2015).

	WATER TRADING	WATERSHED MANAGEMENT PAYMENTS	WATER CREDITS	WATER OFFSETS	WATER INVESTMENT FUNDS/BONDS
DESCRIPTION	Exchange of interchangeable 'allocations': volumes, characteristics or values generating economic incentives for efficient use or reductions in emissions. Often related to statutory allocations and targets, though can be informal.	Payment to 'providers' based on commitment to catchment management desirable by 'service receivers'. Often informal and voluntary. Can be for specific services or via rolling funds for a range of services.	Generation of revenue, payments or reputational currency (claims) against actual or promissory commitments, in which one party promises to pay money to the other under specific terms. Often informal.	Payments or investment in projects and actions which attempt to balance or substitute for water use and impacts, or to lever greater access or volumetric use of resources.	Mechanisms, information and vehicles designed to attract investment and a for profit return on investment with potential social and environmental benefits.
EXAMPLES	Formal and informal water allocation & rights trading; Water Quality Trading.	Payment for Watershed services; Watershed management funds.	credits/certificates Water restoration certificates Green water credits Carbon co-benefits.	Net Positive Impact Initiatives; Offsetting and Neutrality schemes.	Indexes, water bonds, water stocks, water mutual funds, climate bonds, green funds.
IMPLICATIONS FOR SUSTAINABLE WRM AND WATER SECURITY	Potential value for WRM in a limited set of contexts, conditional on strong regulation.	Valuable for WRM in a limited set of basin contexts.	Verification of claims may drive action. Strategic value likely to be limited. Significant associated hazards.	Unlikely to have value. Potentially damaging.	Further research and analysis needed.
IMPLICATIONS FOR STEWARDSHIP	Proceed with caution.	Proceed with caution.	Proceed with caution.	Avoid.	Develop an informed position.

The resilience of the private finance system is systemically linked to that of supply chains. Water risks faced by producers will translate into financial risks to the providers of capital. Furthermore, as shown by Nel *et al.* (2011a), poor land-use practices by producers (leading to the destruction of ecological infrastructure) will lead to increased risk to natural disasters such as flooding, fire and sea storms – hence an increase in the risk exposure of the insurance industry.

On the other hand private finance has potential to shape behaviour across such supply chains. All working capital loans are subject to conditions set from a risk assessment process, whilst investors hold considerable shareholder power over companies. All insurance premiums are written against a set of criteria that determine the behaviour of clients. One only needs to consider the massive growth in the private security industry as a result of insurance policy conditions, to understand the potential of insurance to shape behaviour.

Given the increasingly prominent role of the finance sector in the agricultural sector, and the difficulties of enforcing environmental legislation, it was inevitable that organisations concerned

with environmental degradation would turn their focus towards financiers as an important systemic lever for environmental governance. Many South African bank managers and insurers have more contact with, and better information on, farmers and the local environment than the Department of Environmental Affairs (DEA) or Department of Water and Sanitation (DWS). In most instances, financiers are more able to exert positive influence and incentives over farming practices than organisations that have recourse only in terms of environmental legislation.

Being focused on the Greater uMngeni Catchment, the study explores whether lenders, investors and insurers can create immediate incentives that would lead to improvements in ecological infrastructure by placing additional conditions on the services they provide to businesses operating within the catchment.

1.5 The Ecological Context for Collective Action in the Greater uMngeni Catchment

Situated in the province of KwaZulu-Natal, South Africa, (figure 1.5) the uMngeni Catchment covers an area of 7,963km^2. The central artery, the uMngeni River, is 255km long from its source (uMngeni Vlei at an elevation of 1,830m) to its estuary on the Durban coastline (Mitchell *et al.*, 2014). Precipitation in the region is subject to the ENSO, and two severe droughts and two major flood events have marked water flows in the uMngeni over the past three decades (River Health Programme, 2002). At the time of this study (October 2015) stakeholders in the catchment are again concerned about drought (AgriSA, 2015).

Figure 1.5: Location of the uMngeni catchment in KwaZulu Natal, South Africa

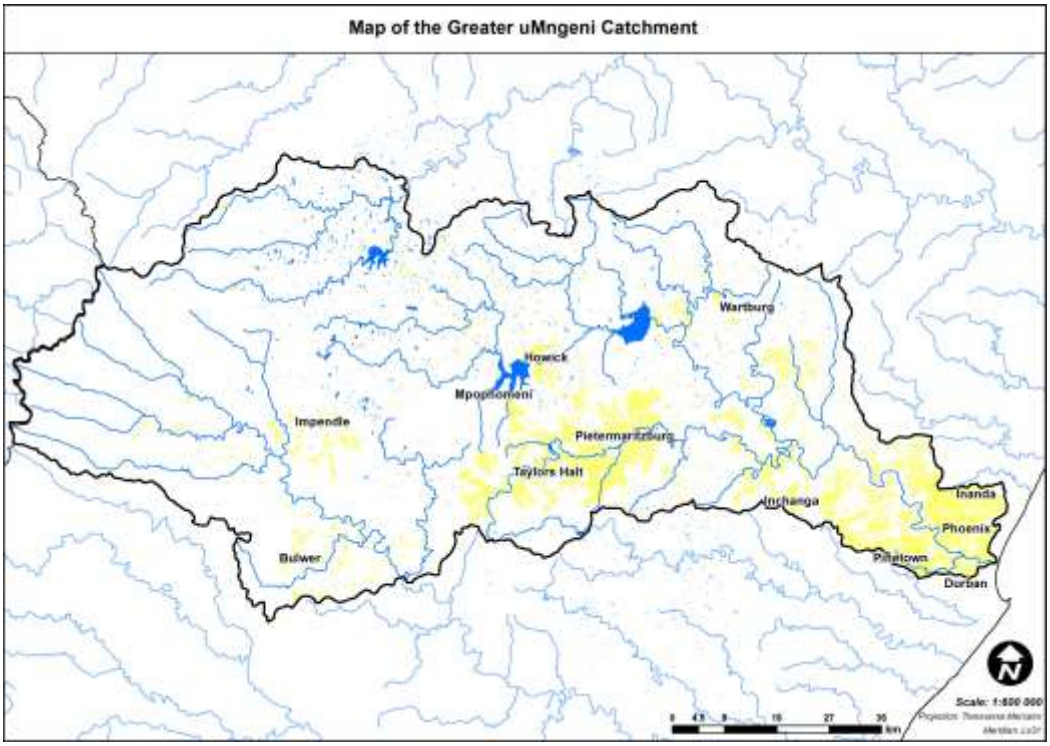


Figure 1.6: Map of the Greater uMngeni River Catchment area.

The boundaries of the catchment do not align neatly with the boundaries of the local municipalities. Figure 1.7 shows the overlap between the Greater uMngeni River Catchment and the municipal boundaries in the area.

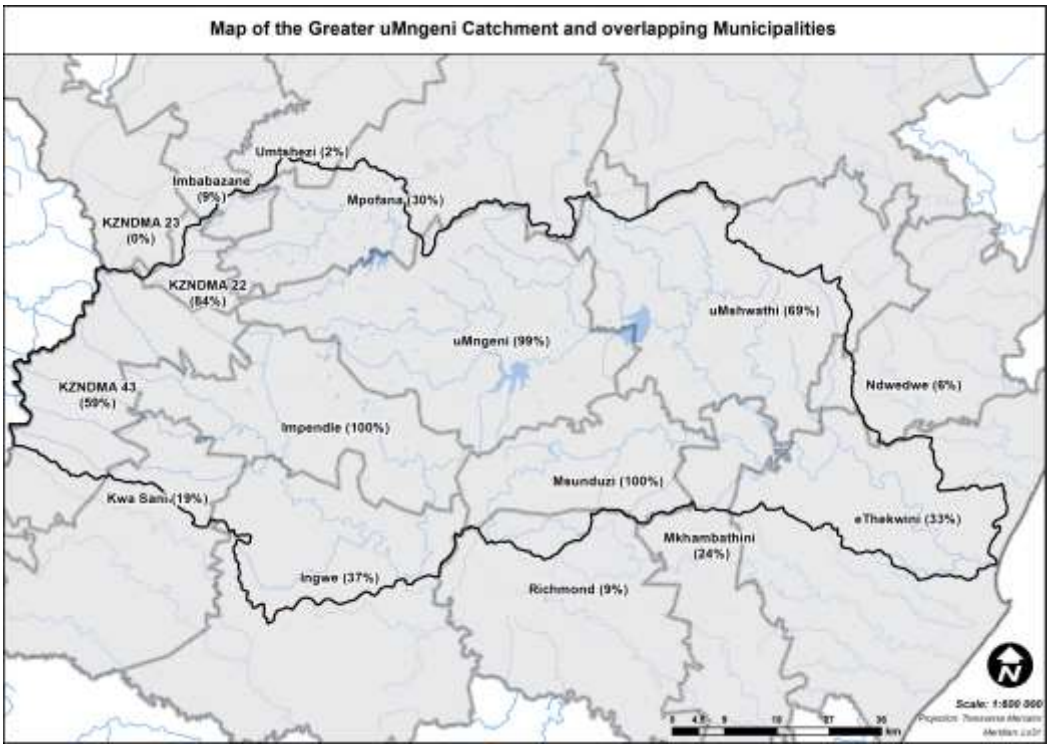


Figure 1.7: Map showing the overlap between the Greater uMngeni River Catchment and municipalities in the area.

Together the eThekwini Metropolitan Municipality and uMgungundlovu District Municipality (made up of the local municipalities of Msunduzi, uMshwathi, uMngeni, Richmond, Mkhambathini, Mpofana and Impendle) have a total population of around 4.45 million people, of which the majority directly depend on water resources from the uMngeni River system (Hay, Breen, & Nkhata, 2014). Water demand in both of these municipalities is growing, and the current water supply infrastructure is reaching capacity (Department of Water Affairs and Forestry, 2008). On the economic front, the catchment is a part of the uMvoti to uMzimkulu Water Management Area, which contributes 11.5% to South Africa's Gross Domestic product (GDP), with 80% of this contribution coming from the Durban-Pietermaritzburg region (Hay, *et al*., 2014).

The Greater uMngeni River Catchment is under significant ecological pressure, which some reports suggest is impacting on economic development, human health and ecology (Hay, Breen, & Nkhata, 2014). Growth in water demand in the catchment, coupled with intermittent drought periods, necessitated the construction of phase one and two of the Mooi-Mngeni Transfer Scheme, in recent decades. The scheme transfers water to the uMngeni River from the Mooi River (Trans-Caledon Tunnel Authority , 2015). Additional schemes, such as the Mkomazi-Mgeni Transfer Scheme, involving the transfer of water from the uMkhomazi River to the uMngeni River Catchment are also being proposed as part of the effort to meet future water demand in the catchment (Department of Water Affairs, 2014).

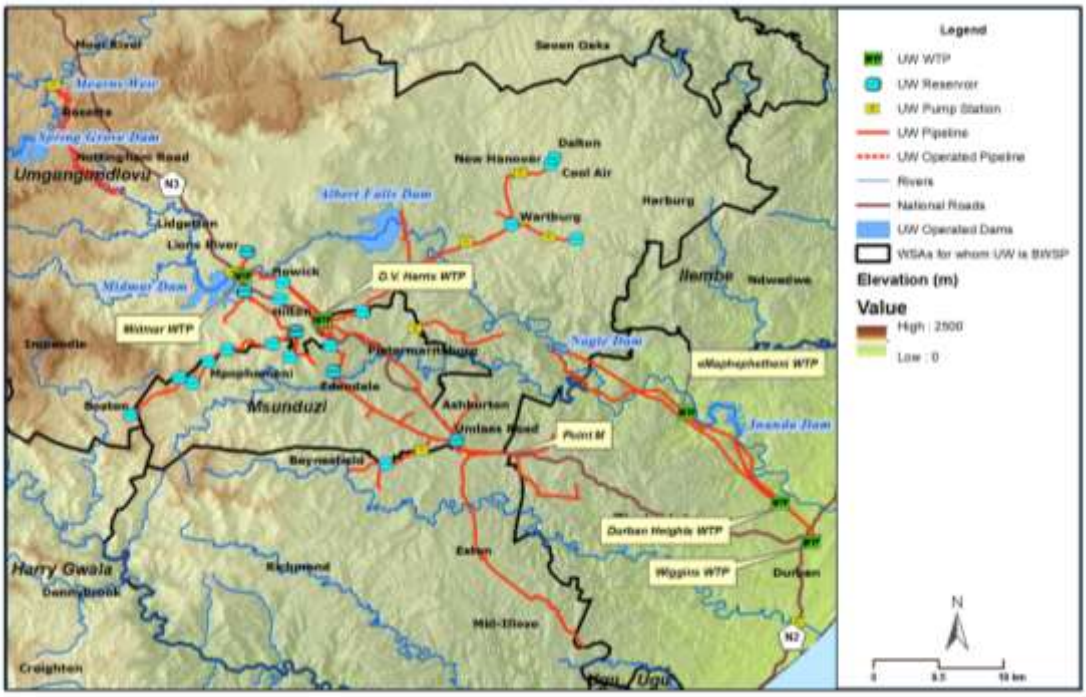


Figure 1.8: Key elements of engineered infrastructure under the management of Umgeni Water (UW) in the greater uMngeni Catchment (source UEIP, 2015, shared information from K.Zunckel)

The inherently variable flow of water in the uMngeni Catchment's main arteries is mediated by five major dams: Spring Grove Dam, Midmar Dam, Albert Falls Dam, Nagle Dam and Inanda Dam. Current demand for water in the catchment (406 million m^3 per annum) exceeds the available yield (381 million m^3 per annum), necessitating an inter-basin transfer via the Mooi-uMngeni Transfer Scheme

(MMTS). A second phase of this scheme is planned for construction at an estimated cost of R6 billion (Umgeni Water, 2014a).

The “ecological reserve” (22 per cent), forestry (11 per cent), irrigation agriculture (8 per cent) and leakages and theft (9 per cent) constitute half of the demand for water from the catchment. The balance goes to households (24 per cent), distribution losses (12 per cent), industry (8 per cent) and commerce (6 per cent). The state of environmental degradation in the catchment is being detailed in a parallel study being conducted by SANBI, but it is generally accepted that the region is subject to soil erosion and rising water contamination.

Increasing human settlement in the catchment has also inundated the existing sanitation infrastructure in towns such as Pietermaritzburg, and water quality has suffered as a result. Stormwater ingress into the sanitation system accounts for frequent sewerage spills in towns such as Pietermaritzburg (DUCT, 2015). Water quality in the catchment is declining due to overloaded sanitation infrastructure that cannot cope with the increase in population numbers, ageing infrastructure, industrial waste in the stormwater system and organic inflows from farms. In 2012 a study commissioned by the Water Research Commission (WRC) showed that the uMngeni River is highly contaminated, containing bacterial pathogens such as *Salmonella spp., Shigella spp.* and *Vibrio cholera* (Lin, Ganesh, & Singh, 2012). Additionally, the study found that the microbiological and physico-chemical qualities of the uMngeni River did not meet the target water quality ranges of Total Coliforms (TC), Faecal Coliforms (FC), Enterococci (EC) and Faecal Streptococci (FS) levels for the recreational and drinking uses as stipulated by the DWS (Lin, Ganesh, & Singh, 2012).

The coverage of invasive alien plant species is also increasing in the catchment, impacting both on water supply and water quality. Access and availability of water has been further reduced due to leaking infrastructure, poor water conservation practices, and the historical under-pricing of water that has led to profligate use and high levels of wastage. Soil erosion caused by overgrazing and infrastructure development has reduced the storage capacity of dams in the catchment. The increase in coverages of invasive alien species, land transformation and sand mining have impacted on the biodiversity of the region (Hay, Breen, & Nkhata, 2014) (DUCT, 2015).

Priority catchments for intervention are identified in Jewitt et al. (2015). The maps presented below show the location of priority catchments within the Great uMngeni area for different types of intervention to ensure ecological infrastructure is maintained or enhanced. This includes areas to be conserved, rehabilitated and alien vegetation to be cleared and rehabilitated.

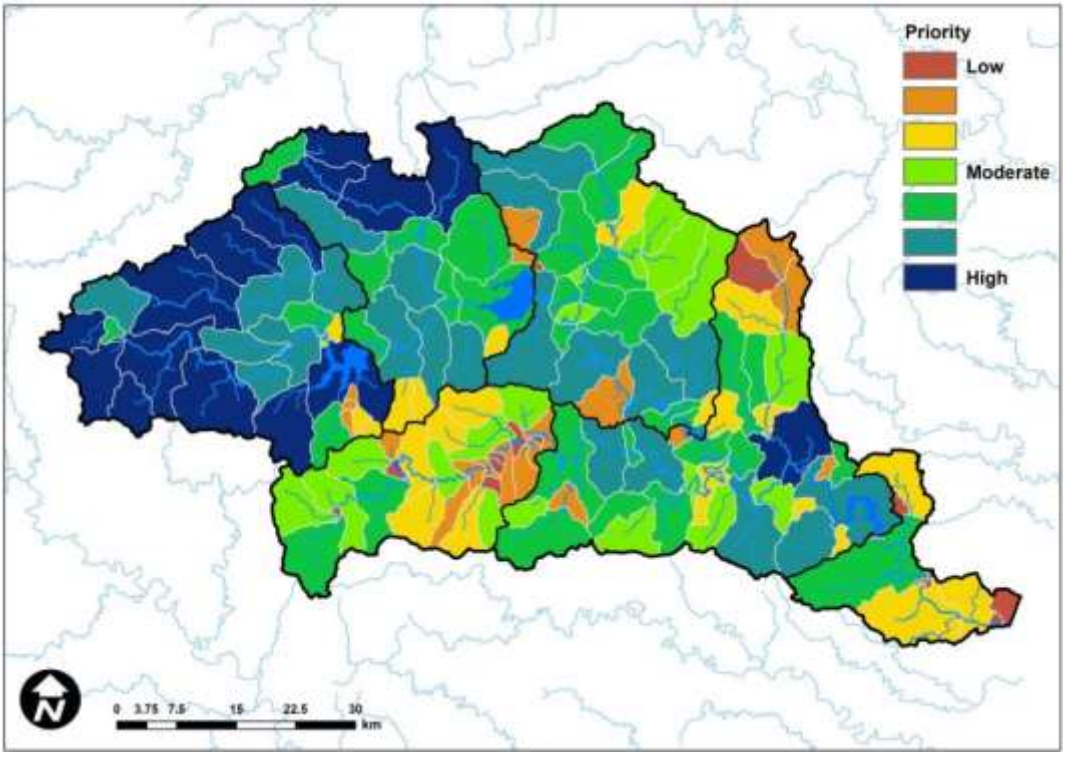


Figure 1.9: Priority catchments to conserve natural vegetation to maintain streamflow, dry-season baseflow and sediment retention (Jewitt et al, 2015)

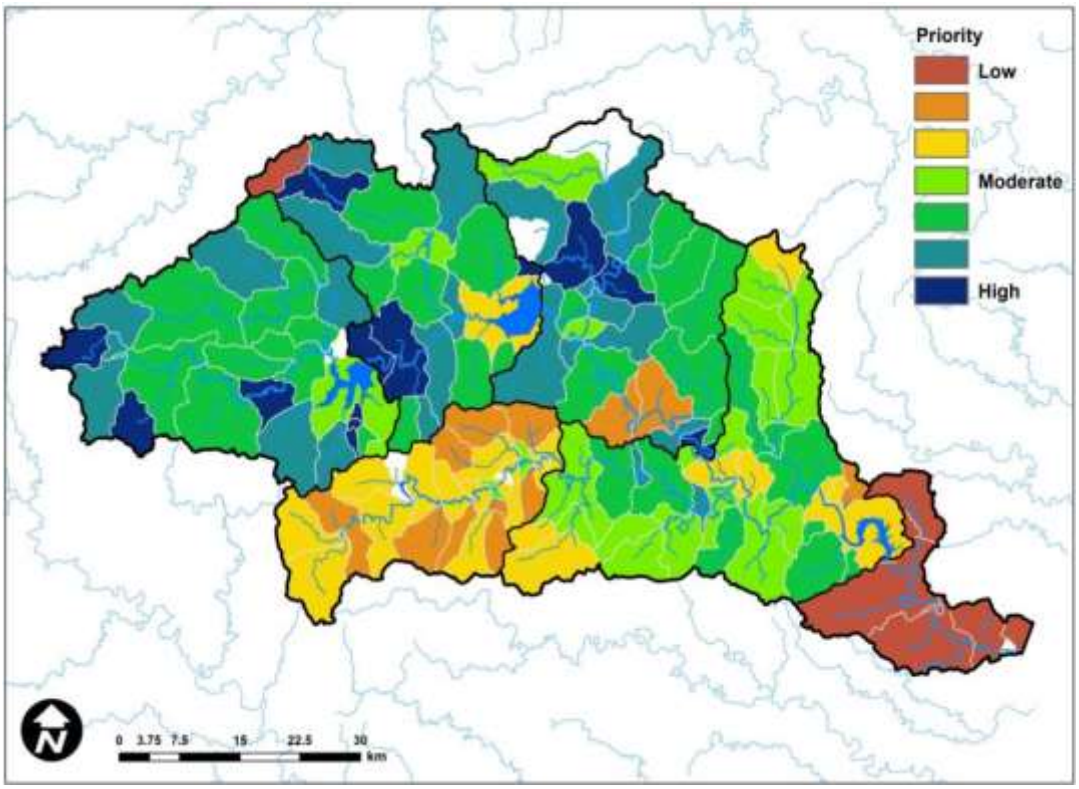


Figure 1.10: Priority catchments to rehabilitate degraded vegetation to improve streamflow, dry-season baseflow and sediment retention (Jewitt et al, 2015)

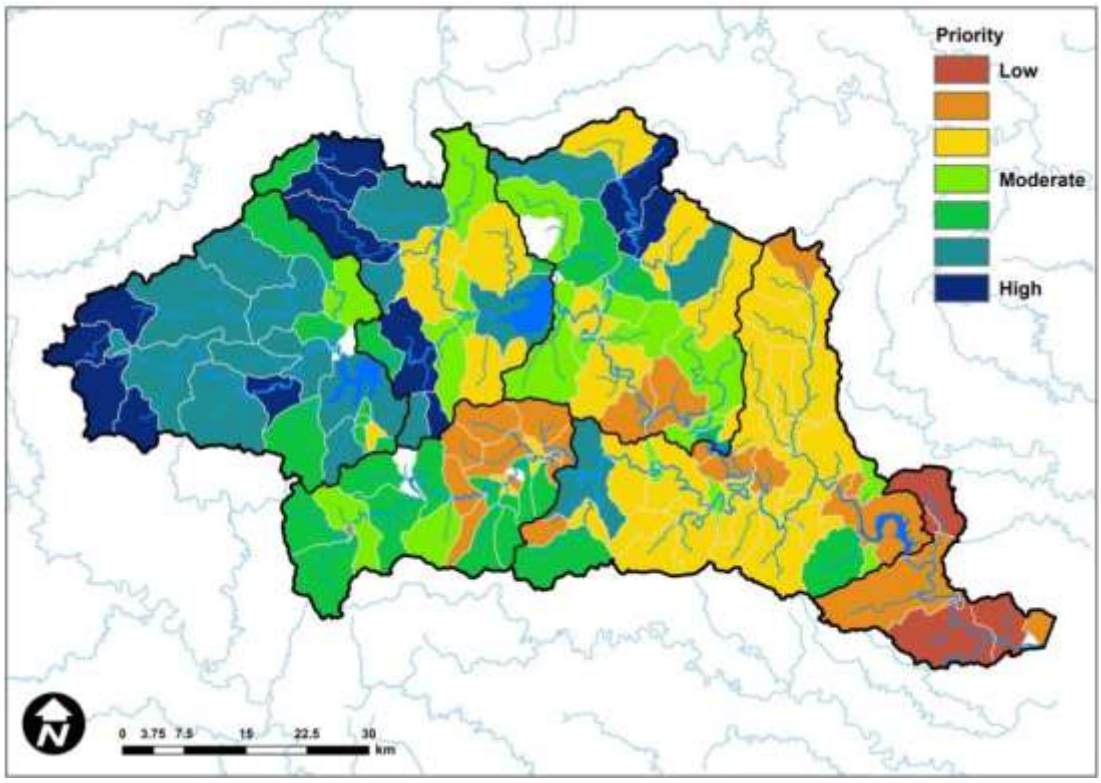


Figure 1.11: Priority catchments to rehabilitate degraded and invasive alien vegetation to improve streamflow, dry-season baseflow and sediment retention (Jewitt et al, 2015)

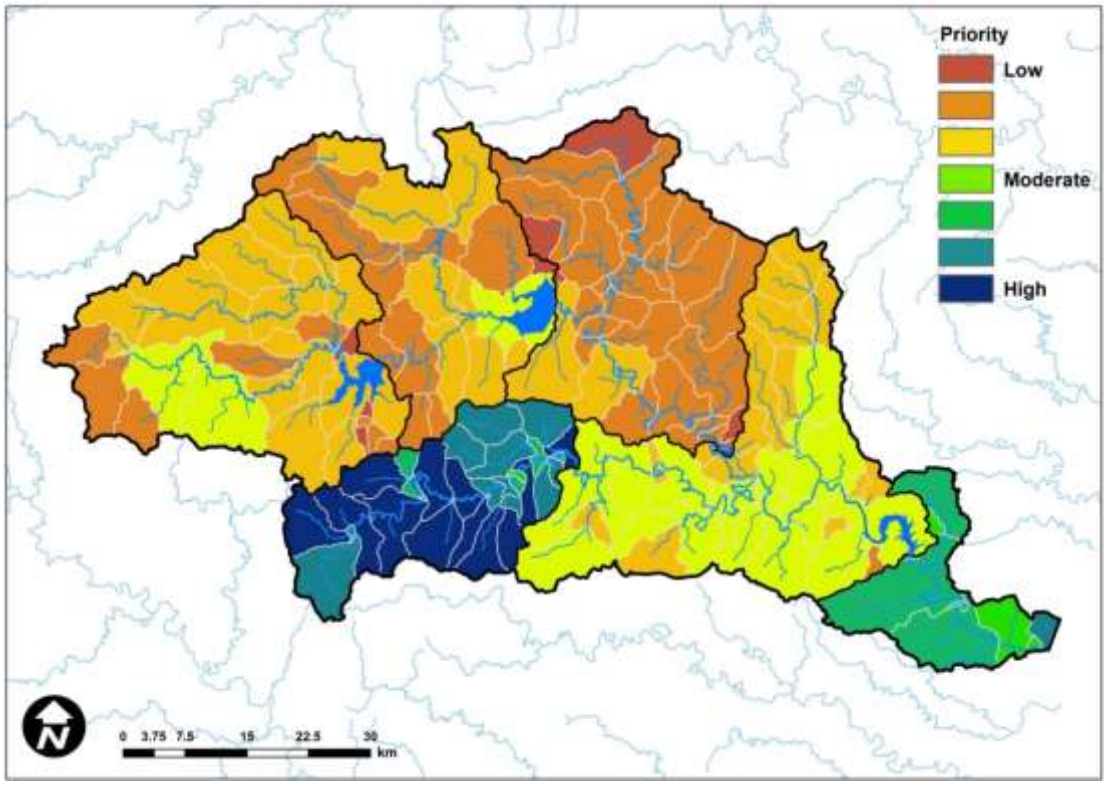


Figure 1.12: Priority catchments to enhance flood attenuation (Jewitt et al, 2015)

1.6 Approach

Fundamentally the team aimed to answer the following questions: 1) How can different market mechanisms be co-ordinated to leverage collective action at the catchment level; 2) What is the role of private finance in bringing greater cohesion to these efforts; and 3) What sort of governance systems are best suited to drive this collective action.

A multi and trans-disciplinary approach was adopted, with experienced researchers from economics, resource-economics, information systems, GIS and integrated water resource management. The team liaised with the UEIP at biennial meetings and held annual UEIP- research steering committee meetings in partnership with the sister SANBI project and a closely linked WRC project undertaken by UKZN.

An applied research and action learning approach was used to gain insights into how we can leverage collective environmental action with geographically confined ecosystems. Information gathering followed both desk top research and extensive interviews with local actors as well as national actors (in the banking sector). In exchange for the information gathered from interviewees a commitment was made to maintain confidentiality regarding the information provided by specific organisations. Accordingly, all information gathered has been collated and summarised, and no interviewee is directly quoted in this report.

Organisations and individuals interviewed during this phase included members of the UEIP, the major banks and insurers in the area, farmers and representatives of agricultural organisations. Direct financial data could not be shared by the banks and insurers as this information is protected. However, qualitative characterisation of the key issues and pressure points were discussed. This provides insight, but does not allow a quantitative analysis.

Section 2 summarises the information gathered on private finance flows to the major impacting sectors in agriculture, forestry and human settlements in the catchment. Potential points of influence within private finance are discussed.

Section 3 discusses the design criteria for information systems in multistakeholder collective action and outlines how the project has initiated and contributed to open access tools which will enable private sector engagement.

Section 4 outlines the current trends of private sector investment into ecological infrastructure, world-wide and suggests institutions and finance mechanisms which are most appropriate in the uMngeni Catchment.

Section 5 summarises the key findings and presents recommendations for further action, particularly policy interventions which fulfil the mandate of the Green Fund.

2 FINANCIAL CHARACTERISATION OF THE UMNGENI CATCHMENT

2.1 Introduction

This section outlines the role that private sector finance does, and could, play in promoting sustainable water resource management in the production supply chains within the Greater uMngeni Catchment. The report provides an overview of the private sector financial flows to the two sectors (in the Greater uMngeni Catchment) which have the greatest impact on water resources and the state of the catchment: agriculture and human settlements. This is done to understand the incentives available to private sector lenders, investors and insurers; incentives which encourage better business practices to promote long-term sustainability of water resources.

2.2 Rationale

Since the 1950s the role of finance in the global economy has increased significantly (Epstein & Jayadev, 2005)[1]. In the United States of America, for example, the ratio of financial to non-financial profits increased from 20 percent in 1983 to 50 percent in 2001 (Krippner, 2011). The agricultural sector has been party to this change: the finance sector's proportion of the entire agricultural value chain has grown since the Second World War (Burch, 2013; Isakson, 2013).
The increasing uptake of finance by farmers is testimony to the important role that this finance (loans, equity and insurance) plays in the sector. The financialisation of agriculture has driven growth in the production of food and fibre, enabled the use of sophisticated machines in production and processing, and ameliorated the risks associated with the agricultural sector's innate seasonality and weather-dependence.

The same financialisation has, however, been associated with undesirable developments – many of them external to the actual farm – in which this finance-driven expansion has failed to provide appropriate signals to investors and savers with regards to all the risks and opportunities (Burch, 2013; Isakson, 2013). It is these financial sector 'blind-spots' that have seen this sector implicated in financial-sector contagion and in environmental collapse. For example, the ability to leverage a farm to access finance has seen farmers expand the physical footprint of their production, sometimes into virgin lands and forests, without consideration of the value and importance of the ecological capital they are destroying. This expansion is aided by machinery, itself financed, and thus has driven declining employment across the global agricultural sector and also the destruction of the natural resources on which some of the world's poorest people depend directly for their livelihoods (Cook *et al.,* 2010).

Similarly, the economies of scale generated by capital-intensive agriculture have created market barriers for new entrants and smaller farmers, particularly those without freehold title over land that can serve as collateral. Furthermore, the need to honour debt obligations has seen farmers

[1] (Epstein & Jayadev, 2005) describe financialisation as, "the increasing importance of financial motives, financial actors, financial markets, and financial institutions in the operation of economies and their governing institutions, both at the domestic and international level".

adopt increasingly intensive production techniques and short-term perspectives, for example, irrigation-intensive crop production, sterilisation and nitrate loading of soils, and intensive livestock husbandry. Significantly, these practices have negative consequences for long-term soil fertility and water resources.

South Africa, as with most countries, has environmental legislation that is intended to mediate between agriculture's quest for profit and the protection of the environment from irreparable harm. Endangered species, water pollution, soil erosion and soil contamination legislation in South Africa is intended to protect the natural environment from potential harm caused by intensive agriculture. Again, as with many countries, these statutes have proven very difficult to enforce. The extensive spatial nature of agriculture makes policing inherently difficult. The complexity of environmental interactions and the temporal lags between an action and its environmental consequences confound the attributing of an observed environmental degradation with a particular farming practice.

Given the increasingly prominent role of the finance sector in the agricultural sector, and the difficulties of enforcing environmental legislation, it was inevitable that organisations concerned with environmental degradation would turn their focus towards financiers as an important systemic lever for environmental governance. Many South African bank managers and insurers have more contact with, and better information on, farmers and the local environment than the Department of Environmental Affairs (DEA) or Department of Water and Sanitation (DWS). In most instances, financiers are more able to exert positive influence and incentives over farming practices than organisations that have recourse only in terms of environmental legislation.

Financial institutions have become more aware of their influence and the responsibilities that come with it. It is not only environmental groups that have looked to financial institutions to increase their influence. Anti-terror, tax revenue collectors and Black Economic Empowerment interests have all looked to harness the reach and the influence of the finance sector. The Exxon Valdez disaster in 1989 precipitated global scrutiny and shareholder awareness of some of the unforeseen costs associated with the prevailing industrial development model, and the role of finance in that model. Since that time, finance institutions globally, and in South Africa, have begun to appreciate that their business depends on environmental goods and services and a degree of environmental stability, and that the reputational and operational risks of ignoring the environment can be significant.

In response, financiers have adopted commitments (such as the Third Basel Accord[2]), standards and reporting measures (such as Environmental, Social and Governance (ESG)[3]) as a means of accounting for their own behaviour and ensuring that they contribute in some way to the public goods on which their business activities depend. These standards are reviewed in the section of this report entitled "Legislation and Financial Governance". The onerous reporting requirement is something that most banks (at least unofficially) lament as both an additional demand on their time and as being

[2] 2 **Basel III** (or the **Third Basel Accord**) is a global, voluntary regulatory framework dealing with bank capital adequacy, stress testing and market liquidity risk. Basel III was developed in response to the deficiencies in financial regulation revealed by the financial crisis of 2007–08. Basel III was intended to strengthen bank capital requirements by increasing bank liquidity and decreasing bank leverage.

[3] **Environmental, Social and Governance** (**ESG**) refers to the three main areas of concern that inform the evaluation, measurement and reporting of the sustainability and ethical impact of an investment in a company or business. ESG is the catch-all term for the criteria used in 'socially responsible investing'.

necessary but insufficient when it comes to managing environmental risk. ESG reporting is particularly poor at addressing the types of systemic environmental risks that cause either environmental or financial collapse (CISL & UNEP-FI, 2014).

This study recognises the need for iterative improvements in the statutes that bind the activities of the financial sector, and accepts the current limitations in financial sector governance to effect an improvement in the environmental condition of the study area. Being focused on the Greater uMngeni Catchment, the study explores whether lenders, investors and insurers can create immediate incentives that would lead to improvements in ecological infrastructure by placing additional conditions on the services they provide to businesses operating within the catchment.

In this way the study looks for financial incentives that connect (1) the widespread understanding that the viability of the finance system is linked to the resilience of the production supply chain, which in turn relies on the ecological infrastructure of the catchment; and (2) the day to day business and profitability of financial service providers in the Greater uMngeni Catchment system.

To achieve this, the study provides an overview of the 'financial ecosystem' in the Greater uMngeni Catchment. This characterisation describes the key sectors in the region and the financial flows between private sector financiers and these key sectors. The hope is that this knowledge could be applied to identify incentives and opportunities for the financial sector to catalyse the type of systemic change in the land-use activities that would be good for the environment and simultaneously more profitable for the local finance sector, as well as for local land users.

The study has wider implications. An estimated $90 trillion will be invested in the African continent in the next 15 years as economic and population growth combine with urbanisation to stimulate Africa's economy (Watkins, 2015). Much of this investment will take place under conditions of weak governance and concerns have been raised about the environmental impact that will be caused by this investment and associated economic growth (Parnell, 2015). This research shows an incentive for financiers to become enforcers of stricter environmental legislation, and this approach could be applied elsewhere on the continent, including to the conditioning of Climate finance.

2.3 Method

The first phase of the project involved a desktop review of existing information regarding the financing of the agricultural and residential sectors in the Greater uMngeni Catchment area. The purpose of the desktop review was to determine what information already existed and to identify sources of further information. In addition to the desktop review the project team met with key individuals working on the uMngeni Ecological Infrastructure Partnership (UEIP) to gather recommendations on stakeholders that would be in a position to provide insights into the operation of private sector finance in the Greater uMngeni Catchment area.

The second phase of the project involved face-to-face interviews with stakeholders who could discuss a farmer perspective on private finance in the catchment. The initial set of stakeholders was compiled from names provided by key informants in the first phase, but a broader group of

interviewees was assembled based on recommendations and referrals of those interviewed – i.e. following a 'snowball sampling' method (Goodman, 1961).

Initially farmers themselves were interviewed in order to understand the extent and nature of involvement by financiers and insurers. It became apparent, however, that the perspectives of individual farmers were specific to their own experience and farming circumstances. As a result, the focus of this phase shifted to interviewing institutional stakeholders, such as those from farmer representative organisations that could provide general information related to how the members or their respective sectors finance their business activities.

During the third phase, face-to-face interviews were conducted with financial institutions to gather general information regarding debt, equity and insurance provision to the various agricultural sectors. The questions posed were focused on, firstly, understanding the extent of finance and insurance in the catchment, secondly, the procedures followed by banks and insurers respectively for assessing client's risk profiles (with particular attention given to the influence of environmental risk on clients' financial risk profile), thirdly, the financial implications of poor catchment management for banks and insurers, and finally, the opportunities and costs associated with incentivising activities that prevent environmental degradation.

In exchange for the information gathered from interviewees, a commitment was made to maintain confidentiality regarding the information provided by specific organisations. Accordingly, all information gathered has been collated and summarised, and no interviewee is directly quoted in this report. Organisations and individuals interviewed are similarly not identified. Direct financial data could not be shared by the banks and insurers as this information is protected. However, qualitative characterisation of the key issues and pressure points were discussed. This provides insight, but does not allow a quantitative analysis.

It is the primary purpose of this section to describe qualitatively the financial ecosystem (finance, investment and insurance) that supports water and land use (primarily agricultural land use) in the Greater uMngeni Catchment area.

2.4 Legislation and Financial Governance for Water Resources

South Africa was presented with the rare opportunity to redraft key national policies in 1994, and used this opportunity to draw eclectically on international best practice. New legislation was approved in part to give meaning to South Africa's celebrated democratic Constitution, but also as part of the process of re-integrating into the international community.

2.4.1 Environmental Legislation

South Africa's environmental legislation adopted much of the thinking with regards to environmental justice, integrated resource management and sustainability that had begun to emerge in the mid-1990s (Reed & De Wit, 2003). In general, South Africa has struggled to set up the local institutions required to implement much of its environmental legislation. The policies and

aspirations remain recognised as being very good, and in some ways this study looks at new ways of achieving the policy goals. Key legislation is reviewed below.

2.4.1.1 National Environmental Management Act (Act No. 107 of 1998)

The National Environmental Management Act (NEMA) is South Africa's over-arching environmental legislation and outlines the governance structures for ensuring that the environmental right in the National Constitution ("Everyone has the right to an environment that is not harmful to his or her health or wellbeing") is effected. The Act recognises that "Sustainable development requires the integration of social, economic and environmental factors in the planning, implementation and evaluation of decisions."

It is often assumed that NEMA pronounces on riparian set-back lines – something that is central to the relationship between agriculture and the quality of water resources. This is not strictly true. The National Environmental Impact Assessment Regulations promulgated under NEMA presents just one framework under which riparian set-backs can be established, with the National Water Act (Act No. 36 of 1998) being the other law that regulates activities in close proximity to watercourses. The 2014 Environmental Impact Assessment Regulations stipulate that Environmental Authorisation (subject to Basic Assessment) is required for almost all activities in a watercourse, or within 32 metres from the edge of a watercourse or wetland, excluding where such construction will occur behind a development set-back line. The regulations define various size and locational thresholds for these activities, which in some cases may allow activities in close proximity to watercourses to be exempted from requiring Environmental Authorisation.

NEMA therefore only regulates certain types and scales of activities within and in close proximity to watercourses, and there are no legislated requirements regarding riparian buffer zones for agriculture. In the absence of such laws, the then Department of Water and Forestry put forward recommendations for the forestry sector stating that the minimum buffer between the outer boundary of a riparian zone and plantations should be 20 metres, but these remain recommendations (Department of Water Affairs and Forestry, 2008).

In addition, the Water Research Commission (WRC) has compiled a preliminary guideline for the site-specific determination of buffer zones for rivers. The guidelines take a number of factors into consideration including the risk posed by the development and the sensitivity of the water resource (Water Research Commission, 2014). The WRC's recommendations recognise the importance of riparian buffer zones for preventing nitrate run-off from fertilisers and livestock entering water resources, for preventing soil erosion and for supporting biodiversity. They do not, however, provide a legal basis for informing land use.

2.4.1.2 National Environmental Management: Biodiversity Act (2004) NEMBA and regulations for alien and invasive species controls (2014)

The continued invasion of alien plants, which consume more water than indigenous counterparts and reduce biodiversity, is a critical driver of catchment degradation and reductions in water yields in the study area.

The Alien and Invasive Species Regulations (2014) were introduced in order to reduce the spread of alien invasive plants in South Africa by involving land owners in assisting to eradicate alien invasive plants. The regulations list the different alien plants according to four different categories, 1a, 1b, 2 and 3. Category 1a alien plants are required to be eradicated by the landowner and category 1b alien plants are required to be controlled. The Department of Environmental Affairs may be called on to assist with the removal of these plants. Category 2 alien plants are only allowed to be grown if the landowner is in the possession of a permit and need to be contained. Category 3 alien plants are species that are subject to exemptions. Category 3 alien plants that exist in riparian areas for example are considered as Category 1b alien invasives.

With regards to change in ownership of land, land owners are required to inform the purchaser, in writing, of the presence of listed invasive species on the specific piece of land. Furthermore if the seller of the land has an existing permit to grow certain alien invasive plants, this permit is not transferred to the purchaser, and a new permit has to be applied for. Contraventions of the regulations may result in fines of up to R10 million and imprisonment of up to 10 years.

There is considerable concern and confusion about the practicality of implementing these new regulations from land-owners and the forestry sector in particular. However, they do offer a regulatory foundation on which lending conditions could require stronger compliance and alien management by land-owners.

2.4.1.3 National Water Act (Act No. 36 of 1998)

Preamble:

"*Recognising that water is a scarce and unevenly distributed national resource which occurs in many different forms which are all part of a unitary, interdependent cycle;*

Recognising that while water is a natural resource that belongs to all people, the discriminatory laws and practices of the past have prevented equal access to water, and use of water resources;

Acknowledging the National Government's overall responsibility for and authority over the nation's water resources and their use, …:

Recognising that the ultimate aim of water resource management is to achieve the sustainable use of water for the benefit of all users;

Recognising that the protection of the quality of water resources is necessary to ensure sustainability of the nation's water resources in the interests of all water users; and

Recognising the need for the integrated management of all aspects of water resources and, where appropriate, the delegation of management functions to a regional or catchment level so as to enable everyone to participate;"

South Africa's National Water Act,36 of 1998

Agriculture and forestry have historically been the greatest consumers of water in South Africa, but this is changing as urban water demand increases. South Africa is a water scarce country and has always had to manage its available water resource to meet multiple needs. The National Water Act (NWA) drew heavily on the Dublin Principles[4] for integrated water resource management and proposed a radical reform of water allocation in South Africa that included a shift from supply management to demand management, a guaranteed minimum allocation of water to each citizen, the inclusion of an environmental right to water, the 'environmental reserve' in order to maintain the functioning of hydrological ecosystems, water pricing instruments that reflected the social costs and scarcity value of water, and the formation of Catchment Management Agencies and Water User Associations to oversee the governance of water.

The Act also defines wetlands and riparian habitats in some detail. Wetlands are considered as "*Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."* Riparian habitat includes the "*Physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas*."

The NWA is codified in the periodically updated National Water Resource Strategy (NWRS) aimed at, "*Managing Water for an Equitable and Sustainable Future.*" Crucially the NWRS outlines a hierarchy of water use in which agriculture and forestry are accorded a very low priority. The implication should be that these two sectors are the first to experience water rationing in times of scarcity, however, given that these two sectors currently use the most water and that the local water management institutions to affect water allocation reform have not been established, this rationing does not always ensue.

Section 21 of the Act describes 11 different water use types that require registration or authorization from the Department of Water and Sanitation. The listed water use types include water storage (i.e. in dams), abstraction from a water resource (ground and surface water), irrigation of water or effluent, stream flow reduction activities, impeding or diverting the flow of water in a watercourse, alteration of the bed or banks of a watercourse, discharging waste or water containing waste into a water resource or to land, and any activity within 500m of a wetland. Depending on the scale and location of the water use activities, they may either need to be registered or licensed. Water Use License Applications must be supported with a detailed assessment of the impact of the proposed water use activity on local and regional water resources.

Essentially, it is this requirement that may influence the setting of riparian and wetland buffer zones and set-backs.

[4] The Dublin Principles were developed at a meeting of experts in January 1992 and presented at the Rio Earth Summit later that year. The four principles are: 1) Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment; 2) Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels; 3) Women play a central part in the provision, management and safeguarding of water; and 4) Water has an economic value in all its competing uses and should be recognised as an economic good.

2.4.1.4 National Environmental Management: Waste Act (Act No. 59 of 2008)

The proclamation of the "Contaminated Land Provisions", which came into effect on the 2nd of May 2014 under the National Environmental Management: Waste Act (Act No. 59 of 2008), provides a crucial backdrop for this project. According to these Provisions, financial institutions are obligated to rehabilitate contaminated land before it can be transferred to a new owner. This is applied to banks in the case of repossessed properties where clients were unable to afford remediation. The Act transfers the ultimate risk for environmental damage back to the lenders and, in theory, will see them applying greater due diligence on low-probability, high-cost risks that might need to be factored into financial decision making. The proclamation was intended to tackle South Africa's acid mine drainage problems, however, contaminants are defined as including biological waste and hazards, and so could find wider application.

2.4.2 Financial Policy

The increasing mobility of financial capital necessitates that South Africa's finance sector is governed by a combination of international and local legislation.

Environmental damage feeds back to the financial sector in a number of ways: under-performing or non-performing loans when deteriorating resource quality or quantity undermines productivity; risk of litigation for environmental breaches; inability to raise capital due to lack of appropriate disclosure on Environmental, Social and Governance (ESG) risks; reputational risk and loss of low-cost depositor capital if clients react to publicly perceived environmental damage.

International efforts to avoid these risks rely on the Third Basel Accord (Basel III), which was an update of the Second Basel Accord following the 2008 financial crash, aimed at ensuring that banks would hold more capital. Basel III also required the application of 'stress testing' to ensure that banks are capable of withstanding a wide range of contingencies. ESG reporting requirements emerged from both the governance requirements and the public perception that banks need to exert more influence. ESG reporting is now a prerequisite for the raising of financial capital and accreditation as a financial lender, and requires financial institutions to report on their exposure and commitment to:

i. **Environmental:** Greenhouse gas (GHG) emissions, biodiversity loss, pollution and contamination, carbon regulation exposure, renewable energy;
ii. **Social:** Labour practices, community displacement, human rights, health and safety, financial inclusion;
iii. **Governance:** Corruption and bribery, reputation, management effectiveness.

ESG reporting represents a relatively new requirement for financial institutions, many of which are still developing their capacity to account on these fronts. Already, however, there is a sense that ESG reporting may not yet reflect the systemic risks or associated potential - such as climate change, water scarcity or failed-state status - that affects the ability of any financial system to prosper (CISL & UNEP-FI, 2014). On the contrary, concern has been raised about the Basel III requirement to hold additional capital as security when investing in novel or unfamiliar ventures, and the regressive implications of this requirement in the context of redirecting finance towards low-carbon, climate-adaptive ventures.

2.5 Private Financial Flows in Agriculture in the Study Area

2.5.1 Overview

Agriculture is a significant economic activity in the Greater uMngeni Catchment. The catchment supports a diverse range and scale of agricultural activities from large-scale corporate and commercial farmers to small-scale and emerging farmers. For the purposes of this study, confidential interviews were conducted with organisations that have knowledge of farming in the catchment, as well as with several farmers. Interviewees highlighted that there is a general trend of consolidation in the commercial farming sector within the catchment. As a result, the total number of commercial farmers has been reducing over time, and the remaining farmers have enlarged their holdings and production capacity. Farming also appears to be becoming increasingly capital-intensive in certain sub-sectors.

A brief overview of the significant agricultural sub-sectors in the catchment is presented below. However, since catchment boundaries are not used to track information by any sub-sectors operating in the catchment, it is difficult to estimate their exact size and structure.

Forestry is a significant agricultural sub-sector in the Greater uMngeni Catchment, accounting for 13% of land cover in the catchment. Figure 2.1 shows the location of the 103,571 hectares of land used for plantation forestry in the Greater uMngeni Catchment. Forestry plantations found within the catchment include three commercial timber species, all of which are non-indigenous to the region, namely Pine (*Pinus* spp.), Gum (*Eucalyptus* spp.) and Wattle (*Acacia* spp.) (Janet Edmonds Consulting, 2015).

Another significant agricultural sub-sector in the catchment is sugarcane. Sugarcane crops in the Greater uMngeni Catchment are mostly grown under dryland conditions and are predominately located in the vicinity of the Noodsburg Sugar Mill in Dalton. Based on interviews with stakeholders it is estimated that approximately 120 commercial sugarcane growers operate in the Greater uMngeni Catchment.
Figure 2.2 shows that sugarcane farming in the catchment is dominated by commercial farmers, whose farms cover 36,141 hectares and 4.5% of the catchment area. Emerging farmers only account for 259 hectares (0.7% of the total) of the sugarcane plantations in the region.

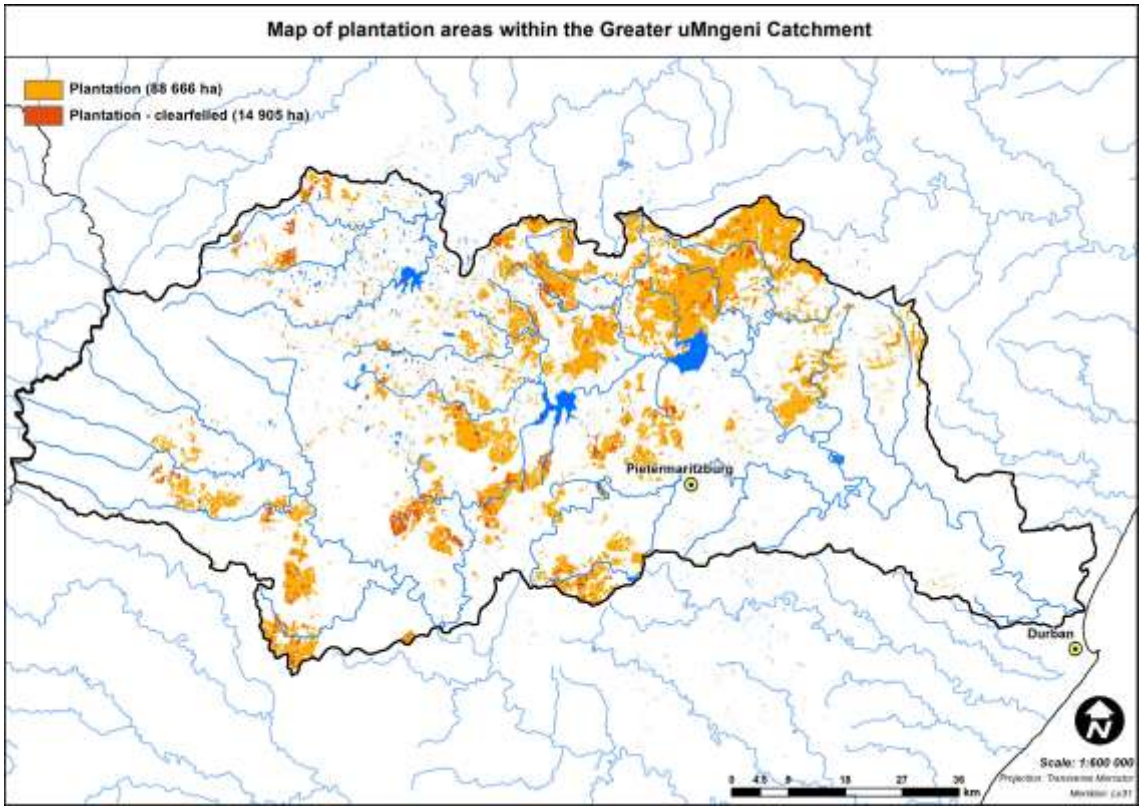


Figure 2.1: Map showing forestry plantation areas within the Greater uMngeni River Catchment.

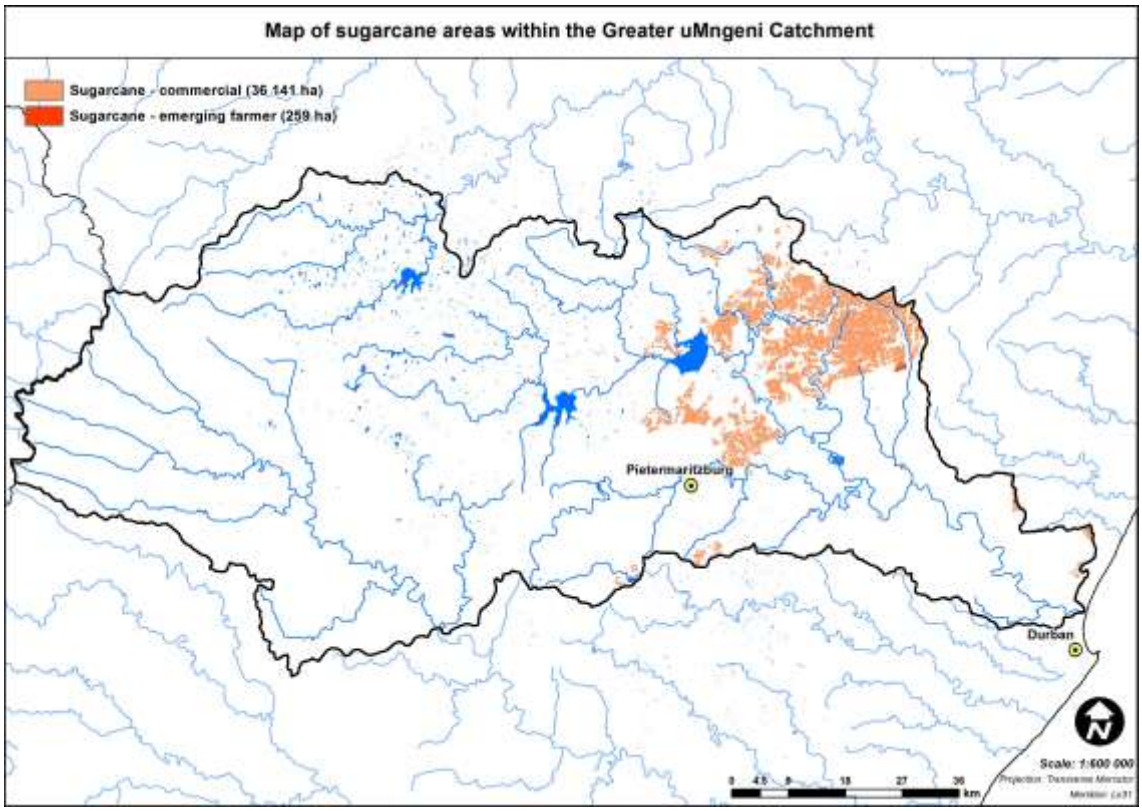


Figure 2.2: Map showing sugarcane plantation areas within the Greater uMngeni River Catchment.

The agronomy sub-sector (excluding sugarcane, which is discussed above) comprises crops such as fruit, potatoes, maize, soya and other vegetables. (Figure 2.3) shows the coverage of orchards, commercial dryland and irrigated crops in the catchment.

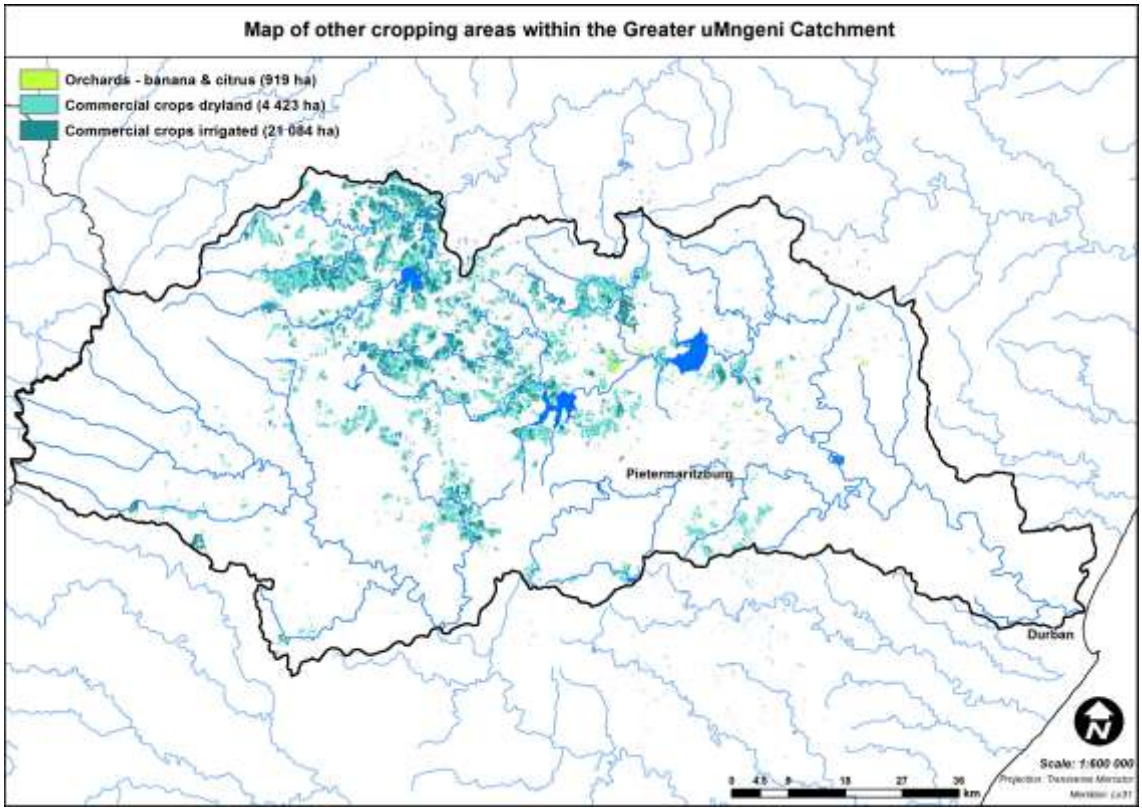


Figure 2.3: Map showing the cropping areas within the Greater uMngeni River Catchment

Other agricultural sub-sectors operating within the catchment include dairy, poultry, beef and pork. The poultry industry has two main components, namely broiler production and egg production. In the Greater uMngeni Catchment, broiler production is dominated by corporate producers. In particular, Rainbow Chickens, which is a wholly owned subsidiary of RCL Foods Limited, is estimated to account for 80% of broiler production in the catchment. There are very few other commercial broiler producers; however, there are a number of small-scale poultry producers that target the live-sales market. On the other hand, and with regards to egg production, it is estimated that about 20 commercial farmers account for 80% of production in the catchment. One corporate, Nu Laid, has a few farms in the area, while there are also a number of small-scale producers operational in the catchment.

Dairy is a significant sub-sector in the catchment, and dairy farms are generally located in the in Kamberg / Mooi River, Fort Nottingham / Lions River areas, and the Karkloof Valley (Janet Edmonds Consulting, 2015). The dairy sub-sector is estimated to consist of between 70 to 80 commercial farmers. Since it is estimated that a minimum of 300 cows is required for viable production, there are no small-scale producers in this sub-sector in the catchment.

Piggeries can also be found throughout the Greater uMngeni Catchment. A number of large operations, comprising up to 2,000 sows or more, and small or emerging operations with less than 50 sows, are all located in the catchment (Janet Edmonds Consulting, 2015).

Beef is not a large agricultural sub-sector in the catchment and most commercial farmers in the beef sector are not exclusively focused on beef production (Janet Edmonds Consulting, 2015). Commercial beef farming typically operates with a combination of pasture and veld grazing. However, there is at least one feedlot in the catchment, namely Triple A, which is located in the Albert Falls area.

2.5.2 Financial Flows

This research project looked at the three main categories of private finance flows within the agriculture sector in the Greater uMngeni Catchment, specifically, equity finance, debt finance and insurance. These are each considered in the following section of the report.

2.5.2.1 Equity Finance

Commercial farming is a capital intensive enterprise that requires considerable funds for land, buildings and equipment. In the case of family-owned farming businesses, a considerable portion of the equity required for these businesses is provided by the family itself. The proportion of these funds that can be considered to be 'own equity' varies considerably. For instance, some farms are owned debt free. However, most farms rely on a certain level of debt to operate. Based on the interviews conducted for this report, it is estimated that for most family-owned businesses between 55% and 80% of the equity is 'own equity' supplied by the family itself.

In addition to family-owned commercial farms, there are a number of large corporate entities operating in the catchment. Generally these are listed companies with equity owned by shareholders. The corporates with the most significant operations in the catchment are SAPPI Limited and RCL Foods Limited (owner of Rainbow Chickens). Other corporates that have an interest in the area include AFGRI, ASTRAL and MONDI Group. In its 2014 integrated report, SAPPI Limited indicated that it had $2,990 million in capital, of which $1,044 million was in the form of shareholders equity (SAPPI, 2014). It should be noted that SAPPI operates in South Africa and internationally and as a result only a small portion of its total holdings fall within the Greater uMngeni Catchment. In its 2014 integrated report, RCL Foods Limited reported total assets of R19,910 million, of which R9,436 million is shareholder equity (RCL Foods Limited, 2014). RCL Foods Limited has four operating subsidiaries with Rainbow Chickens, the dominate broiler producer in the catchment, being one of these four.

With regards to small-scale or emerging farmers operating in the catchment, in many cases it is likely that all of the equity is 'own equity'. However, government is actively supporting these groups through two main channels. Firstly, government provides direct support to emerging farmers, for example, set-up kits (for new poultry producers) or agricultural extension support may be provided. Secondly, through its land reform programme, government acquires land which is either restored to the original owner communities or is redistributed. In the cases of redistribution, equity is provided by the state and transferred to beneficiary communities.

It is only in the case of large corporate organisations that the ownership equity is provided by people and organisations not directly involved in the operation and management of the agricultural enterprise. Most of these corporates are listed on the stock exchange and as a result have dispersed ownership. These stock exchange listed companies are expected to operate at a much higher level of transparency than unlisted companies, and the annual reports of these companies provide comprehensive information on a range of issues that may be of interest to shareholders. These annual reports provide information on compliance of the companies with relevant legislation and aim to demonstrate a high level of commitment to compliance since non-compliance could be a business risk going forward.

2.5.2.2 Debt Finance

Debt finance is an important input to commercial and corporate farming in the Greater uMngeni River Catchment. However, only limited debt finance is available to small-scale or emerging farmers, as securing the debt is often a challenge for these groups. Most banks reported that they did not provide finance to small-scale growers, except in the sugarcane sub-sector where banks are able to take a cession with the sugar mills as security. In the forestry sub-sector, both SAPPI and MONDI have initiatives that allow for certain small-growers to access finance. Finance accessed by small-growers is typically production finance that allows the grower to finance the planting of the crop.

Corporate Debt

Corporate organisations are significant users of debt finance. However, their debt finance is generally not raised at a local level to finance local operations, but is rather raised at a group scale and as a result generally cannot be specifically linked to a geographic area or subsidiary. SAPPI comprises of two legal entities namely SAPPI Southern Africa Limited and SAPPI Papier Holding GmbH, which is the international holding company. SAPPI Southern Africa Limited issues debt in the local South African market for its own funding requirements and SAPPI Papier Holding GmbH issues debt in the international money and capital markets to fund SAPPI Limited's business practices outside of South Africa (SAPPI, 2014). The net debt of SAPPI across all operations was $1,946 million (65% of total capital) at the end of its 2014 financial year. $97 million of this debt is South African debt. According to SAPPI Limited's latest debt update, the majority of the company's debt is public debt, with only 11% being bank debt (SAPPI, 2014).

RCL Foods Limited on the other hand reported total long and short term debt of R4,648 million (23% of total assets) at the end of its 2014 financial year (RCL Foods Limited, 2014).

Privately owned farms' debt

Family-owned commercial farms in the catchment are also significant users of debt finance. They are typically accessing this finance from the four main commercial banks of South Africa namely Standard Bank, First National Bank, Nedbank and ABSA. Each of the banks has specialist agriculture divisions based in Pietermaritzburg and focused on providing for the financing requirements of farmers. The three main forms of debt financing that farmers make use of are:

1. Term loans with repayment periods of between five and fifteen years.
2. Asset finance for vehicles and equipment with repayment periods of up to six years.
3. Production loans and / or overdrafts with a twelve month repayment periods.

The main form of security used by banks is a bond against the farm itself. Other forms of security include the assets that have been financed, and life insurance policies. It should be noted that while most debt is secured, not all debt is always fully secured.

Staff from the specialist agriculture divisions of the above-mentioned banks keep in close contact with the farmers, who are their clients, and would in all likelihood visit their clients at least once a year. In the case of new credit applications, banks are largely concerned with three issues:

1. **Repay-ability**: This was highlighted by banks as their most important consideration. When considering 'repay-ability' banks will examine the business plan of the farm to check if on paper the operation is able to cover the costs of repaying the loan. Banks also consider the management ability of a farmer when considering 'repay-ability', and look for evidence that a farmer is a good manager. Several of the banks indicated that good environmental practices on a farm are a signal of a good manager, and one of the banks indicated a preference in the forestry sub-sector to giving loans to farmers that have achieved Forestry Stewardship Council (FSC) certification. Banks also noted that the farm must have sufficient water rights to sustain the level of farming described in the business plan. In this way, water rights form part of the collateral that a bank might consider before providing a loan, but banks do not look beyond the farm to ascertain the likelihood of water rights being honoured, or the catchment's ability to support all rights in a given year.

2. **Land value**: As discussed above, bank finance is mostly secured against fixed property. Important to the banks is to ensure that the land value of a property being used as collateral is sufficient to secure the loan. Banks normally do an internal valuation of the property at the outset of the process to satisfy themselves that the value is sufficient. Furthermore, to conclude the process, an external valuator is brought in to make a formal determination of land value. The water rights linked to a property is an important consideration in determining land value. Specifically to Greater uMngeni River Catchment, Banks noted that, while land values in the catchment have been increasing, the inclusion of water value to the value ascribed to land makes no assessment of the reliability of the water over time or the ability of the catchment to support all allocated water licenses.

3. **Compliance**: All banks check for compliance with environmental impact assessment regulations when funding new buildings. In addition, banks will check for appropriate water use licenses and waste water management permissions in cases where this is applicable.

The process of approving a new credit application typically takes two to three weeks and banks highlighted that a quick turnaround was critical for securing new business.

Based on interviews with banks it is estimated that approximately R1.8 billion of finance is supplied to commercial farmers in the Greater uMngeni Catchment by banks. It is estimated that most family-owned farms have debt of between 20% and 45%. While higher debt ratios may occur, it is supposed that most farms with a debt ratio of more than 50% would not be economically sustainable. Payment default rates in the agriculture sector in the uMngeni catchment were

reported by banks as being between 0% and 1%. Other than steps taken at the outset of the credit application process to determine 'repay-ability', banks attributed the low payment default rates to the active effort they make to manage potential defaulters by restructuring debt, and to farmers selling up before defaulting on their loan repayments.

Since small-scale growers have limited access to debt finance and corporates are accessing debt at a geographic scale beyond the catchment, it is not likely that the behaviour of these two groups can be influenced through locally based debt finance providers. However, family-owned commercial farms are significant users of debt finance. Accordingly there is a possibility of influencing their behaviour through debt finance if the agricultural divisions of these banks are prepared to take steps to influence behaviour of their clients. There are two key questions to consider in this regard:

1. What mechanisms could banks use to influence the behaviour of their clients?
2. Is there an incentive for banks to influence the water management behaviour of their clients?

There are three broad categories of mechanism available to banks:

1. **Placing pre-conditions on the provision of finance:** Banks already use this mechanism to influence behaviour. For instance, banks will not fund new agricultural buildings without proof that the farm has complied with Environmental Impact Assessment regulations requirements and have the required water use license to support the level of farming activity described in the application for finance. It should, however, be noted that all banks interviewed indicated that providing a fast response to credit applications was critical to securing clientele. Accordingly banks have an incentive to minimise the number of issues that need to be investigated by the agricultural division when determining if a loan will be granted or not. Thus, making use of this mechanism could have ¢ financial implications for any bank that is acting in isolation.

2. **Stress testing and preferential interest rates:** Stress testing is a financial sector requirement under Basel III, and South African banks test their market positions against a variety of political and economic contingencies. Banks do not, however, currently stress test their loan books against systemic environmental pressure such as prolonged drought, deteriorating water quality or increased fire risk. Banks could offer the clients that have limited exposure to environmental risk, superior environmental performance, and/or environmental risk mitigation and adaptation strategies in place, preferential interest rates to reward them for responsible behaviour. Use of this mechanism may be limited by the need for banks to provide equitable access to finance for clients. Since the bank would be providing preferential interest rates (if using this mechanism) there may be a potential-earnings loss to the bank.

3. **Providing bespoke finance for activities that improve catchment management:** Banks provide overall finance for agricultural operations that may include activities that are good for catchment management. However, as an additional incentive banks could provide specialist finance for activities that are good for catchment management. ABSA already has

such an offering in place as a result of a partnership with the French Development Agency. Through this partnership ABSA is "*Offering commercial businesses in South Africa an up to 7% rebate on loans of up to R100-million that are used to fund energy efficiency or renewable energy projects.*" (Engineering News, 2014). One of the first beneficiaries of this programme was a fruit farm in the Western Cape that installed a 1 MWh rooftop solar photovoltaic system. Biogas, solar PV, wind power, solar thermal and energy efficiency projects all qualify for this incentive (Engineering News, 2014).

There are three broad reasons why banks may want to incentivise better water management behaviour amongst their clients:

1. **Action by banks could reduce risk or financial losses:** Banks interviewed for this report did not believe that they experienced any losses as a result of poor catchment management in the uMngeni and pointed to the low payment default rate with regards to agricultural debt to demonstrate this point. Since the payment default rate for banks is so low in the agricultural sector, it cannot be reasonably expected that any steps taken by the banks to influence environmental management behaviour would reduce their level of risk or any financial losses. As a result, there is currently no visible financial benefit to banks if they incentivise better environmental management behaviour amongst their clients.

2. **Action by banks could create new business:** Banks interviewed all expressed an interest in funding initiatives such as biogas digesters that could contribute to improved catchment management. However, few clients have actively expressed an interest in these types of installations and there is no demonstrated financial case for installations of this nature available to banks and their clients.

3. **Action by banks is required to protect their reputation:** Some banks expressed concern about the reputational risk of funding an enterprise that becomes known to have significant negative environmental impact. Banks already take a number of steps to protect themselves in this regard and in particular require compliance with regards to Environmental Impact Assessment regulations and obtaining appropriate permits for waste water disposal. This incentive clearly exists in the cases where substantive negative impact can clearly be demonstrated to banks. However, this incentive is expected to be less successful in cases where farm activities do contribute to broader negative impacts on the catchment but where such impacts can't be specifically linked to one farm.

2.5.3 Insurance

Insurance is important for corporate and family-owned commercial farms in the Greater uMngeni River Catchment.

2.5.3.1 Corporates

In the case of corporate organisations active in the catchment, they appear to bundle assets together for insurance purposes, to reduce costs. For instance RCL Foods Limited reports "*The Group now applies an umbrella approach to insurance and aims to insure all Group companies under the same insurance structure*" (RCL Foods Limited, 2014). As a result, operations in the Greater uMngeni

River Catchment are not independently insured from operations in other areas. In addition to bundling assets to secure improved insurance premiums, corporate entities do not insure for all risks and they make active decisions on the level of risk they are prepared to carry internally.

SAPPI Limited notes "*The group has an active programme of risk management in each of its geographical operating regions to address and reduce exposure to property damage and business interruption…The self-insured retention portion for any one property damage occurrence is US$26 million (€20.5 million) with the annual aggregate set at US$42 million (€33 million). For property damage and business interruption insurance, cost-effective cover to full value is not readily available. A loss limit cover of US$951 million (€750 million) has been deemed to be adequate for the reasonable foreseeable loss for any single claim*" (SAPPI, 2014).

2.5.3.2 Family-Owned Farms

Family-owned commercial farms in the Greater uMngeni River Catchment access insurance from short term insurance providers such as SANTAM and MUTUAL & FEDERAL. In addition there are two specialist agricultural insurance providers operating in the catchment, namely SAFIRE and GROCANE (for more information on GROCANE and SAFIRE see text boxes below). Insurance products that farmers make use of include the standard range of short term insurance products used by most businesses as well as insurance products of specific relevance to farmers such as spread of fire, crop and livestock insurance. It is estimated that about R5.8 billion in commercial farming assets are under insurance in the Greater uMngeni River Catchment.

GroCane

GroCane is a co-operative that was founded in 1949 when commercial sugarcane growers found that they were unable to source insurance at a reasonable price. It currently has 1,540 members (GroCane, n.d.) and provides members with cover in the case of damage to sugarcane from fire. GroCane also provides two smaller policies linked to their main cover that are underwritten by other insurers, namely South African Special Risk Insurance and Spread of Fire insurance. Members are charged a premium annually in arrears based on tons of sugarcane delivered to the sugar mills. GroCane makes use of re-insurance with underwriters to protect itself against large-scale loss. Its head office is located in Mount Edgecombe and it is the dominant provider of fire risk insurance to sugarcane farmers in the Greater uMngeni River Catchment.

Safire

Safire was established as a co-operative in 1987 "*when a group of farmers and timber-growers decided to act to curb the spiralling costs of insuring their timber. They created a unique insurance co-operative to respond to the specific requirements of their niche market*" (Safire, n.d.). In 2000 the co-operative converted to a public insurance company and was granted a short term insurance licence. Safire currently provides a wide range of domestic, commercial and agricultural insurance products and, because of its history, agriculture forms a significant niche within its business. With regards to crops, Safire provides insurance for timber, cane and macadamia nuts. It also offers livestock insurance. Safire makes use of re-insurers to insure itself against catastrophic loss. Safire's head office is based in Pietermaritzburg and it is the dominant provider of fire risk insurance to commercial timber growers in the Greater uMngeni River Catchment.

It should be noted that in the case of GroCane and Safire, the dominant risk that is being insured is fire, which is the key risk in sugarcane and timber operations. As such, insurance for other crops such as maize and soya beans covers a broader range of risks. For instance Mutual & Federal's "agricrop" insurance solution provides cover for items that Mutual & Federal describes as direct risks (e.g. hail, fire, chemical overspray and transit), and systemic risks (e.g. drought, excessive heat waves, frost, excessive rainfall, uncontrollable plant diseases, pests and wind damage) (Mutual & Federal, 2015).

The majority of insurance applications received by short term insurance providers are approved electronically. The insurance decision is made based on a declaration of facts by the entity being insured that may have a bearing on the level of risk. However, most specialist agricultural insurers are likely to visit the farm and undertake a risk assessment of their own. For instance, when insuring crops against fire, risk insurers will visit the farm in question and complete a risk assessment that looks at issues such as management of fire risk and access to water in the case of a fire. The outcome of the risk assessment can influence the premium charge, the amount of cover, and the size of the excess.

Interviews with farmers and farmer representatives in the catchment revealed that most farmers do not insure against the full suite of risks that they face. The main reason cited for this was the high cost of insurance. However, in some cases the particular insurance product required is not available at a price that makes it practical for a farmer to use. For instance, Potatoes SA reported that the cost of insuring potatoes against hail damage is prohibitively expensive. It should also be noted that for many crops it is unlikely that a total loss would be experienced by the farmer as it is often possible to recover a portion of the crop.

Farmers and farmer representative organisations reported that insurance only accounted for a small portion of operating costs. However, it should be noted that farmers take steps within their operations to manage the various risks that they face. For instance, in the timber sub-sector a farmer in a high risk hail area may opt to plant more hail resistant species. Farmers would also provide for a percentage of loss in their business planning.

2.5.3.3 Small-Scale Growers

Since small-scale growers do not appear to make use of insurance, and corporates are accessing insurance at a group level with no specific link back to the catchment, it seems unlikely that the behaviour of these two sectors within the catchment can be influenced through insurance providers. However, family-owned commercial farms are significant users of insurance, some of which is provided by insurers located in the catchment, and so there is a possibility of influencing their behaviour through insurance agencies if the agencies are prepared to take steps to influence behaviour of their clients. There are two key questions to consider in this regard:

1. What mechanisms could insurers use to influence the behaviour of their clients in the catchment?
2. Is there an incentive for insurers to influence the water management behaviour of their clients?

With regards to the first question, insurers are very active in influencing the behaviour of their clients in the catchment and this can be clearly demonstrated in the case where insurers are offering fire risk insurance. Most of the insurance activity in this regard is focussed on influencing the behaviour of their clients to reduce risk, and insurers have four key mechanisms used for this purpose:

1. Refusing cover or imposing limitations on the amount of cover a client can access in cases where the client is not able to manage their risk sufficiently.
2. Offering clients lower premiums if risk management measures are put in place.
3. Offering clients a lower excess if additional risk management measures are put in place.
4. Invalidating insurance in cases where minimum risk management requirements have not been implemented.

In addition to influencing the behaviour of clients, some insurers get proactively involved in interventions that reduce fire risk. For instance, they provide active support to fire protection agencies in the catchment and Safire has a programme to promote the safe harvesting of honey, since this has been identified as a major cause of fires in rural areas. As part of this programme Safire provides education to communities who engage in honey collecting and also donates smoker units to promote responsible removal of honey (Forestry South Africa, 2013).

2.6 Private Financial Flows in Residential Development in the Study Area

2.6.1 Overview

Residential development in the Greater uMngeni Catchment is concentrated in the more urbanised municipalities of Msunduzi and eThekwini. This is depicted in
Figure 2.4, which shows that 4,520 ha (0.5% of the catchment) of the catchment area contains settlement areas with a relatively high density. The map also shows that low density and rural settlements which account for 32,148ha (4% of the catchment) and 23,993 ha (3% of the catchment) respectively, are located in the Ingwe, Impendle, Msunduzi, uMshwathi and eThekwini municipalities.

A large portion of land in KwaZulu-Natal is traditional land allocated to the Zulu nation. This land is administered by the Ingonyama Trust Board, and the sole trustee is the Zulu King (Ingonyama Trust Board, n.d.). Ingonyama Trust land accounts for 139,209 ha or 17.5% of the catchment area. Ingonyama Trust land is concentrated in the eThekwini, Ingwe, Impendle, uMshwathi, Mkhambathini, Richmond and Ndwedwe Municipalities.

There are four main types of residential dwelling the catchment. Formal dwellings that are built according to an approved plan, rural dwellings and informal dwellings. There are no accurate statistics available for residential development in the catchment, since information on housing is not collected on a river catchment basis. However, it is possible to make some estimates that give a picture of the relative scales of different types of residential dwellings the catchment.

The dominant dwelling type in the catchment is 'formal', according to the 2011 Census of South Africa. Table 2.1 shows the total number of households in the municipalities that fall within the catchment, and the percentage of formal dwellings per municipality. Based on the coverage of each municipal area within the catchment boundary, the estimated number of formal dwellings which exist in the catchment is 420,683 (Statistics South Africa, n.d.).

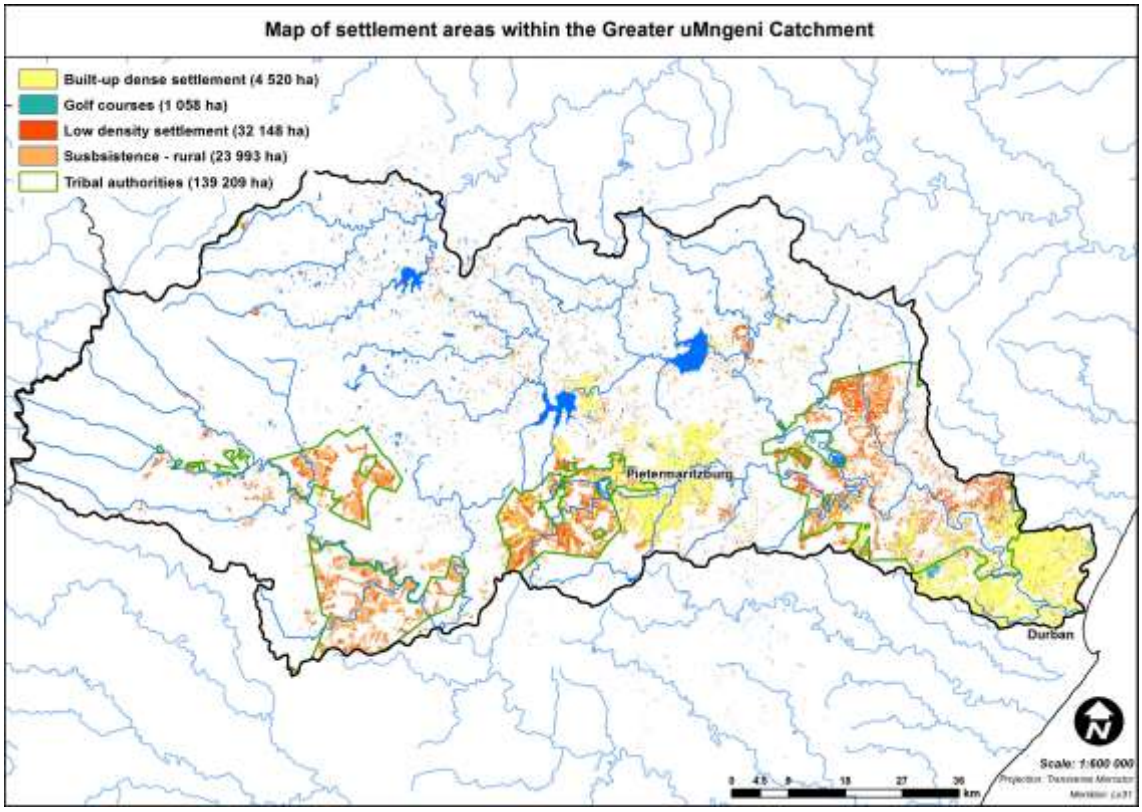


Figure 2.4: Map showing settlement areas within the Greater uMngeni River Catchment.

Table 2.1: Calculation of estimated number of formal dwellings in the catchment (Statistics South Africa, n.d.)

NAME	NO. OF HOUSEHOLDS	% OF FORMAL DWELLINGS	NO. OF FORMAL DWELLING	% OF MUNICIPAL LAND WITHIN THE CATCHMENT	ESTIMATED NO. OF FORMAL DWELLINGS WITHIN THE CATCHMENT
MSUNDUZI	163,993	73.7%	12,0863	100	12,0863
IMPENDLE	8,203	44,1%	3,618	100	3,618
UMNGENI	30,490	85.4%	2,6038	99	25,778
UMSHWATHI	28,124	62.7%	1,7634	69	12,167
INGWE	23,073	30,1%	6,945	37	2,570
ETHEKWINI	956,713	79%	755,803	33	249,415
MKHAMBATHINI	14,964	48.9%	7,317	24	17,56
MPOFANA	10,452	76,1%	7,954	30	2,386
KWASANI	3,673	67,5%	2,479	19	471
RICHMOND	16,440	54,7%	8,993	9	809
NDWEDWE	29,200	48,5%	14,162	6	850
TOTAL					**420,683**

It is also possible to estimate the number of agricultural households in the catchment. Based on the coverage of each municipal area within the catchment, the estimated number of agricultural households in the catchment is 96,639 (Statistics South Africa, n.d.).

Table 2.2: The estimated number of agricultural households in the catchment (Statistics South Africa, n.d.).

NAME	NO. OF AGRICULTURAL HOUSEHOLDS	% OF MUNICIPAL LAND WITHIN THE CATCHMENT	ESTIMATED NO. OF AGRICULTURAL HOUSEHOLDS WITHIN THE CATCHMENT
MSUNDUZI	35,527	100	35,527
IMPENDLE	4,630	100	4,630
UMNGENI	6,767	99	6,699
UMSHWATHI	9,329	69	6,437
INGWE	12,872	37	4,763
ETHEKWINI	105,567	33	34,837
MKHAMBATHINI	5,067	24	1,216
MPOFANA	3,258	30	977
KWASANI	1,176	19	223
RICHMOND	5,629	9	507
NDWEDWE	13,710	6	823
TOTAL			96,639

With regards to informal dwellings in the catchment, there are also no accurate figures available. A consultant active in the housing sector in KwaZulu-Natal estimates that there are approximately 110,000 informal structures in the catchment (Mann, 2015). About 95,000 of the informal structures thought to be in the catchment can be found low down in the catchment and within the eThekwini Municipal Area boundary (Mann, 2015).

Initial studies indicate that changes in urban and peri-urban settlement (including the provision of formal and informal energy and sanitation services to these settlements) constitute a significant source of habitat destruction and land degradation in the Greater uMngeni Catchment (Nel, pers.com). Tracking the influence of finance on this development is, however, more difficult.

2.6.2 Financial Flows

2.6.2.1 Equity

Similarly to the rest of South Africa, 'own equity' supplied by households is an important contributor to residential development in the Greater uMngeni Catchment. Residential development in the low income and informal sectors is often self-funded through incremental savings by households, i.e. the house is slowly built as funds become available (Mann, 2015). Wealthier households are more likely to be accessing mortgage finance, however, they would also self-fund a portion of their home.

In addition to the 'own equity' supplied by homeowners themselves, the state also provides equity for residential development. Funding from the state includes subsidies and grants to individuals, and finance to municipalities for infrastructure (Financial and Fiscal Commission, 2013). The state primarily provides housing finance to low-income groups through the National Housing Subsidy Scheme (NHSS) (Gardner, 2003). The NHSS provides the following different subsidies: Individual

subsidies; Project-linked subsidies; Institutional subsidies; Consolidation subsidies (allocated to households that accessed subsidies pre-dating 1994); Relocation subsidies; and Savings-linked subsidies. In addition, the government does provide subsidies for rural housing where individuals do not have legally secure tenure, but functional secure tenure such as in instances where land is governed by a tribe, such as the Ingonyama Trust land in KwaZulu-Natal (Gardner, 2003). In the Greater uMngeni Catchment it is estimated that about 47,000 houses have been developed in rural areas through state funded housing projects (Mann, 2015).

A final category of equity finance to consider is that which is supplied by private property developments for the establishment of private estates. Many of these private developments are located within formal planned areas, however, some are located in rural locations away from municipal service infrastructure.

Thus the most significant opportunity to influence residential development in the catchment through equity lies with state funded projects. This is due to the state being the single funder and having a vested interest in protecting the ecological infrastructure of the catchment. Since this report is focussed on opportunities in the private finance sector, this opportunity will not be examined further here.

2.6.2.2 Debt Finance

Debt finance is an important input to residential development in the Greater uMngeni Catchment. Statistics from the National Credit Regulator show that mortgage finance is mostly provided to households in South Africa that have a monthly income of over R15,000. Approximately 80% of private financing for housing is provided to this income group, with the remaining percentage provided to households that earn between R7,500 and R10,000 per month. Very few households that earn below R7,500 have accessed mortgage finance (Financial and Fiscal Commission, 2013). Households that earn between R3,500 and R7,500 can, however, qualify for a mortgage bond of between R140,000 and R300,000. Research by the National Credit Regulator also found that less than 10% of mortgage bonds granted were below R350,000 (Financial and Fiscal Commission, 2013).

In addition to mortgage finance, low income households can access unsecured lending for some of their residential development requirements. According to the National Credit Regulator, low-income groups account for a significant proportion of total unsecured lending, and accounted for 40% of the value of unsecured credit in 2012. It is, however, difficult to determine whether this credit was used for housing (Financial and Fiscal Commission, 2013) since it is unsecured and the lending institution is rather evaluating creditworthiness based on the ability of the individual to repay as opposed to what the individual plans to spend the money on.

There is limited opportunity to influence behaviour when development is funded through the unsecured lending market, since the lender is not tracking what the finance is being used for and as a result would not be in a position to impose restrictions or reward behaviour in that regard.

In terms of formal mortgage finance, the primary opportunity to influence behaviour would lie with the financing of “greenfields” development by a private lender. These developments are already required to comply with local municipal planning requirements as well as environmental impact

assessment regulations, but it is not clear whether these instruments capture all systemic environmental risks, including exposure to heat stress and the increasing intensity of hail and rainfall, absolute water shortages or the inability to grow certain types of crops in a given region. These changes are affected by environmental pressures and can materially affect the value of the assets which banks use as collateral.

In both greenfields developments and existing settlements, opportunities exist for banks to reduce these environmental pressures through the financing of infrastructure and technologies that, for example, reduce water run-off, promote passive cooling and the reduction of urban heat islands, reduce energy expenditure or maintain ecological flood buffers.

2.6.2.3 Insurance

There are a large number of short term insurers active in the South African market that service the residential sector. These include Santam, Mutual & Federal, OUTsurance and Hollard. Since response time is an important factor in securing business, most insurance applications received by short term insurance providers are approved electronically and the insurance decision is made based on a declaration of facts by the homeowner.

According to the Statistics South Africa Income and Expenditure of Households Survey of 2012, on average 2% of household expenditure in South Africa is utilised for insurance connected with a dwelling (Statistics South Africa, 2012). There is considerable variation regarding expenditure on insurance depending on the location of a household as shown in the table below.

Table 2.3: Percentage of household expenditure on insurance connected with a dwelling (Statistics South Africa, 2012).

CATEGORY	% OF HOUSEHOLD EXPENDITURE
Urban Formal	2.3
Urban Informal	0.0
Traditional Area	0.1
Rural Formal	2.9

Since insurance connected with a dwelling is not a significant factor in either urban informal or Ingonyama Trust areas, there does not appear to be an opportunity to influence behaviour in the Greater uMngeni Catchment of the urban informal or Ingonyama Trust areas through insurance. On the other hand, households located in formal urban areas and more formalised rural developments are active users of insurance connected with a dwelling, so there may be possibility of influencing their behaviour through insurance agencies if the agencies are prepared to take steps to influence the behaviour of their clients. As with the agricultural sector there are two key questions to consider in this regard:

1. What mechanisms could insurers use to influence the behaviour of their clients in the catchment?
2. Is there an incentive for insurers to influence the environmental behaviour of their residential clients?

With regards to the first question, as discussed previously, insurers are very active in influencing the behaviour in the catchment and have a number of mechanisms available to them.

With regards to the second question, the following were identified by a short term insurer as the three main risks for the Greater uMngeni Catchment:

1. Fire.
2. Hail.
3. Excess rain, resulting in flooding.

In terms of fire risk as discussed in previous sections, insurers take measures to promote the management fire risk in the catchment. With regards to the other two areas of hail and excess rain, an interviewee in the short term insurance sector expressed the view that "*there do not appear to be any measures that we could impose on our clients, or support the implementation of, that would reduce our risk and so allow us to reduce premiums.*"

As indicated previously, insurers are very active in influencing behaviour in the catchment when they believe change in behaviour will reduce their risk exposure. However, in the Greater uMngeni Catchment insurers would need to be provided with clear evidence regarding how a particular change in behaviour would reduce their direct risk. At this point insurers in the catchment do not see any opportunity to reduce their direct risk exposure. This reflects the industry's reluctance to move as individual institutions in response to systemic risk. However, there is opportunity to influence the industry as a whole via industry organisations such as the South African Insurance Association (SAIA).

2.7 Emerging Insights on the Finance Sector's Ability to Influence Land Use Patterns

The financial characterisation provided by this study supports the requirement in the study Terms of Reference to, "*Evaluate the role of private finance in catalysing systemic change and collective action in the key production supply chains within which they are invested*". This approach represents a departure from the traditional environmental monitoring and management approach, which is based on policing environmental legislation. Instead, the focus is on a) "*Opportunities for the financial sector to catalyse systemic change and collective action*", b) "*Private sector finance's …. incentive to promote better water resource management*" and c) the "*Identification of key leverage points for the financial sector to influence more sustainable behaviour.*"

The study reveals a strong conceptual case for this approach:

- Financial institutions are a significant and critical component of the economy in the Greater uMngeni Catchment. It is estimated that banks provide approximately R1.8 billion of debt finance to commercial farmers in the catchment, and approximately R5.8 billion worth of assets within the commercial farming sector are insured.

- The catchment is water-constrained and more efficient use of the available water (including a more rational allocation and the prevention of water contamination) would enhance the profitability of businesses that the financial institutions serve.

- The level of interaction between bank branches and farmers is relatively strong and the communication includes a focus on risk, water and land value, as well as operational actions at the farm site.

- Banks place value on water rights in the process of awarding loan finance, and have both an intimate understanding of which operations in the catchment are successful, and an over-arching perspective of why one operation is better than another. More than in most organisations, bank managers are exposed to both on-farm decisions and catchment-wide implications.

- The flow of finance and insurance does influence business operations, and financial institutions (by virtue of their growing global influence) are themselves under increasing pressure to report on their environmental (and social and governance) impact.

This is the theoretical potential. However, central to the actual merits of this approach is whether banks and insurers have a perceived incentive, at the local scale, to encourage a higher degree of ecological integrity. This incentive rests on the benefits to banks and insurers of having more clients that are less prone to insured environmental disasters outweighing the additional costs of ensuring stricter compliance – where stricter compliance might truncate their markets through shedding non-compliant land users, or land users that are placing the catchment's natural resource at risk.

In order to understand the practical potential of this in the context of the Greater uMngeni Catchment, this potential is examined below for each of the three private finance sectors discussed in the report:

1: Equity: In general very few agricultural and residential development entities make use of institutional equity (i.e. registered investors) to fund their activities. However, there are several stock exchange listed companies active in the catchment. These companies make use of shareholder equity and are required to report publicly on a substantial range of issues of relevance to their commercial activities. Listed companies in the catchment demonstrate a high level of transparency regarding their operations and a significant level of concern regarding compliance. These companies would consider non-compliance with any legislation relevant to preserving ecological integrity in the Greater uMngeni Catchment as a business risk that could reduce their attractiveness to shareholders. Beyond non-compliance, in the context of their concerns about shareholder confidence, it is expected that these companies could also be influenced to change behaviour in cases where it can be demonstrated that a changed behaviour would improve the financial sustainability of the company, or where continuing with a behaviour that has a negative environmental impact would reflect poorly on the reputation of the company. It also may be possible to influence the behaviour of stock exchange listed companies through shareholder activism or institutional shareholders who may have considerable holdings in single companies. In cases where specific issues of environmental

concern can be demonstrated to these shareholders, they may be prepared to engage with the company directly using their significant holdings as a basis for discussion.

2: Debt: Local banks have the potential to influence some of the behaviour of their clients in the catchment through imposing pre-conditions, preferential interest rates and providing bespoke financial products for activities that contribute to improved catchment management. At the moment banks claim not to have a financial incentive to impose pre-conditions or preferential interest rates that might enhance the catchment's ecological infrastructure. This is, in part, due to the banks' ability to insulate themselves from the operational risk of their clients through debt restructuring – banks in the catchment have regularly restructured agricultural debt following floods and droughts. In addition, public funded disaster relief is widely used. As a result they face very little financial incentive to encourage land users to adopt more sustainable practices.

This tendency is further supported by the observation that banks do not look beyond the farm to ascertain whether the hydrological resource can support all water rights. Equally banks tend not to focus on the foregone opportunity of more clients or more profitable clients if the resource was more efficiently utilised. The potential for the bank, if water in the catchment was better managed, is not something that most banks are well equipped to identify. Realising this counterfactual does not appear in any local banker's key performance indicators – most of which relate to the number of clients and their credit repayment rates.

Stronger incentives exist in terms of protecting against reputational risk and general compliance with legislation. Banks are already taking action in this area by requiring compliance with Environmental Impact Assessment regulations in terms of NEMA, and water and waste water licensing requirements. Through these efforts, they already make an important contribution to good environmental practice in the catchment. Banks could be expected to take additional action in this regard where attributable negative impact of their clients can be clearly demonstrated to them.

2.7.1 The Current Role of Private Finance

There may be financial incentive (albeit limited) to provide bespoke financial products for activities that improve catchment management where these activities can be proven to be financial viable.

1: Insurance: The main motive for insurers to incentivise better management of ecological infrastructure by their clients is to reduce the risk they are exposed to. Insurers interviewed for this report did not believe that there are actions they might adopt, beyond fire risk management, to reduce the level of risk they are exposed to in the catchment. The risk of fire is the issue of most concern to insurers active in the Greater uMngeni Catchment. After fire, other risks that were cited as concern areas were hail and flooding. With regards to managing fire risk, insurers can and do take measures to contribute to the reduction of that risk in the catchment. With regards to the other risks, some insurers are not exposed to those risks and those that are did not feel that there are any actions they can take to reduce their risk exposure. Since insurers are already taking some action in the Greater uMngeni Catchment to reduce their risk, it is clear that they would be prepared to take additional action that reduced their risk if the risk reduction

benefits of these actions can be proved. Once again, the critical need is for interventions that have demonstrated benefits in terms of risk reduction.

In addition to the sector-specific issues discussed above, additional observations that apply across these categories are reflected below:

- Finance institutions point out that it is their responsibility to comply with legislation, not to enforce it. The distinction is subtle, but while bank managers and insurance providers have more contact with land users than water and environmental officials respectively, they do not see it as their responsibility to enforce environmental behaviour that is not legislated or to adopt a policing of compliance (that has traditionally been seen as the responsibility of public sector authorities). As such, until they are confronted with a clear incentive to act, finance institutions are comfortable simply checking compliance with environmental legislation in a desk-top process.
- The cost of explicitly assessing environmental risk is high, and not something that banks are well equipped to undertake. Insurance companies have begun recognising systemic risks such as climate change, but still struggle to reduce it to specific policies at the farm scale. The credit risk adage that good farmers tend also to be good stewards of the land appears to hold true in Greater uMngeni Catchment. But the notion of good land stewards (or 'good jockeys' as they are often referred to) does not appear to take into consideration long-term risks, risks that are beyond the 'jockey's' control, or risks that do not manifest in the financial bottom line in the short term. While banks are required to 'stress test' their loan books for political and economic contingencies, they do not do this for environmental risk, and the outcome of stress testing tends not to translate to amendments to the terms of finance at the farm-scale.
- The extension of credit and insurance in the catchment is a competitive process. Finance houses find themselves under pressure to assess and approve loans and insurance packages before their competitors do, especially when the provision of these packages is linked to the transfer of land. The competitive nature of the industry serves as a disincentive to conduct detailed enquiry into difficult to discern environmental risks.

Perhaps most critically, the finance institution is not in a position to identify or engage the systemic risks in the catchment. Finance and insurance contracts are negotiated at the farm scale and predicated on the repayment capacity of the given farmer. While environmental scarcity and degradation can affect this repay-ability, its distinct impact is seldom isolated or detected. At the farm scale, finance and insurance decisions seldom factor in their systemic effect on water availability, water quality or the future risk of water scarcity, and the reciprocal (in which finance decisions impute these influences on repay-ability) is also not considered.

More specifically banks and insurers tend, at the local scale, to be focused on business operations and on extending their market share through the extension of credit and insurance to new clients. As such, they tend to focus more on opportunities than on risks and bias their dealings towards concluding deals. Certainly they have little incentive, at the local scale, to engage systemic risks or to reflect too deeply on public goods such as the integrity of the water resource. Where they did this,

they would expose themselves to free-riders eager to draw down the public good while themselves exploiting the resource.

It need not be this way. In spite of low payment default rates, the Greater uMngeni Catchment presents the opportunity for a more profitable local economy in which finance (and the price of finance) sends a more definitive message to investors and savers regarding long-term risks and opportunities. For this to be the case, the finance sector would need to engage more deeply with the natural science of the region as the foundation on which their business models depend. Equally, natural scientists would need to be more explicit about the finance sector implications of environmental trends in the catchment.

A collective effort that benefits all stakeholders and the environment requires a convening force, and better communication across sectors and disciplines. At the moment, the environmental risk is not sufficiently acute to force financial institutions to play this convening role, and there is no public sector entity playing this role in a pre-emptive fashion. Finance institutions are complicit in land use activities that are compromising the resource, but many of these activities are not illegal (especially give the absence of an enforceable riparian buffer zone for agriculture), and even where they are illegal, attributing a breach to a particular offence is not only difficult, but unlikely in the absence of more rigorous environmental policing.

This does not mean that finance institutions could (and should) not use their influence to apply a greater scrutiny of environmental impact, only that such efforts are likely to be limited in their extent or impact given current business models.

2.7.2 Potential Influence of Private Finance on Ecological Infrastructure.

A pragmatic approach for private finance institutions could involve focus on three distinct areas:

1. Understanding and communicating the specific details of negative impact behaviours on ecological integrity of the Greater uMngeni Catchment. While there is clear evidence that the Greater uMngeni Catchment is under stress, there are very few examples attributing this impact to the behaviour of specific entities or farming practices. There are also very few studies demonstrating how good environmental stewardship might benefit financial institutions in material ways in the short-term and at the local scale. As discussed above, it is very difficult for private finance institutions to respond to systemic risks, however, if presented with clear evidence of a negative environmental impact associated with activities funded by private finance, there is a basis for engagement as these institutions have a general concern regarding compliance and reputational risk. To engage research that identifies impacts of specific entities or practices is therefore required. This would not only help to leverage action by private financial institutions, it could also leverage behaviour-change by the entities themselves, as well as public sector organisations with an oversight role.

2. Developing new financial products for the uptake of technologies and activities that address the systemic environmental risk. Examples include incentives such as the financing (and encouraging of finance through preferential terms) of more efficient irrigation technology

and biogas digesters that could capture livestock slurry and convert it to energy; reduced insurance premiums or preferential finance for farmers that establish viable buffer zones; rewarding farmers that adopt soil management practices that reduce the impact of drought periods on crop and livestock productivity; extension of finance for households that install composting toilets and biogas digesters that reduce nitrate leachate from French drains; finance for the inclusion of gutters and water tanks that prevent soil erosion around low cost housing; and finance for solar pumps that simultaneously reduce greenhouse gas emissions and exposure to electricity outages. They could also include disincentives for activities and technologies that exacerbate the system pressures, to ensure that negative externalities were brought to bear on those causing them.

In each example (and there are many such innovations), the change presents a benefit for the client, a new business opportunity for the finance institution, and a reduction of systemic risk that benefits the client and the finance sector in the long term. Banks and insurers do not have the ability to compel their clients to adopt such innovations, but could draw greater awareness to their availability and ease the cost of their uptake. Such an approach could become the first critical step in a collective shift towards better finance, better businesses and better environment in Greater uMngeni Catchment.

3. Use of new metrics to refine credit worthiness assessments which account more completely for water security risks – in particular the management of effluent and alien vegetation. The intimacy of the relationship between local bank managers and their clients in Greater uMngeni Catchment is one of the factors that supports the success of the finance sector in the region. Banks tend to know when their clients are in difficulty and can apply restructuring or other measures timeously. As environmental pressures in the catchment increase, however, the manner in which businesses manage their natural resources will become crucial to their competitiveness and their survival. Thus the types of questions that bank managers ask of their clients before approving a loan will need to change to include an understanding of adaptability, resourcefulness and environmental risk mitigation strategies. There is growing evidence that companies that perform well on resource efficiency, adaptability and greenhouse gas emissions tend to present fewer financial risks (Harford, 2012)[5], in part because attention to these items tends to signal competent management. In this sense, banks might do well to introduce environmental screening as part of their appraisal of repay-ability, for the purpose of assessing both environmental and management risks of their loans. The United Nation's Ecological Accounting approach is currently being explored by Statistics South Africa and SANBI, and if combined with existing appraisals of credit-worthiness could provide some of the attributes of a more effective and appropriate financial screen for banks, investors and insurers.

[5] See Osmosis Investment Management for a local example

3 TOOLS TO ENABLE THE PRIVATE SECTOR

3.1 Introduction

This phase of the research evaluated the nature of the governance models and the needs of individual stakeholders in order to design the optimal Integrated Information Management & Modelling System (IIMMS). The tasks and activities for this Phase were framed and guided by the needs of collective action to support the engagement of private sector finance role players in the greater uMngeni catchment, particularly those who are part of the uMngeni Ecological Infrastructure Partnership (UEIP).

Such a system needed to take account of existing tools, and incorporate data and information from bio-physical, economic, and social sources – including a growing wave of citizen science programmes and open platforms such as Google Earth. It needs to enable interaction, shared understanding and, most importantly, collective (coordinated) action by non-water specialists at a catchment scale. It is important to note the emerging nature of the understandings sought in Phases 1 to 3, because it is the emergent nature of what is a complex, messy ("wicked") problem that is an overarching context for the IIMMS development.

3.2 Information Characteristics to Support Private Sector Engagement

A key overarching requirement (of the emerging IIMMS) is that it should play a positive role in supporting private sector engagement. An analysis of such a requirement yields at least 5 key contributions from an IIMMS, namely, that it should contribute to:

- symmetry of knowledge amongst market role players,
- transparency of information between market role players,
- ease of connectivity between sub-systems and market role players,
- enabling market role players to gain insights into the value proposition of any initiatives,
- lowering of transaction-costs for market role players of exchanging communications and information.

Each of these contributions will be explored briefly, and subsequently the criteria for the design of an IIMMS are assessed, *inter alia*, against these requirements.

1. **Symmetry of information and knowledge:** If one party to a market transaction has better information and or knowledge about the issues, than the other party, then there is an imbalance of power in the transaction. This represents a potential market failure and in the worst case, exploitation. Such asymmetry of market related information is a moral hazard and in the already highly skewed water information and water knowledge landscape in South Africa the lack of access to information on water related matters is a major issue if

one is seeking to facilitate fair market mechanisms. Such mechanisms are deemed imperative for private sector engagement. It was therefore important to ensure that the IIMMS was open access and not limited behind any institutional firewall that excluded all but employees of that institution. It needs to be noted however, that knowledge hinges upon capacity and levels of expertise in specialist professions. Some tools are necessary that bring specialist information to non-specialist, but impacted stakeholders.

2. **Transparency:** Transparency of all the information involved in determining the values of water and ecological infrastructure, as well as that of the financial flows, is imperative for market mechanisms to work well. Transparency is essential for symmetry of information and to reduce transaction costs in determining market value and executing market transactions. The IIMMS therefore needed to be a system that could be deemed transparent, by any set of metrics.
3. **Connectivity:** Collective action can be enabled when are stakeholders are able to connect and share relevant information freely. The IIMMS therefore had to be a system wherein no physical or IT barriers stopped a connection between buyer and seller in the market. There may well be socio-political disconnections imposed on the IIMMS but these barriers are beyond the scope of the IIMMS designers to control. The knowledge barriers to connection need to be overcome by learning and strategic relationships with partners, as is the case in many other business endeavours.
4. **Value propositions:** The recent publication by Morgan and Orr (2015) entitled "***Value of Water****: a framework for understanding water valuation, risk and stewardship*" stresses the need for extensive interaction and exchange of information and knowledge between a range of stakeholders in order to realise and to protect the value of water. Morgan and Orr (2015) also make a very clear distinction between the cost, the price and the value of water. The IIMMS needs to be a system that enables extensive and affordable interaction and exchange of information between, and the co-generation of information amongst, market stakeholders. Key to this is a shared understanding of the value of ecological infrastructure and down-stream benefits.
5. **Transaction costs:** High transaction costs related to collective action would stifle private sector participation and also skew the market in favour of those who can afford these high costs. Therefore it was imperative that the IIMMS facilitate very low transaction costs for multi-stakeholder co-generation and exchange of information related to water, ecological infrastructure and financial flows. In this regard the water stewardship sections (3.5 and 3.6) of this report are important. The Alliance for Water Stewardship Standard encourages collective action and sharing to bring down the cost of setting up joint information management and modelling systems. This is to reduce the transaction costs of sharing and also that of information gathering and access. All of the aforementioned support better private sector engagement.

3.3 Context for Information Sharing in Collective Action

To understand a key strategic imperative underlying the design approach followed in the IIMMS it is necessary to understand the factors that influence, in any given context, the placing of a value on water and hence the financial flows that should be ascribed to water.

Morgan and Orr (2015) explain that the cost, price and value of water are not the same thing. To produce "financial flows" based on cost and/or price of water alone would be misleading as the diagrams in Figures 3.1 and 3.2 (Morgan and Orr, 2015) show. Such approaches would not serve the interests of ecological infrastructure. It is not surprising that much of the information required to clear up the uncertainty, and to estimate value, is not available from the businesses interviewed during this study. Unfortunately, businesses are reluctant or legally prevented from revealing their financial figures and therefore in most cases even cost and price figures are not known beyond select few in the field. Furthermore, nor are the systemic linkages and assumptions that are so vital to understanding these numbers and to translate them into value. This provides a significant challenge to the IIMMS design and development. However, it is a real part of the socio-financial challenge and therefore must be integrated into the design in a manner that matches world best practice.

Figure 3.1: The value of water to a company, the economy, society and nature.

Note the emphasis on information and the place of complexity theory and scenario modelling in Figure 3.2, below. Both complexity theory and scenario modelling are recognised to be of vital importance in forming the strategic thinking underlying the design of the IIMMS. In addition, information is imperative for water stewardship as the following quote affirms: *"information is critical to understanding stakeholders, water risks and opportunities, and suitable responses. Contextual information is at the heart of water stewardship and is a critical criterion"* AWS International Standard (2014; pg 71; para 1).

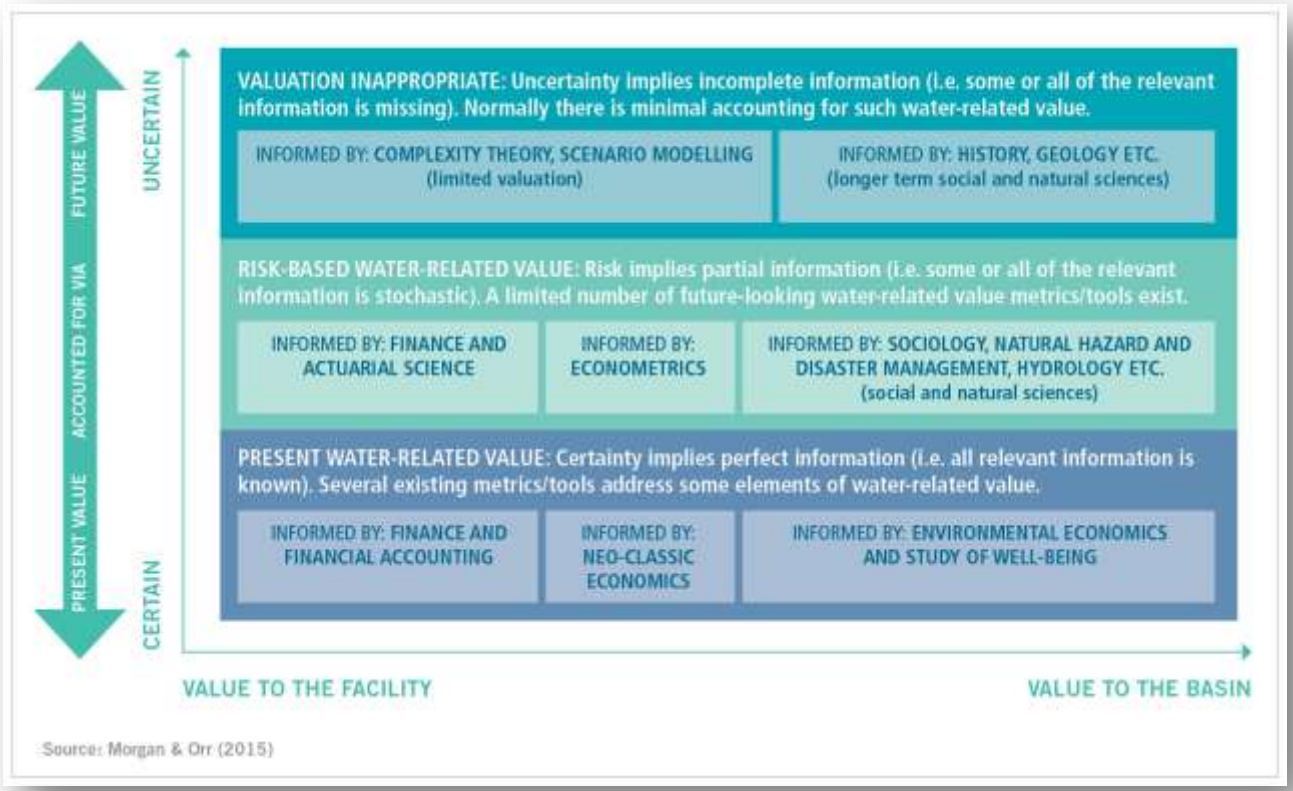


Figure 3.2: How valuation is affected by uncertainty.

One of the key strategies underlying the IIMMS design is to enable a start to be made in the multi-stakeholder engagement processes around the small amounts of information and the tentative, value generating relationships that are evident. If the stakeholder engagement continues in an atmosphere of appreciative inquiry, then more and more useful information and assumed relationships will be revealed. In this way the IIMMS grows itself and the information and knowledge thus generated become more and more socially robust, as described by Nowotny et al. (2001). The crucial role of multi-stakeholder action in and with the IIMMS development, and its use, is strongly emphasised.

Thornton, et al. (2013) reviewed a number of case studies against the 10 key attributes of a wicked, complex problem and found strong evidence to suggest that eutrophication of water bodies was indeed a wicked problem. This confirms the view that the challenges facing the designers of this IIMMS belong in the top left hand corner of Morgan and Orr (2015) diagram in Figure 3.2. Furthermore there is much consensus that the water related challenges in South and Southern Africa constitute a wicked problem. The assessment of water related benefits, of which ecological infrastructure is an integral part, are embedded in dynamic, complex, conflict ridden, uncertain and value laden multi-stakeholder challenges in southern Africa. Thornton et al., (2013); Ison, pers comm.,(2013); Bristow, pers comm., (2013); Colvin, pers comm., (2013); Turton, pers comm., (2013); and McCool, pers comm., (2012) all confirm that these challenges constitute a wicked problem, as explained by Rittel and Webber (1973) and Ritchey (2013).

There is a growing body of literature on post-normal science responses to wicked problems, for example, Kastenhofer (2011); Valkering (2009); Frame and Brown (2008); Funtowicz and Ravetz (1993), which the design of this IIMMS takes into consideration. There is also a growing body of literature on participatory agent-based modelling responses to wicked problems, for example, Reed et al. (2013); Von Korff et al. (2012); Bots et al. (2011); Valkering (2009); Haxeltine et al. (2008); Lotze-Campen (2008); Matthews et al. (2007); Tabara et al. (2007); Guyot and Honiden (2006); CasCastella et al. (2005) and Ramanath and Gilbert (2004). Taken together this evidence supports the view that participatory agent-based social simulation modelling, framed in the paradigms of post-normal science, is appropriate for multiple stakeholders to seek to address wicked water related problems. The design of the IIMMS takes all this into consideration. According to Achorn (2004) the techniques of complexity theory have contributed to agent-based modelling, which, Achorn contends, is a new way of doing science. Agent-based modelling is compatible with quantitative and qualitative research methods, according to Achorn (2004), and is able to display complex behaviours whilst starting with simple rules of learning and assumptions. All the above have informed the direction of the IIMMS design and this accords strongly with the Morgan and Orr (2015) diagrams in Figures 3.1 and 3.2 above.

It is interesting to note some of the current discources and il-logic that emanates from the finance industry around matters of complexity and risk. SEction 4 outlines a preference in the finance community to require a proven track record before any investment will be made in new ideas and concepts. It is accepted that the finance community may say this (and even believe it), however, their actions belie this. An example is the modelling that such businesses do in their planning. The insurance and finance industry employ actuaries and other analysts for this express purpose i.e. they make huge investments of time, resources and money on the basis of complex modelling of processes and assumptions of what may happen in the future. Complexity, uncertainty and modelling is placed in the top corner of Figure 3.2 (Morgan & Orr, 2015) where value is found in a water space that is undeniably complex, dynamic, messy and uncertain. That the finance community has risk in their vocabulary is proof that they do invest where there is uncertainty and where proven track records are not possible e.g. in the numerous alternative energy ventures or in climate change mitigation and adaptation efforts.

Morgan and Orr (2015) depict how valuation is affected by uncertainty, (Figure 3.2 above). This implies having to engage ideas and concepts that do not have a proven track record if one is going to get any idea of value, and also any chance of protecting that value either collectively of individually. The plethora of collective action endeavours to either gain or protect value in this realm is strong evidence for the need of an IIMMS that can serve this complex space. The WWF has invested significant efforts into learning Theory U (discussed further in Section 3.4) and particularly the approach taken by Scharmer (2009a) in which the concept of *learning from the future as it emerges* is promoted. The IIMMS is designed to assist socio-financial processes in the emergence of that future, whatever it may be. The IIMMS design seeks to avoid the contradictory situation in which people acknowledge the complexity of their challenge, but then refuse to engage any processes which are proven to enhance learning and coping in complex situations.

Another *de facto* indicator of complexity in the problem space, in which the IIMMS is being designed, is the existence of the 36-member uMngeni Ecological Infrastructure Partnership (UEIP). A few of the complex dynamics that are in the various sets of expertise in the 36 UEIP member organisations are their respective world views, their organizational dynamics and their people dynamics. Furthermore it is evident that there are a great deal more than 36 organisations operating in, or influencing appreciably, this space. Harrington (2015) found this complexity in the catchment and in the UEIP (in his study on governance) and called for conflict resolution mechanisms in the UEIP. This call for conflict resolution mechanisms was echoed by Hay (pers comm. 2015). The design and development of the IIMMS has also taken into account the need for it to be used in conflict resolution. The criteria to give effect to this are discussed in Section 3.7.3.

If one takes note of the number of different forms of convening e.g. forums, committees, partnerships, management agencies, task teams, associations, movements and networks (all designed to address water related challenges with collective actions) it is reasonable to pursue some form of theoretical understanding of such collective approaches. The focus of this section is on information management and information co-generation systems (models) where information is an imperative in all forms of collective action. Theory U, as presented by Scharmer (2009a), is gaining prominence worldwide and was chosen as a preferred approach to the meta thinking and actions to guide collective approaches. Theory U as a key strand in supporting action learning in a social context and to thereby deepen its collective understanding and 'sensing' of the complex realms in which it operates. The crucial role of information in such understanding is emphasised by the Alliance for Water Stewardship:

"To gather and understand critical water-related contextual information about the site's catchment. This information is critical to understanding stakeholders, water risks and opportunities, and suitable responses. Contextual information is at the heart of water stewardship and is a critical criterion." AWS International Standard v1 pg 71

3.3.1 Theory U and Co-Generation of Understanding and Collective Action

The co-generation process of understanding benefit and value flows related to water and ecological infrastructure is influenced to a large extent by the Theory U work of Scharmer (2009a). It is imperative to understand systems before intervening strongly in them if avoiding unintended, often negative, consequences is a goal. Water related ecological systems are so complex that it generally takes wise collective approaches to ensure that interventions do not lead to negative unintended consequences (Thornton *et al*., 2013). This point is also made in section 4 on the fundamental difficulties in channelling investment and finance towards ecological infrastructure and concludes that central to the challenge is understanding these difficulties and finding means to address them.

Scharmer's Theory U is being promoted as a potential way forward in developing the kinds of understanding, actions and leadership development processes required to address the water and ecosystem related challenges that we face. Scharmer (2009) provides a useful matrix to show the different types of knowledge and intervention points for developing such leadership. Table 3.1 (below) shows that to develop system-wide transformational capacity building within a multi-stakeholder innovation, transformational self-knowledge and a whole-system approach is required. There are generic similarities between this Table 3.1 and Figures 3.1 and 3.2 by Morgan and Orr

(2105) described earlier. One thing that is evident from such contexts is that a uni-disciplinary, simplistic information management and modelling system is not going to be adequate to support such complex processes. Especially if the financial flows that are declared by stakeholders are simply costs and prices that lead to a distorted picture and thus do not reflect the real value of water or the value of the ecological infrastructure that the water supports and vice versa.

Table 3.1: Types of knowledge and intervention points to bring about change (Scharmer, 2009)

	TYPE OF KNOWLEDGE		
INTERVENTION POINTS	Technical knowledge (technical skills)	Relational (stakeholder coalition building)	Transformational Self-knowledge (Identity, Will)
WHOLE SYSTEM (MULTIPLE ISSUES)	System-wide technical skill building/training	System-wide relational capacity building/training (multi-stakeholder dialogue)	**System-wide transformational capacity building (multi-stakeholder innovation)**
INSTITUTION (SINGLE ISSUE)	Institutional technical skill building/training	Institutional relational skill building/training (multi-stakeholder dialogue)	Institutional transformational capacity building (multi-stakeholder innovation)
INDIVIDUAL	Individual technical skill building/training	Individual relational capacity building/training (multi-stakeholder dialogue)	Individual transformational capacity building (multi-stakeholder innovation)

The design of the IIMMS reflects the information system requirements for such capacity development. This "space" in the top right hand corner of Table 3.1 coincides in nature with the top right hand corner of Figures 3.1 and 3.2 in this report, and these are taken from Morgan and Orr (2015). This complex space also coincides with "***Interactive Development of Options"*** space in the centre of the diagram in Figure 3.3 below, which is taken from internal strategic perspectives document published by DWAF (2004). The diagram in Figure 3.3 may be slightly old and not the newest diagram, of many emanating from the Department of Water and Sanitation (DWS) and other role players. However, what is significant about the diagram is the centrality of the interactive generation of options and the installed modelling systems to manage and co-generate information. The extensive reference base quoted in Section 3.3, and the strong strides made by water stewardship concepts world-wide, are evidence of the needs for interactive co-generation of options. Theory U provides an internationally recognised theoretical framework for such co-generation of thought and action.

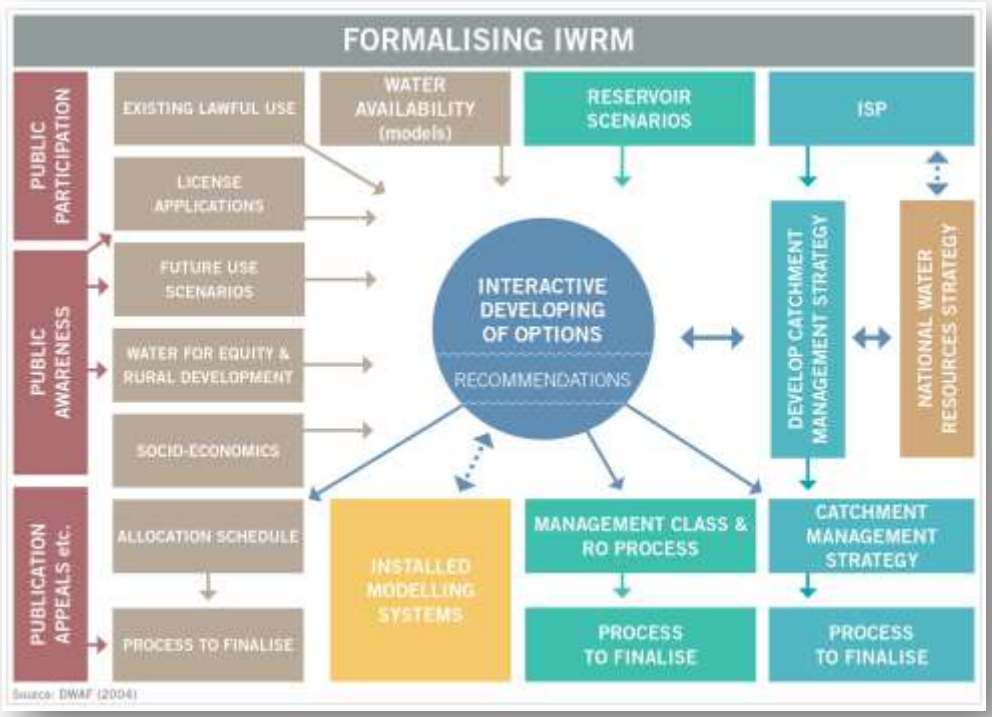


Figure 3.3: Diagram showing DWAF's Integrated Water Resource Management approach.

If one brings Figure 3.3 into a diagram depicting the learning loops in Theory U then Figure 3.4, below, is the result.

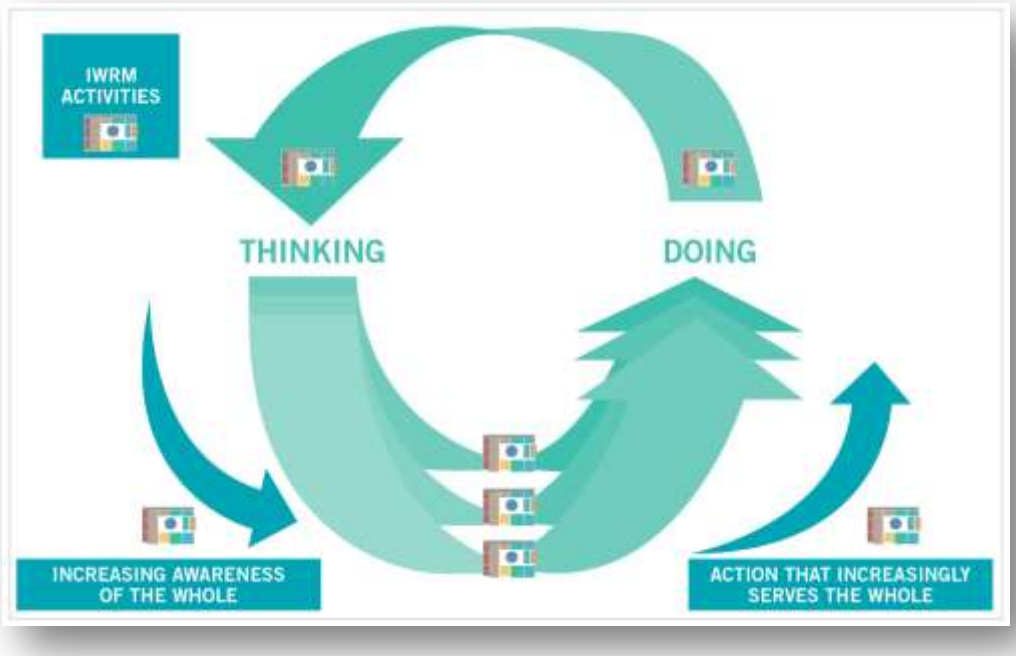


Figure 3.4: Interactively developing integrated options in water management using Theory U as a collective learning framework (after Senge *et al* 2005).

The IIMMS must enable the elements and flows of Figure 3.3 to emerge and grow in clarity as the IIMMS is used and enhanced by multi-stakeholder engagement processes. Such interactive processes are crucial for generating socially robust knowledge and change according to Pahl Wostl (2007), Nowotny *et al*. (2001), and Tabara *et al*. (2007). Socially robust knowledge is also termed actionable knowledge and such knowledge generation requires processes that are imbedded in the design of the IIMMS and are reflected in the criteria agreed on (as presented in Section 3.7.3). Section 4 reinforces the needs for socially robust information generation processes when he states that it is relatively easy to make the case for investment in ecological infrastructure, but that it is more difficult to make the same case with full cognizance of the constraints applied by personal incentive, the financial challenges of any change, and institutional influence.

Given these difficulties it is reasonable to assume that one research report is not going to be sufficient to cause behavioural change. This assumption is reinforced by Scharmer (2009) and Morgan & Orr (2015), plus a very large body of literature, some of which is referenced in this report, related to the wicked characterisation of this topic.

The report by Morgan and Orr (2015) addresses the logjam inferred in section 4 which highlights the structural difficulties that currently prevent private banks from investing in ecological infrastructure. However, under the paradigms of water stewardship (discussed in Section 3.5 and 3.6) this logjam may be broken by the logic that many borrowers are only able to inflict ecological damage because of the capital that banks loan them. The borrower is therefore an integral part of the supply chain feeding money into banks, through interest charges. As such, financial institutions seeking AWS International Standard certification for their water stewardship need to look into the water related issues in their supply chain. If higher interest rates on loans issued to companies operating in water risky areas are going to be a reality, the banks need to prepare for the day when the above logic is presented to them and they are required to "*walk the talk*" and acknowledge their own part in the chain of damage to ecological infrastructure.

In Figure 3.2 Morgan and Orr (2015) advocate scenario modelling and below is a diagram from Pahl-Wostl (2007) which reflects such modelling, which the IIMMS is also designed to be capable of enabling. This Figure 3.5 leads to understanding how modelling can be conceived as a socio-technical process.

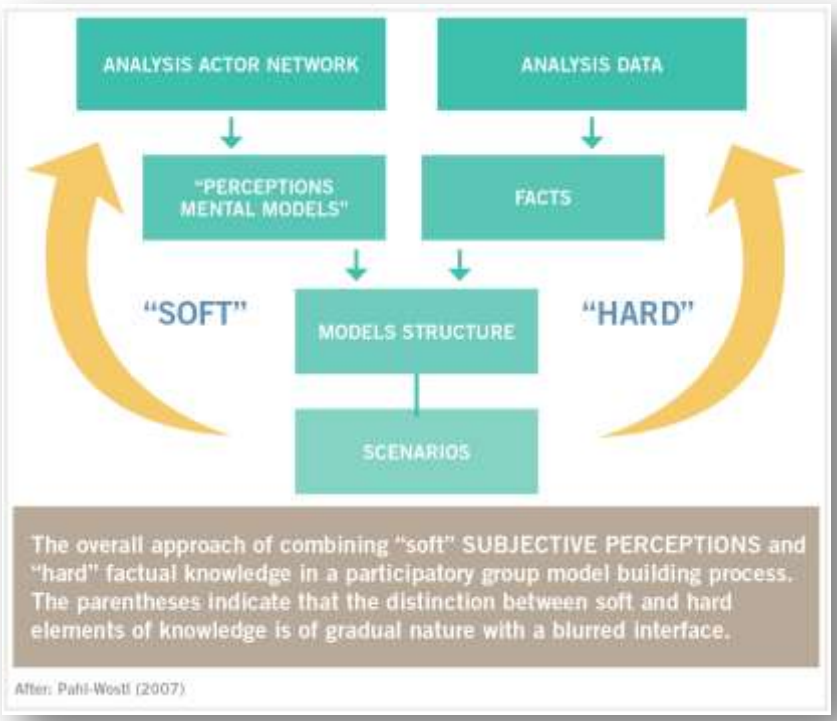


Figure 3.5: Participatory scenario modelling

By linking Figures 3.4 and 3.5, and work by Nonaka (2004), Figure 3.6 is generated. The IIMMS is designed to serve such processes which will be at the heart of a growing web of private sector collective action for a commons resource that will characterise investment into ecological infrastructure.

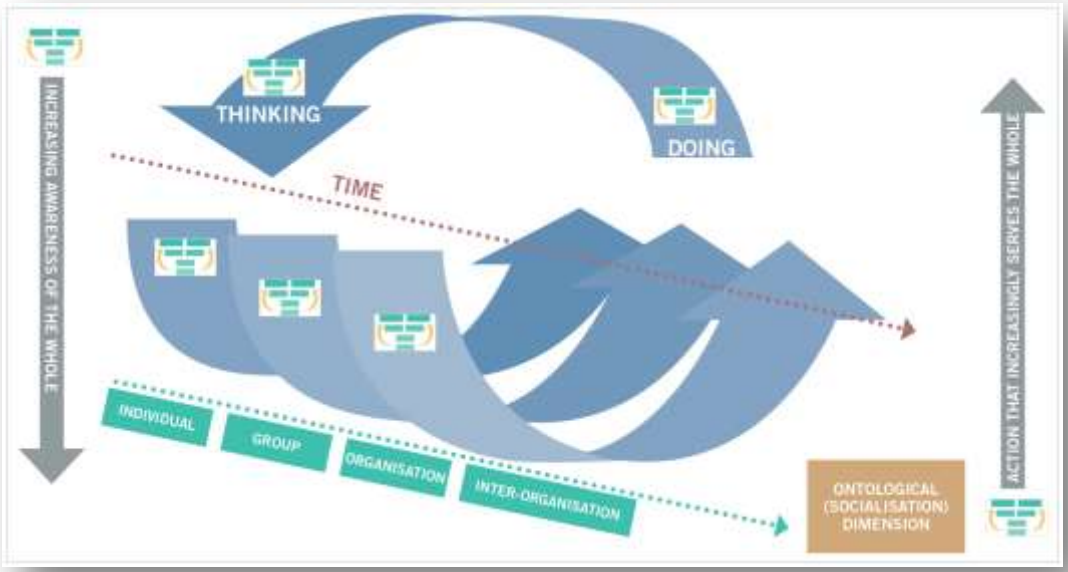


Figure 3.6: Combining learning models from Scharmer (2009a), Nonaka (2004) and Pahl-Wostl (2007)

The top right hand corner of Table 3.1 by Scharmer (2009), which highlights the importance of self-knowledge, identity and will, and again reinforces that the IIMMS needs to be more than simply a technical tool. The IIMMS needs to be part of a multi-stakeholder polycentric process which supports the need for a thorough understanding of the practical and institutional context, including personal incentives that shape existing flows of investment. Furthermore this will involve leveraging existing programmes and policies, including the National Water Act (1998), that is only partially implemented. When fully implemented the state could initiate the critical shifts in South Africa's public funding to support ecological infrastructure and water security in the uMngeni and other catchments.

The extracts below further reinforce the need for the IIMMS to be much more than a single model and definitely not a single, simple spreadsheet tool. The IIMMS needs to be an integrated system of models and information systems as the name implies and it needs to emerge, grow, unfold and evolve out of the complex multi-stakeholder, polycentric processes discussed in this report and for which the core design criteria (researched, presented and explained in Section 3.7.3) are imperative. The many good ideas in this space rely on a degree of collaboration that is politically and institutionally complex. Given this the multi-criteria assessment of options in the financial flows space will not provide definitive answers on the relative merit of options, but it will provide a consistent means of exposing trade-offs and thus will be useful in compiling possible options. The IIMMS is designed to accommodate and facilitate such processes, as the criteria discussed in Section 3.7.3 will reflect.

Sections 2 and 5 refer to financial sector blind spots. The Theory U process work of Scharmer (2009a) and the learning processes of Nonaka (2004) and Pahl-Wostl (2007) are specifically crafted to reveal such blind spots. The IIMMS is designed to serve such processes to promote less and less 'blindness' in collective endeavours in the ecological infrastructure realm, as more and more assumptions are surfaced and more linkages are understood. Whilst financialisation of agriculture has provided the means to drive up production and reduce risk induced by pests, disease, weather seasonality and drought, the external damage of these activities have been a financial sector 'blind spot'. This has seen the financial sector implicated in environmental collapse, and financial and market contagion.

As Morgan and Orr (2015) explain the revelation of value requires *inter alia* a complex process of modelling and the IIMMS is designed to be socio-technically capable of supporting such a process, which must also include urban processes, as the following extract indicates:

"finance has driven declining employment across the global agricultural sector and destruction of the natural resources on which some of the world's poorest people depend directly for their livelihoods" (Cook et al., 2010).

This has led to the growth of urbanisation and particularly urban poor, hence the IIMMS must be able to assist engagement with both urban water modelling and also urban poor (through citizen science). McKenzie and Cartwright (2015) explain that market barriers to small farmers, generated by economies of scale, have increased the rate of urbanisation and at the same time sterilised soils and over loaded them with nitrates with long term negative consequences for soil fertility and water resources.

The IIMMS could contribute to the understanding of the value of not farming a piece of land. If rewards are to be commensurate with benefits to others. The need for speed, connectivity and socially robust knowledge generation to frame and describe the complexity of environmental interactions and the temporal lags between an action and its environmental consequences often blur attribution between observed environmental degradation and a particular farming practice. The criteria at the heart of the IIMMS are designed to help stakeholders simulate a range of scenarios in time scales that enable timely learning. (This is why Morgan and Orr (2015) have scenario modelling prominent in their diagram, see Figure 3.2.)

There is a growing and widespread recognition that collective action on a scale hitherto unimagined is needed in the water related space (WEF, 2015). One area where this is apparent is in the Strategic Water Partners Network (SWPN) which created a national platform for the private sector to address shared water issues with DWS.

In self-governing systems, the role of information is crucial. An examination of the Design Criteria for the IIMMS reveals that it has been designed to serve into and with self-governing multi-stakeholder polycentric systems. It is inevitable that a finance sector, alerted to the dangers of systemic risk in the realm of water by the World Economic Forum Global Risks Report (2015) will want to see a greatly increased amount of information and disclosure on sites that apply for loans. Full information and systems understanding on the part of the site owners will inevitably have an effect on interest rates and the IIMMS would need to contribute to such deeper understanding.

Parnell (2015), emphasises much of $90 billion investment will take place under conditions of weak governance. Concerns about the environmental impact that may be caused by these investments and the associated economic growth are not surprising. The IIMMS, therefore, needs to operate effectively in the self-organising and self-governing space of behaviours when public sector governance systems are weak on implementation, monitoring and evaluation.

Section 2 indicates in a number of places that information that they discovered was highly bound by confidentiality requirements. This reveals a vital part of the sociological system, within which the financial flows systems, that we seek to discover, are living. It is a system which is deliberately blind and secretive to itself. If such a system is to cope with complexity it has to change and address complexity at the fundamental level of transparency. Even given full transparency the systems are complex and complicated. In a blanket of secrecy and non-disclosure, trust, systemic understanding, the ability to sense what is going on and the fore warning to respond, are all curtailed drastically. An IIMMS that does not address the fundamental issue of developing trust, transparency, early full systems sensing and alerts in a hyper-connected way that does not pre-judge where the risk is emanating from, is of little use.

Non-disclosure of water related information, particularly water quality data and information (even from public institutions) is widespread. This information forms the basis for understanding the biophysical systems that make possible the resources (or potential resources) that trigger financial flows.

Without disclosure we are going to remain limited in our understanding the condition of the resource base and consequent impacts on benefits and financial flows. The emergence of a wave of interest in water stewardship may catalyse such a change and the AWS International Standard is very specific and clear in its call for transparency and disclosure. If the interest in water stewardship translates into actions, then an IIMMS of the nature of the one being developed in this project is imperative. The nature of the IIMMS is known by the Criteria reported in Section 3.7.3. The sad irony is many of the people who agreed to the goal of creating shared value by forming the UEIP are the ones blocking the flow of information.

Despite the current impasses with regard to information access it is nevertheless imperative to develop systems of linked models and information systems. There is wisdom in the philosophy in the IIMMS that "*modelling is a process of making implicit assumptions explicit*." It is also imperative, as the design criteria of the IMMS stress, that the IIMMS itself be integral to the social processes which surface the many, varied and often contested or previously unknown assumptions of the multiple stakeholders in the picture.

The extract below again shows the vital importance of the IIMMS being designed to facilitate the emergence of such new institutions in the same way as technologies like the internet, remote sensing, the algorithms & technical conventions underlying credit facilities such as VISA. The primary successes of the IT industry have been in the sociology of collective action where conflict over a limited common resource, namely battery energy, are legendary amongst 1000 strong design teams operating simultaneously all over the world. The technologies and their high levels of integration are the outcome of such a sociological revolution in a fiercely competitive business space. Ironically the finance industry employees leading edge IT is intricate systems and yet does not appear to understand the underlying sociology of its creation. The resistance to initially share information has limited the information content of related products and processes in this project. This is an area that the UEIP cam address in further meetings.

South Africa has struggled to create the local institutions required to implement much of its environmental and water legislation. The policies and aspirations remain recognised as being very good, and this study looks at new ways of achieving those policy goals. In this regard water stewardship and particularly the specific requirements of the AWS International Standard will address voluntary disclosure and voluntary more compliant behaviours, which are well inside the legislative and regulatory boundaries. The emerging phenomenon of citizen science to which the IIMMS is strongly connected may be the game changer in this impasse of non-disclosure .

Good water stewards desist from taking advantage of loopholes that are left in legislation if taking such a gap is detrimental to the system. If the financial institutions are serious about pursuing water stewardship in the future then they can put pressure on their customers to behave in this regard. Such pressure could become a key instrument in the market mechanisms at play. It will however depend on widespread transparency and the IIMMS could be a major instrument in that transparency, if used wisely by stakeholders.

3.4 A Framework for Collective Action: Water Stewardship

Water stewardship is about engaging those who do not hold a government mandate to manage water resources or water infrastructure and enabling them to contribute positively to water security. For business this means a progression of improved water use and reduced water related impacts of internal and value chain operations. More importantly it is a commitment to the sustainable management of shared water resources in the public interest through collective action with other businesses, governments, NGOs and communities (WWF 2013).

The Alliance for Water Stewardship (2012) further defines water stewardship as ' *the use of water that is socially equitable, environmentally sustainable and economically beneficial, achieved through a stakeholder-inclusive process that involves site and catchment-based actions.*"

WWF has defined 5 steps of water stewardship which culminate in collective action (figure below). The first 3 steps are generally internally and operationally focussed and require leadership buy-in to act on water issues. Other tools such as the Water Risk Filter (www. http://waterriskfilter.panda.org/)

The US based Pacific Institute have compiled a toolbox for the global private sector to support their actions in water stewardship : http://ceowatermandate.org/toolbox/discover-next-steps/

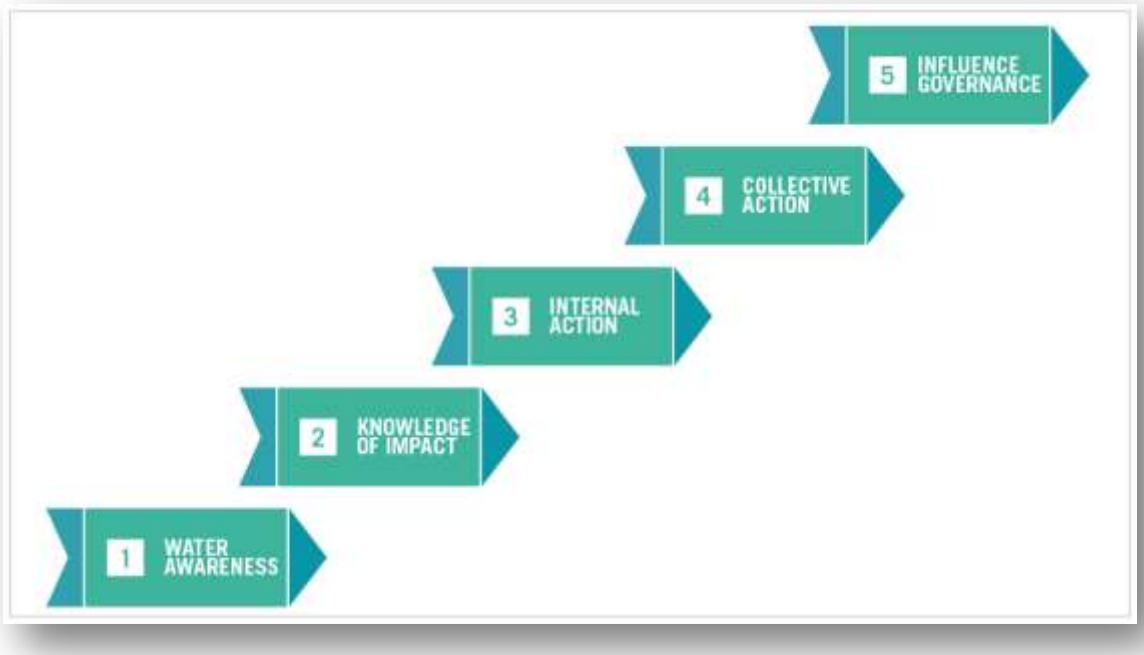


Figure 3.7: Progressive steps of corporate water stewardship.

Water stewardship has been piloted and tested in many basins in the world, usually with a corporate initiator and community and NGO partners, eg – Coca Cola, Marks and Spencer. Good water

stewards understand their own water use, catchment context and shared risk in terms of water governance, water balance, water quality and important water-related areas; and then engage in meaningful individual and collective actions that benefit people and nature. As distinct from IWRM and its founding principles of equity, sustainability and efficiency, water stewardship embodies 'taking care of something which one does not own' or 'of looking after an asset or resource on behalf of others' (Hepworth and Orr 2013).

The AWS International Standard certification will help as an indicator of lower risk for loans and therefore it is reasonable to assume that there will be a drive towards information systems that are AWS International Standard compatible. Finance institutions may find that in the AWS Standard, they have a key aid to asses risk, particularly systemic risk. Non-disclosure and a lack of transparency increases systemic risk. The IIMMS is specifically designed to operate effectively in the AWS International Standards space, which requires full disclosure on all water related information.

One of the areas in which widespread water stewardship could make a significant difference is the speed of dealing with credit applications when a project is dependent on water. The process of approving a new credit application typically takes two to three weeks and banks highlighted that a quick turnaround was critical for securing new business. Furthermore , based on interviews with banks an estimated R1.8 billion of finance is supplied to commercial farmers in the Greater uMngeni River Catchment by banks.

3.5 Alliance for Water Stewardship (AWS)

The Alliance for Water Stewardship (AWS) is an international NGO which has been working with WWF and other global organisations for several years. In 2014 the AWS published Version 1 of its International Water Stewardship Standard which is now being promoted world-wide. A number of the individual organisations in the UEIP are pursuing water stewardship activities and some are using the AWS International Standard as their guide. The DWS is currently developing a policy on water stewardship and is consulting with various stakeholders, including WWF and the AWS in the development of this policy. The AWS in southern Africa is working closely with the International Water Stewardship Programme (IWaSP) to promote water stewardship at all levels in the region. The AWS International Standard is congruent with and supportive of other water related standards, particularly those in the agricultural sphere.

> *" Contextual information is at the heart of water stewardship and is a critical criterion"* WS International Standard (2014) Pg 71

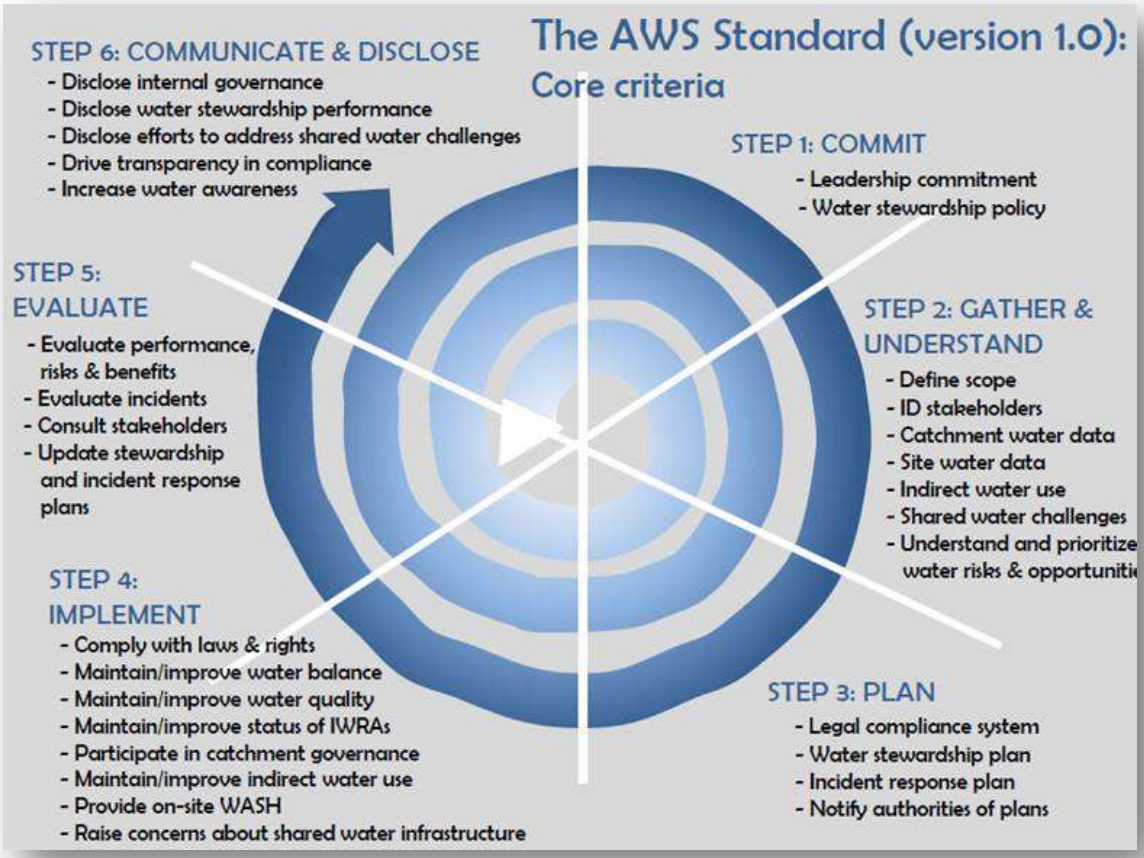


Figure 3.8: Outline of the AWS standard, 6 steps and core criteria for the private sector.

3.5.1 Production Standards for Water in Agriculture.

The World Economic Forums (WEF) Global Risk Report (2015), which places water as the number 1 global risk in terms of impact, has once again highlighted the need for best practices to be adopted by all water users, especially agriculture since it is by far the biggest water user. The hyper-connectedness of water to countless other endeavours is one of the key reasons that water risk tops the WEF (2015) list. In view of this, retailers of agricultural products are deeply concerned about the water related risks inherent in their supply chains. For them to direct their influence in wise directions they need to have good (and appropriate) insights into all water matters in the agricultural supply chain. Water related production standards that apply world-wide are vital to provide retailers, financiers and others in the agricultural supply chain, with fast, comprehensive and meaningful indicators of their water related risks.

Good agricultural practices that address environmental, economic and social sustainability for on-farm processes that result in safe and quality food and non-food agricultural products are imperative. Furthermore, such practices need to include engagement in the catchments in which they operate in order to minimise water related systemic risk induced by activities and situations beyond the farm fence. Production standards are also needed to foster a common currency for interaction in striving for fairness whilst applying instruments to influence supply chain behaviours.

3.5.2 Influence of Water Stewardship on Information Flows.

An assumption in the design of the IIMMS is that the Alliance for Water Stewardship International Standard is going to become a key element in guiding the behaviour of the collective efforts around water related ecological infrastructure in particular and water related matters in general (AWS, 2014). Table 3.2 below shows the key role of information in the AWS Standard. Socially robust and well managed information is central to water stewardship, as referenced earlier. Thus, systems to create and manage information are one of the most important endeavours in the water stewardship learning journey, that multi-stakeholder collective action efforts need to engage in. The IIMMS has been designed and developed with this need in mind.

Widespread adoption of water stewardship in the uMgeni would enable all the information alluded to in Table 3.2 to influence thinking and financial flows to support ecological infrastructure development in the uMngeni.

Table 3.2: Analysis of keywords to show the role that information plays in water stewardship.

KEY WORDS IN THE AWS STANDARD		COMMENTARY HIGHLIGHTING THE IMPLICITNESS OF INFORMATION IN THE WORD
Stewardship	**511**	Stewards share **information**. Stewards are transparent about their water efforts.
Catchment	**428**	catchment is described through visual, geographic and time series ***information*** and relationships between all elements which vary over time
Other (sites; initiative)	**234**	***information*** about what other sites, initiatives, actors, organisations;, issues, trends are affected by the actions of each over time
Quality (water)	**220**	***information*** on water quality for each of many constituents and sources over time and how they combine to create conditions for change in other water quality constituents
Impact	**203**	***information*** on the effect of one action on another issue; matter; person; organisation
Stakeholders	**199**	***information*** on how stakeholders are connected: what information do others want from me & I from them, in order to function?
Risk	**167**	***information*** about the present BUT also about the future given the interactions between dynamic streams of activity and cause & effect.
Share	**166**	***information*** about what is common to share and how that changes when other factors are introduced into the common pool eg. More taps and toilets introduced into the catchment
Information	**136**	***information*** …say no more
Engagement	***122***	***information*** sharing is foundational to any engagement
Future	**100**	the future can be better anticipated (recognising all its compelxities and uncertainties) if ***information*** about the present and information about trends and influences is known
Value	**98**	value is often expressed in a number ie ***information***
Action	**96**	***information*** triggers action. In the absence of ***information*** action is random and mindless.
Change	**94**	***information*** is a key manner in which change is measured and communicated.
Disclosure	**89**	***information*** sharing is imperative for "disclosure"
System	**65**	***information*** linkages are what makes up systems
Understand	**59**	***information*** is crucial for understanding, it is impossible to understand anything in the absence of ***information*** about it.
Collective (actions/ approaches)	**58**	***information*** is central to any form of co-ordinated collective action..if each party is working off different information co-ordination is impossible. Uncoordinated collective action saps resources, energy and motivation.
Agencies	**52**	agents act on ***information***, in the absence of ***information*** actions cannot be guided or conveyed.
Potential	**48**	to indicate or gauge potential one needs to know what will change in the ***information*** set one is currently viewing

Expected	**33**	***information*** is crucial in conveying expectations
Society	**32**	society is a combination of people and the ***information*** that they exchange either digitally or verbally.
Build / Building	**31**	to build often refers to adding to the ***information*** set on a particular thing
Common	**21**	***information*** must be common as well. It is axiomatic that the water resource is common.
Interests	**21**	it is not possible to determine anyones interests unless they share ***information*** about them.
Leadership	**21**	***information*** sharing is a key attribute of leadership. Leaders share appropriate information… full stop.
Transparency	**19**	***information*** sharing is axiomatic for transparency

3.5.3 Web Tool to Support Water Stewardship in South Africa

The WWF's recently launched on-line tool on water stewardship *(https://aws.wwfsa.org.za/aws/home/)* is evidence of a trend towards enabling the wider sharing of information relating to water. The web tool is based on the AWS International Standard. The primary focus of this web tool is to provide an accessible and understandable entry point for farmers to begin engaging the catchment concepts and requirement of the AWS Standard. Currently the web tool has links to supplementary information on water resources in South Africa. The IIMMS developed in this project has links to the WWF web tool and is currently working with WWF as custodian of the web tool to develop links from the tool to information that is particularly relevant to stakeholders in the uMngeni catchment.

As described above the AWS International Standard requires the site seeking certification to gather and understand a large amount of data and information about the site and the water related issues in the catchment. There is therefore a natural synergy and a need for closer integration between the IIMMS developed in this project and the WWF water stewardship web tool. The challenges at the moment in this regard are both technical and institutional, with the latter presenting the largest difficulty. Issues of ownership, branding, responsibility, control, liability, strategy, security, confidentiality and many others come into play when an information system is developed to fill a common space shared by many organisations, some of which are in conflict and many of which are in competition with one another. The private sector financial flows related to water is a particularly dynamic and uncertain space in relation to the aforementioned, which fall broadly into the governance sphere.

3.6 Shared Information and Citizen Science

A strong case has been made for the sharing of information. One of the developments in recent times is the burgeoning of citizen science activities which communicate and report via social media and the internet and increasingly on Google Earth platforms. These developments which are supported in South Africa by the Water Research Commission, WWF-SA and other prominent organisations particularly in the development aid realm are a potential game changer in the information sharing space.

3.6.1 Citizen Science Tools Used in the Catchment

A core element of the citizen science components of the IIMMS is what is commonly known as the Mathuba WIKI. The isiZulu word Mathuba means "*Now is the time*" or "*an opportunity*". The Mathuba WIKI is designed to connect to a wide range of IT related activities in the catchment. It is conceived, developed and lives in a collective space on Google Earth and is not the sole property of any one organisation. The IIMMS developed in this project connects extensively to the Mathuba WIKI, and also contributes to this commons tool. This is typical of the new breed of information system that serves truly collective spaces of engagement over common natural resources.

Mathuba was born out of the realisation that despite the dedicated efforts by many people, over decades, the rivers around South Africa are in poor condition, with levels of pollution rising year by year. Much research has been conducted on rivers and catchments. Yet the report card i.e. the state of our rivers and streams, particularly urban & peri-urban ones, is NOT good.

A small networked group within the uMngeni Catchment started this uMngeni Mathuba WIKI, inspired by Margaret Wheatley, *inter alia*, regarding how real change really happens, and by Gene Bellinger in his talks on Virtual Systemic Inquiry. Their hope is that this WIKI stimulated conversation will lead to socially robust knowledge *(aka actionable knowledge*) developed *inter* alia by engaging in virtual systemic inquiry, on the part of many role players. Such inquiry, could deepen understanding, increase connections and stimulate agency amongst all in the uMngeni Catchment. These activities could lead to the emergence of real change and will lessen systemic risk and improve socio-ecological infrastructure.

This WIKI will also enable citizens in the catchment to contribute to the growing body of citizen science and related collective actions in the uMngeni and other catchments in South Africa. The video at URL *https://www.youtube.com/watch?v=aKG0FS0t1v0* presents a brief glimpse of what organizations, working particularly with youth groups and schools are doing to care for our catchments. These activities and many more are backed by a growing body of best practice in science are gathered and linked in the Mathuba WIKI.

The Mathuba WIKI platform for the UEIP can be accessed at
https://sites.google.com/site/ueipstakeholderengagement/home

The Mathuba WIKI has become the overall holding framework for the hyperspace of conversation, applications, information sets and models which form the core of the IIMMS. The capabilities of the IIMMS to support citizen science links strongly to Principle 2 that emerged from the 2014 National Water Summit, outlined below:

"*Our decisions shall be informed by both the best available science, research and technology, as well as real-life, local experience."* Water Research Commission (2014)

The Water Research Commission (WRC) is following up on this principle by funding key research in this area as is evident from their collaboration with AWARD and the Institute for Water Resources (IWR), in bringing together 'The Forum of Forums' (which took place in October 2015). The main

objectives of that meeting was to discuss the findings of WRC Project K5/2411, 'The Revitalisation of Catchment Management Forums' and to encourage inputs from key stakeholders – researchers, Catchment Management Forums (CMFs) and Catchment Management Agencies (CMAs), community and corporate stakeholders, and officials of the Department of Water & Sanitation.

As the organisers pointed out, the process of revitalising Catchment Management Forums (CMFs) and the roll-out of new Catchment Management Agencies (CMAs) provides opportunities for the **participation of citizens** in catchment management, but also raised key questions about the nature, place, functioning, autonomy, enforcement potential and mandates of Catchment Management Forums (CMFs). The WRC project K5/2411 has undertaken an overview of forums and an inquiry into their place in the process of Integrated Water Resource Management (IWRM). It is now creating a space for the co-creation of responses to various revitalisation proposals by bringing together current and future CMF participants, support officials and interested researchers, to the Forum of Forums.

Forums are generally an important platform supported by local communities as a vehicle for participation in integrated water resources management. Successful platforms for private sector engagement have so far focussed on their needs (EG SWPN, Stellenbosch River Collaborative) and not occupied the same forums. Whilst it is important to link the various communities of practice in water stewardship, differentiated platforms have so far emerged for initial engagements and these are likely to persist.

The IIMMS also serves the space described above. One such local citizen science project the Mpophomeni Sanitation Education Project, a part of which is depicted in Figure 3.9. Amongst other things this project monitors mainline sewage spills in the township 2km upstream of Midmar Dam which is the main drinking water supply dam for the greater Pietermaritzburg and eThekwini areas, which generate about 10% of South Africa's GDP and house about 4 million people.

It is logical to assume that such sewage spills detract from the value of the water and monitoring, reporting and repairing actions add to the value of the water. These spillages over an extended time period have huge economic consequences for the future of Midmar Dam, if it begins to get large algal blooms. So far financial flows from the large and wealthy direct beneficiaries for the services of the monitoring agents (called Enviro-Champs) in the Mpophomeni Sanitation Education Project are lacking. This is definitely one of the "blind spots" of which Scharmer (2009) speaks and the IIMMS is designed to bring light to this blind spot and to feed data from these incidents into high level awareness campaigns and modelling in accordance with Principle 2 of the 2014 National Water Summit Declaration. The IIMMS design team worked closely with this project and related projects that involve township residents and in particular the youth.

Figure 3.9: Multi-organisational endeavour to monitor and report sanitation problems upstream of Midmar Dam

In August 2015, a knowledge transfer event was organised by WWF and Marks & Spencers which involved the Emerging Leaders Programme which Marks & Spencers supports. It included four Enviro-Champs who are engaged with Community Leaders of Prince Alfred Hamlet (near Ceres), where they are experiencing similar issues to those in Mpophomeni and to which they are responding so well. One of the key aspects of taking this work forward and to scale at many sites around South Africa is web based support on Google Earth platforms to showcase these efforts and connect them to similar activities country-wide. The Google Earth Outreach and "Making all voices count" programmes are potential sources of grant funding to take the Mathuba WIKI and related citizen science forward. Figures 3.10 and 3.11 below depict aspects of this work. The red arrow in Figure 3.10 depicts where Midmar Dam is in relation to this sewage spill on a minor tributary flowing into Midmar Dam.

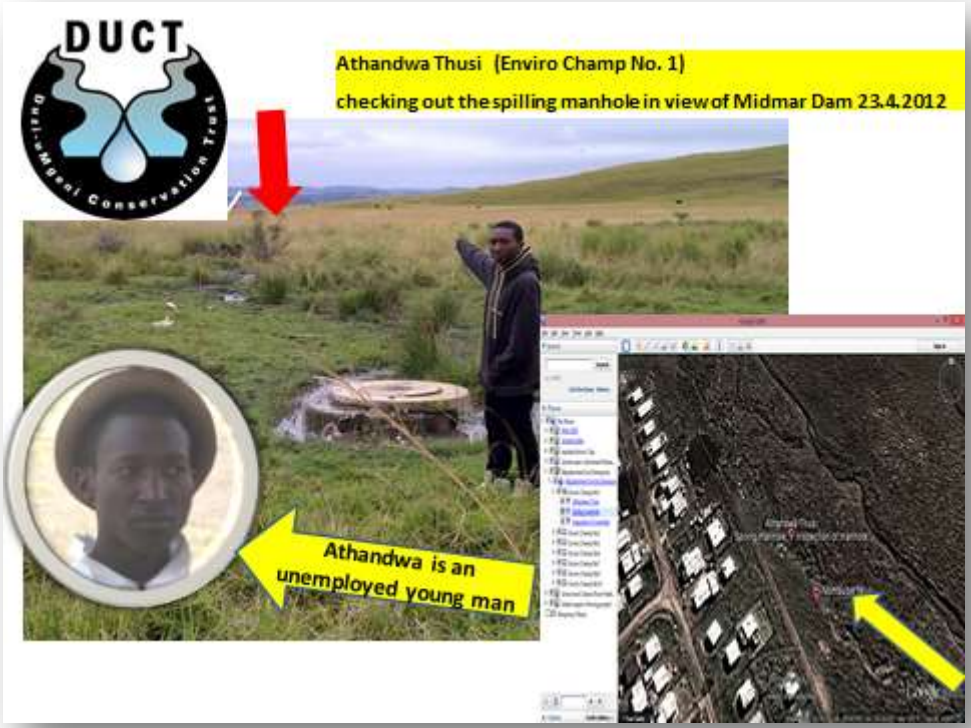


Figure 3.10: An Enviro-champ shows a spilling sewage manhole and the Google Earth image of the location of the manhole is inset.

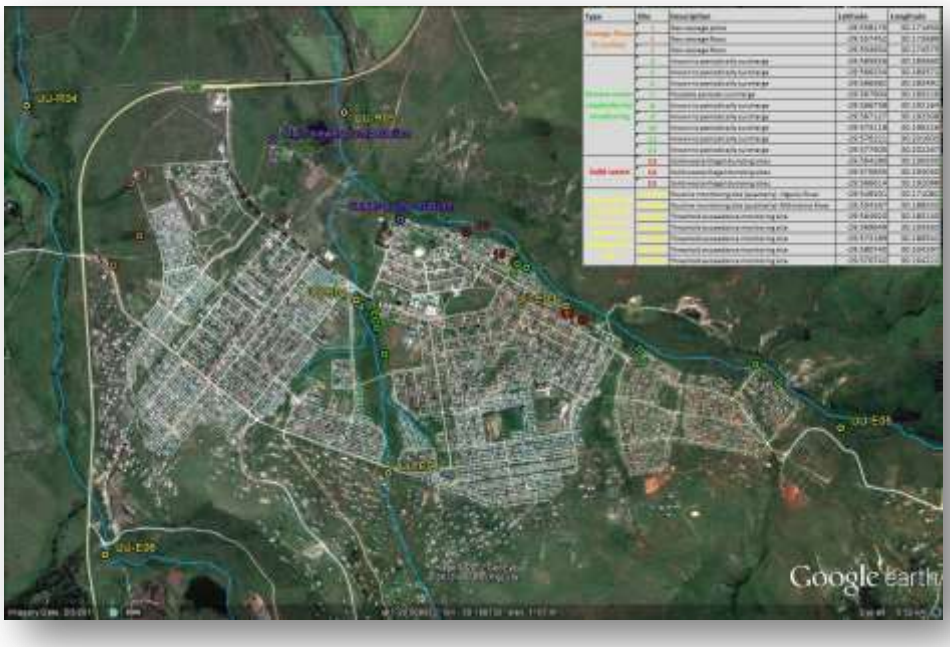


Figure 3.11: Google Earth image of Mpophomeni township showing the location of the sewage manholes alongside streams and with Midmar Dam just out of the picture to the North.

The use of IT and especially the systems of cell phones, web sites, Google Earth and social media applications have with the guidance of the NGOs mentioned in this report contributed to the increasing recognition and funding of these activities by the Water Research Commission and the WWF- Nedbank Green Trust. The miniSASS and the Schools and Citizens River Health Programme, depicted in Figure 3.12, are two of the most active in this space, with the miniSASS programme being deployed at many sites around Southern Africa. Not only is the miniSASS programme contributing to vital bio-monitoring information on streams but it is serving an excellent capacity building role which could be the subject of a full report on its own. The strong links of these programmes with citizen science is evidence of success on this criteria. Section 7.3 contains more on this subject and includes links to the relevant websites to enable the reader to experience some of these aspects of the IIMMS.

Figure 3.12: The miniSASS and the Schools & Citizens River Health Programme.

Links between the labcraft processes and "*Making All Voices Count*" is a key development in Citizen Science and in multi-stakeholder efforts to create innovation and shared value. The IIMMS design is influenced by the principles embodied in this development, which is brought to the internet and offered free of charge by some of the world's largest and leading development agencies.

Figure 3.13: Labcraft developed by the partners in "*Making All Voices Count*".

3.6.2 Design Criteria for Information Co-Generation and Sharing

An extensive process of stakeholder engagement and literature review, plus the testing of some prototypes, was pursued to arrive at the IIMMS design criteria. A set of criteria was derived and these should ensure that the IIMMS can work in a dynamic yet complex, uncertain and emergent, wicked problem space. This is a space that is affected by socio-ecological systems and particularly by real and anticipated changes in ecological infrastructure. In addition the criteria have been developed on a theoretical and practical base to ensure that the IIMMS continues to be relevant in facilitating private sector engagement beyond the lifespan of the current project. The process to arrive at, and the rationale for each of, the criteria are outlined in Figure 3.14.

In the design criteria phase of this project close attention was paid to the stakeholders motives for change and their access to pathways of change, which requires awareness of their connectedness as well as the potential rewards for engaging in collaborative actions. The IIMMS has shown thus far that it addresses all of the aforementioned attention points. The engagement by 17 organisations, in an early prototype of part of the IIMMS, is evidence of success in this area of the IIMMS design criteria formulation, which followed the processes outlined below.

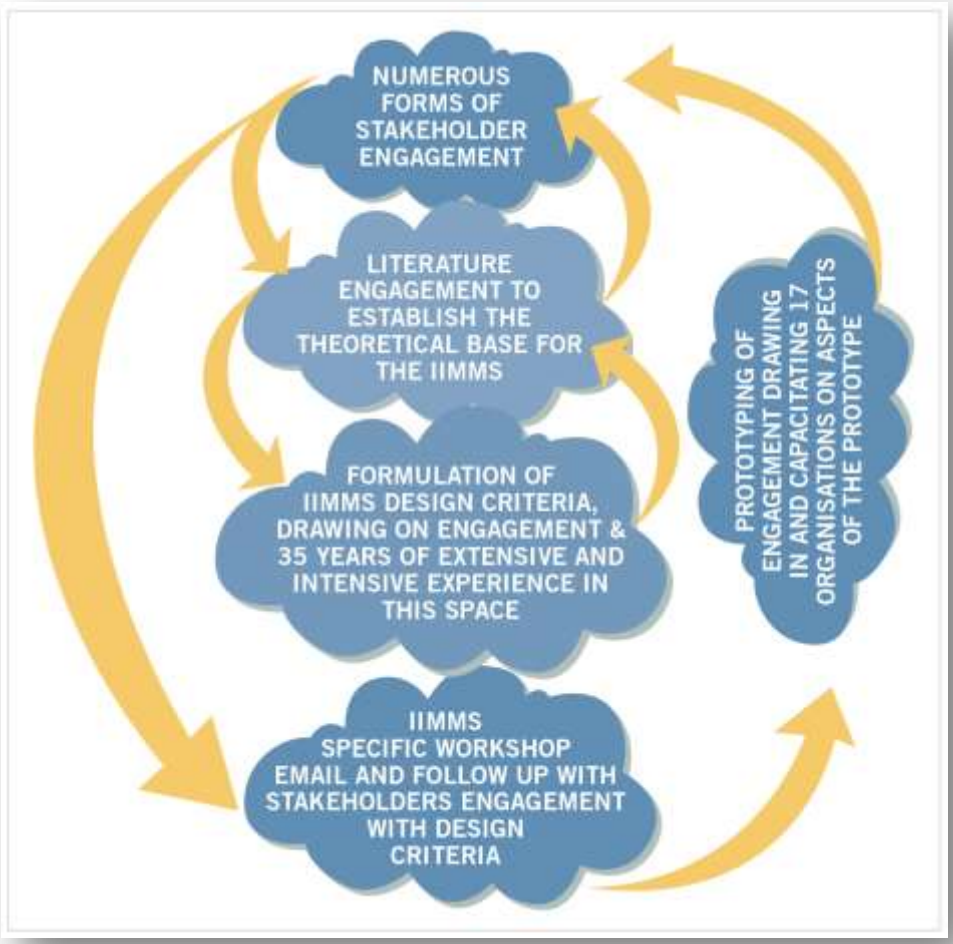


Figure 3.14: Outline of the processes followed in producing the design criteria.

It is important to note the iterative, and stakeholder inclusive, nature of the processes.

3.6.3 Design of the Integrated Information Management and Modelling Platform

The case has been made for an IIMMS to be designed that is appropriate for the complex and emerging context of understanding the private sector financial flows that will *inter alia* support ecological infrastructure in the uMngeni catchment. In this section each of the 20 design criteria that was identified in the stakeholder intensive process outlined above are discussed along with progress on the required prototyping of each element of the system as prescribed by the 20 Criteria.

Criterion 1. The IIMMS should strive to be relevant to stakeholders who are striving to follow the core principles of the National Water Summit Declaration of 2 August 2014, particularly the principle which states "*Our decisions shall be informed by both the best available science, research and technology, as well as real-life, local experiences*".

A prototype of the system was developed along with clear instruction sets and examples of how the process can be continued and expanded into the future beyond the life of the current project. The best available scientific systems were utilised in this process and also the best available processes to stimulate and record real-life local experience. To give effect to this strongly supported criterion the IIMMS development (*https://drive.google.com/file/d/0B3OU751jof9Ed29DRnYwblBjRmc/view*) provides sets of procedures and mechanisms to take stakeholder and citizen science supplied information and link it into the evolving system of biophysical relationships and economic flows that represents the catchment socio-ecological processes, which are the information foundations of any market mechanism for water related ecological infrastructure. *(https://sites.google.com/site/mathubawiki2014/home)*

Criterion 2. The IIMMS should strive to take cognisance of, and align with, the emerging National Integrated Water Information System (NIWIS) which is currently under development within the Department of Water & Sanitation (DWS).

The IIMMS development has followed closely the technical lead provided by DHI Water Environment Health , South Africa (DHI) who are contracted by the Department of Water and Sanitation (DWS) to migrate existing DWS systems in the various directorates into an integrated system to be known as the National Integrated Water Information System (NIWIS). *http://www.gov.za/speeches/dws-launch-national-integrated-water-information-system-niwis-17-jul-2015*-0000 and *http://eadp.westerncape.gov.za/central-environmental-and-water-information-portal/useful-links*

DHI was commissioned to link data sources to the WWF-AWS standard website for South Africa. AWS International Standard *http://www.allianceforwaterstewardship.org/aws-standard-system.html* The Breede-Gouritz CMA is part ofthis initiative. The latter is arguably a logical multi-stakeholder custodian of the web based system was developed by WWF . The AWS International Standard calls for sites (*who seek Water Stewardship Certification*) to disclosed their water balance (*including quality*) information to stakeholders in an accessible form. A number of the uMngeni Ecological Infrastructure Partnership members are showing a keen interest in the AWS International Standard and the Certification journey that this entails. The AWS is presently in multiple conversations to create a water stewardship learning city based around the Msundusi catchment which includes one of the UEIP pilot catchments the Baynespruit. This IIMMS is increasingly forming an integral part of that conversation. A large amount of relevant information for the IIMMS will have to be disclosed and shared with stakeholders in the AWS Standards process. In addition to information disclosure the AWS International Standard requires sites to proactively engage other stakeholders to help them understand the water related systems in the catchment. The IIMMS system is well positioned to be used in this regard as well.

It therefore makes good strategic sense to stay very close to the AWS Standards processes. The AWS has a very close working relationship with the GIZ/DFID funded International Water Stewardship Programme (IWaSP) *https://www.giz.de/en/worldwide/27890.html* which is partnering with a number of large organisations in South and southern Africa. Furthermore, GIZ is a key member of the Strategic Water Partners Network (SWPN). The SWPN has amongst its membership DWS; SALGA; WRC; DBSA;GIZ; WWF; EWT all of whom are effectively members of the UEIP through various

means either as funders (DBSA); WRC or bodies that house members in the UEIP eg. SALGA to which the 3 local authorities in the UEIP are associate members. This all represents a growing convergence around a common IIMMS and DWS is a key player in such a system. DHI is a key player in developing components of such a system as it has been doing now with DWS for years. The UN Sustainable Development Goals (SDGs) and particularly SDG 6 around water and sub goal 6.5 integrated water resources management will make the above all the more important to the IIMMS. Important links that provide more information on the abovementioned elements of this part of the research narrative are to be found at the sites below:

- **NIWIS:** *http://niwis.dws.gov.za/*
- **Breede Gouriz CMA:** *http://breedegouritzcma.co.za/*
- **Strategic Water Partners Network**: *http://nepadbusinessfoundation.org/index.php/research-and-knowledge/publications/254-creating-shared-value-through-innovative-partnerships-strategic-water-partners-network-south-africa*
- **WWF - water stewardship web tool:** *https://aws.wwfsa.org.za/aws/home/*
- **UN SDGs:** *http://www.un.org/sustainabledevelopment/sustainable-development-goals/*

Criterion 3. The IIMMS should strive to take cognisance of all present and emerging technologies and the social practices using these technologies such as those being used and emerging in Citizen Science. In terms of Citizen Science this is a specified part of the WWF led DBSA Green Fund Project brief.

This prototype has received substantial contributions of information and development ideas and support from (17 organisations), namely:

1 Wildlife and Environment Society of South Africa (WESSA)
2 Eco-Schools
3 GroundTruth and their miniSASS project in partnership with WESSA and which is funded by the Water Research Commission;
4 Msunduzi Municipality
5 uMgeni Municipality;
6 uMgungundlovu District Municipality
7 Wildlands Conservation Trust
8 University of KwaZulu-Natal
9 Dusi uMngeni Conservation Trust (DUCT)
10 African Conservation Trust;
11 Msunduzi Innovation and Development Initiative (MIDI)
12 Umgeni Water
13 Department of Environment Affairs;
14 Msunduzi Catchment Management Forum (MCMF);
15 Durban Green Corridor.
16 ASA Global Engagement Programme
17 Mpophomeni Conservation Group (women in agric & conservation)

Many of the links to the contributions to the IIMMS from these organisations can be found at the following URL: *https://sites.google.com/site/ueipstakeholderengagement/enhancing-citizen-science.* One of the pages at this link is depicted in Figure 3.15 below:

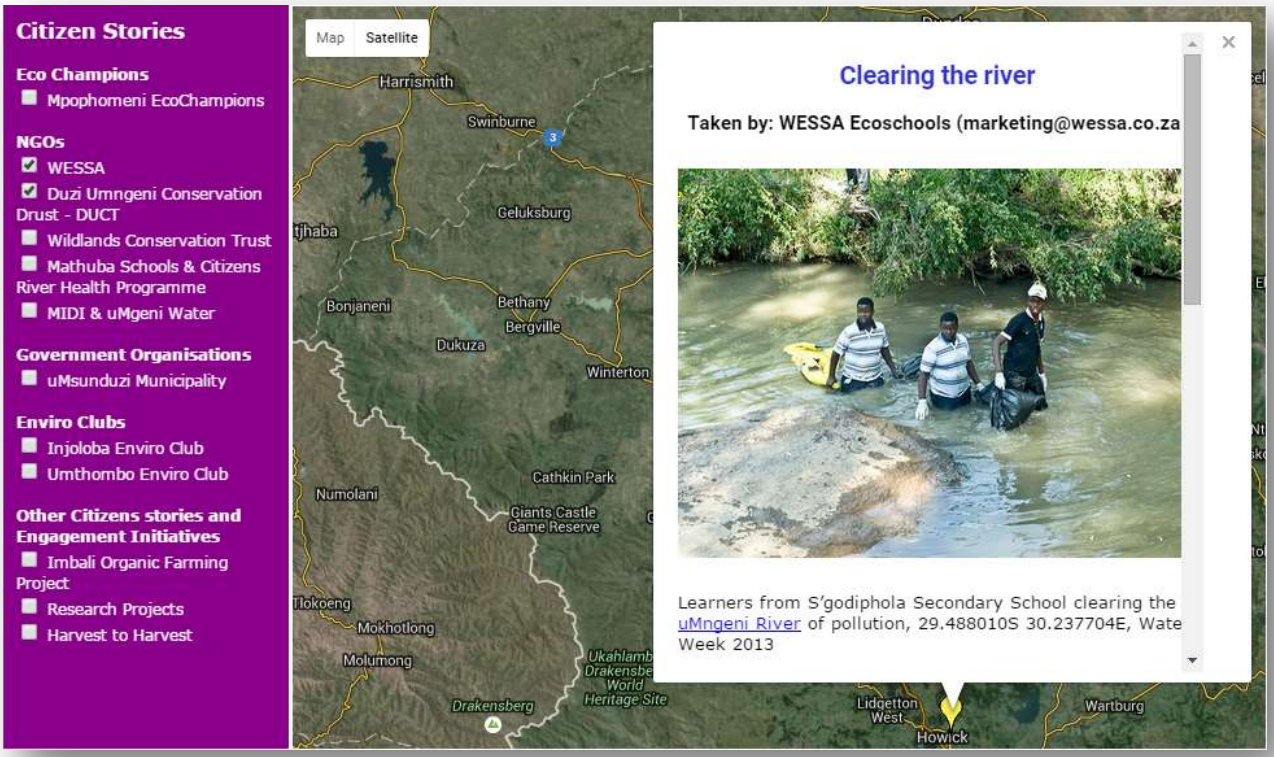


Figure 3.15: Clearing the river in uMngeni with Ecoschools

Much work on populating this prototype has focused on the Baynespruit the Mthanzima (Mpophomeni) catchments both of which are official prototype development catchments for the UEIP. A significant part of the human capacity development has also taken place in this aspect of the project mainly through post graduate students at UKZN and through active participation in a Community of Practice related to Citizen Science which is led by WESSA and GroundTruth as part of a WRC Project. Co-operation with the ASA Global Engagement Programme of GIZ *http://www.asa-programm.de/english/home/* has also been fostered by this part of the IIMMS and both parties have benefitted substantially. Links to MiniSASS and GroundTruth on the Mathuba wiki can be found at the following URL: *https://sites.google.com/site/mathubaWIKI2014/forum/minisass*

There is now positive potential for this Citizen Science aspect of the IIMMS to also be carried into a joint WWF/ GIZ/ Woolworths/ Marks & Spencers/ Alliance for Water Stewardship (AWS) Project in the Breede River Catchment, Western Cape. Also through the MoU between the above and including the Breede-Gouritz CMA there is a strong possibility that this IIMMS will start to be used by role players in that Breede-Gouritz CMA in the same way that it is being used by role players in the

uMngeni, which is part of the Mvoti to Umzimkulu WMA. This is a particularly interesting development from another angle which is that the involvement of GIZ and the AWS in the Breede is through a close joint working relationship between the International Water Stewardship Programme (IWaSP) which in turn is funded through a joint United Kingdom Department for International Development (DFID) and GIZ partnership. DFID in turn is a founder member and major sponsor of a global project entitled Making All Voices Count (*http://www.makingallvoicescount.org)* which is a Google Earth based citizens voices /citizen science form of approach to transparency, accountability and good governance. The Citizen Science aspects of the IIMMS therefore has distinct potential for scaling up to not only the RSA but also SADC, which is something that should interest the Development Bank of Southern Africa (DBSA) and other funders into the UEIP who have a *de facto* mandate beyond our borders, *inter alia* through shared river basin agreements.

Criterion 4. The IIMMS design criteria should strive to take cognisance of international developments in the design and use of such systems and here specifically Cloud Based Systems and OpenMI must be considered.

The IIMMS is presently in the Cloud. The choice of a Web Based System, also known as "the Cloud," was not merely to facilitate access. It also addresses a fundamental challenge in any multi-stakeholder co-operative effort and that is firewall protection on the private websites of the stakeholder groups. The fact that in almost all sizeable organisations who may have contemplated hosting a shared system, the human resources and the financial data are also stored on servers inside the organisations firewall, has been one of the stumbling blocks to multi-organisational co-operation over common, shared IIMMSs. There are now a number of service providers who offer secure server space to host such endeavours as is contemplated with this IIMMS. As it happens DHI has experience in running their systems in such settings. DHI was also a founder member of the OpenMI design movement (*www.OpenMI.org)*. This project has combined with DHI to plan the placement of a prototype Water Resources Information System (WRIS) on an open server. DHI's Water Resources Information System (WRIS) software has been populated for the uMngeni, as far as possible, by the IIMMS Project. This process has revealed resistance within the UEIP to share data and information by placing it on this common platform. This has happened despite the fact that all who have been approached are signatories to the MoU that gave rise to the UEIP. This resistance to share, even public data and information, is something that needs to be addressed at future within the UEIP and a better understanding of the caution and misgivings developed.

Criterion 5. The IIMMS design criteria should strive to embody technological & business case best practice, in terms of both access and openness to the system and also security.

To meet this criterion it was decided to employ a system, which has a long history of development and practice and is used world-wide, in business, government and civil society and which is developed in a highly practical context and for which the business case is tested daily. There are many reasons why the DHI suite of software was thoroughly explored to see if it met this need. Some of these reasons have been mentioned in the criteria analyses above and some will be analysed in the criteria below.

DHI have arguably one of the best water related software sets in the world and the DHI software covers a sizable portion of the needs of this IIMMS. Secondly, if large organisations are going to invest meaningful amounts of time, effort and financial resources in populating the IIMMS then they will want to know that their investment is underpinned by an organisation with footprint, substance and track record in business and software development and support, to carry that investment well beyond 2020. The business reputation and gravitas of DHI is appropriate for the scale of the problem. It is inappropriate to attempt to address a multi-billion Rand, complex challenge with software that has a tiny and inappropriate development and support base, in addition to limited capability for the tasks at hand.

Finally for this criterion it was decided that the Citizen Science related Google Earth Outreach based platform mentioned earlier was to be used since it is a system that provides both access and openness to the IIMMS and also security where appropriate. The details of how this was achieved are presented later in this report. The KMLs can be stored privately on google drive, where they can be protected by stakeholders. However, they can also be made available for public usage in the Mathuba WIKI, by following this link:
https://sites.google.com/site/mathubaWIKI2014/research/data-sources/mathuba-google-earth.

Criterion 6. The IIMMS design criteria should strive to factor in that although the IIMMS is an emerging system of technological components it also has a governance and ownership persona; identity and the *de facto* and *de jure* standing of a collective action product, which is continually emerging and morphing to stay relevant.

This criteria stresses the point right from the outset of the design that this IIMMS is *de facto* co-owned as part of a collective. The reason for this is that if the stakeholders in the uMngeni do not populate it with data and information and use it and interrogate the assumptions inherent and changeable in it, to the point that they grow to trust it then it will not serve them adequately. For the IIMMS to ultimately be considered a success this must be understood by the stakeholders and the various technologies and related processes were chosen to reflect this requirement. The current trend in the increased buy-in to the Citizen Science related Google Earth Outreach *https://www.google.co.za/earth/outreach/* platform mentioned earlier is an example of such buy-in. Seventeen organisations operating in the uMngeni have contributed in a meaningful way to the current standing of that system.

As with any collective action with common pool resources, there is a need for governance rules at various levels to regulate the use and contributions to this IIMMS system. These rules are suggested by the current project and are inherent in the way the IIMMS is set up. However, it needs to be recognised that, by the very nature of the broader system into which it is being gifted at the end of the project, that governance of the IIMMS is a matter for the collective to decide, on an ongoing basis, for the lifespan of the IIMMS.

Current developments in creating ownership of information and sharing rights with collective action for the IIMMS has been made possible through Google resources such as Google Spreadsheets and resulting Keyhole Markup language Zipped (KMZ) which is a file extension for a place mark file used by Google Earth, a compressed version of a KML, which can privately be stored in Google Drive and

shared amongst chosen stakeholders. The Figure 3.16 below depicts how the spreadsheet of Geo-located information can be personalised for a user of Google Earth Outreach. This virtual platform can provide both security and openness.

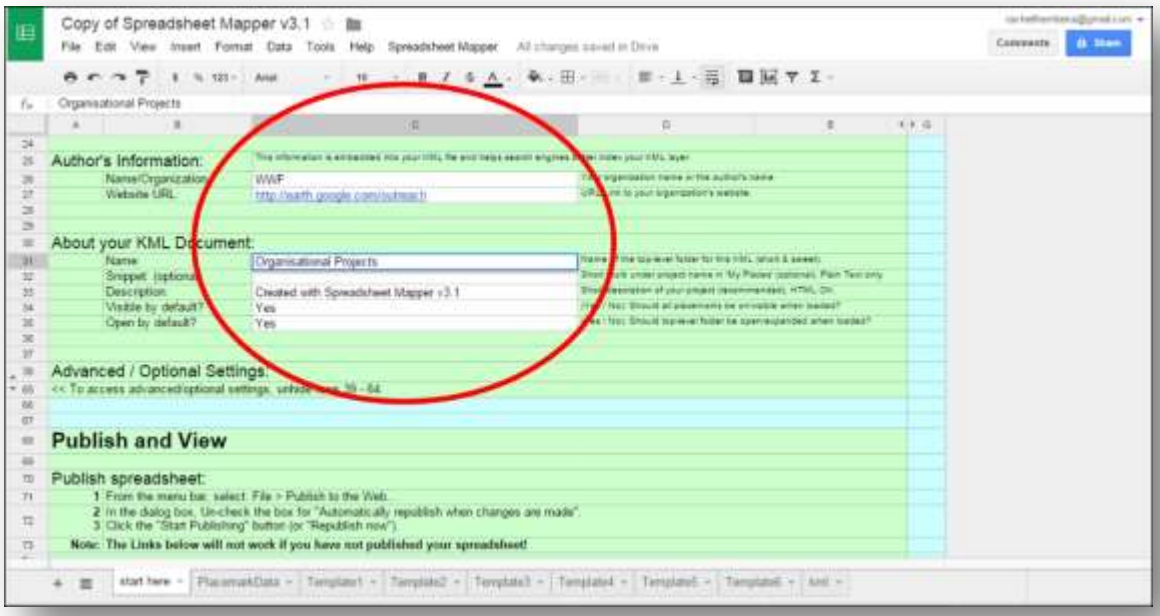


Figure 3.16: Depicts how the spreadsheet of Geo-located information can be personalised for a user of Google Earth Outreach.

The spreadsheet allows for the creation of KML files as well for the place mark data. This KML file can be shared between stakeholders either by email or from a password protected Google Drive. Both these documents can be regularly updated and stored in this space. The diagram in Figure 3.17 below shows how sharing rights can be changed for any document that is stored in Google Drive.

Placing data in a public sharing space such as that of Google Maps enables experiences to be shared. The website has privacy settings as shown in Figure 3.18. These enable access to data and editing rights to be set through decisions by whatever governance process is set up for the IIMMS once operational.

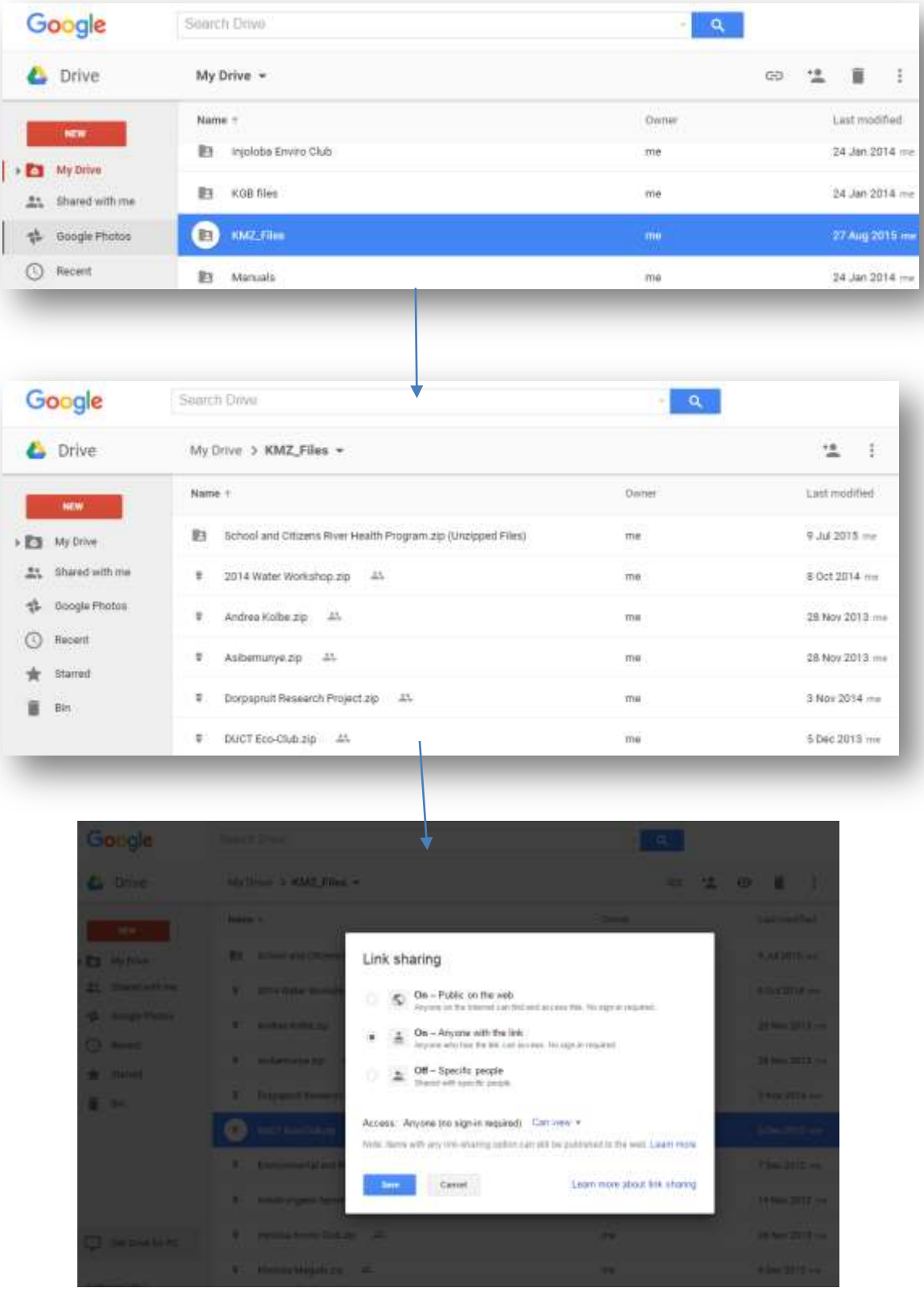


Figure 3.17: Depicts how sharing rights can be changed for any document that is stored in Google Drive

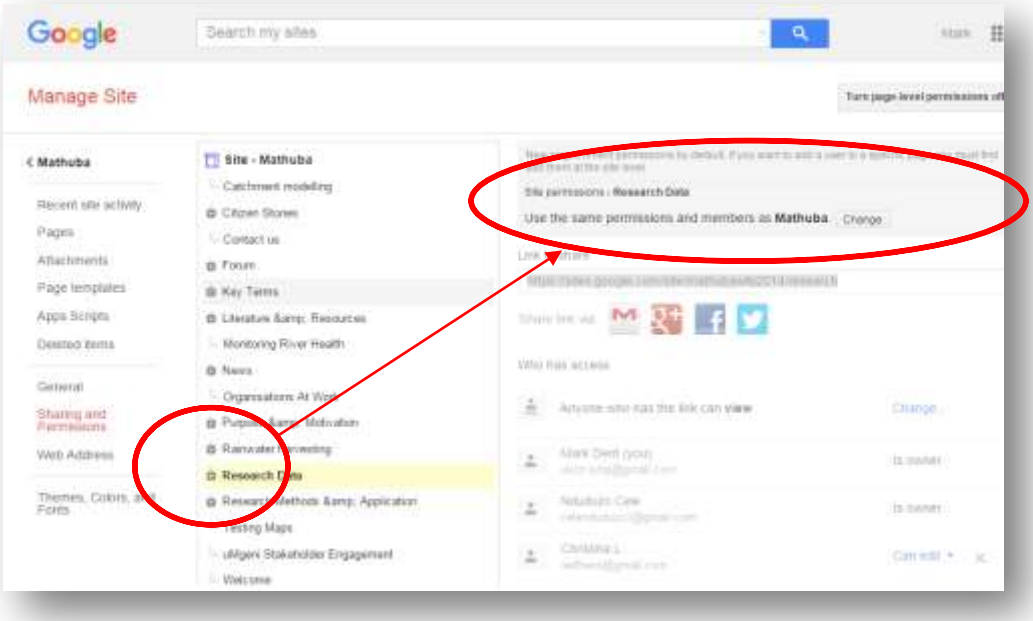


Figure 3.18: The website management screen for privacy settings.

Criterion 7. In view of the fact that the DBSA Green Fund WWF led IIMMS design is being carried out within the broader realm of the UEIP it needs to serve at the very least the needs of the 3 prototype case study sites chosen by the UEIP and these are the Palmiet catchment; the Baynespruit catchment and the Mpophomeni catchment which are all urban.

Progress: There is currently much evidence that the Citizen Science related Google Earth Outreach platform is progressing well in regard to this criterion. It remains for the rest of the appropriate components to meet this criterion. The DHI suite of water related software embodies the SWMM model which is one of the world leaders in urban water information and modelling systems. The IIMMS design has therefore pursued options related to SWMM, within the DHI framework. The big impact of urban settlements and justifies the urban criteria in the IIMMS. These impacts have been negative in terms of the sanitation infrastructure, water quality, storm water ingress and sewage spills. Mngeni Water reports regularly to the UEIP members regarding *E. coli* levels in the Msundusi and its urban tributaries and these have been extremely high and continue to climb.

Criterion 8. The IIMMS should strive to have a strong GIS base in terms of its "look and feel" and user interface. Therefore the relationship between elements of the recommended software and the whole realm of GIS development and Google Earth platforms must be strong and proven.

Progress: The Citizen Science related Google Earth Outreach platform developed in this project is doing well in regard to this criterion. It remains for the rest of the appropriate components to meet this criterion. In this regard it must be noted that DHI is a longstanding development partner with ESRI the developers of the Arc series of GIS products which are the *de facto* standard in the water realm in South Africa. DHI is also moving towards free open source software to be imbedded in its offerings. The DHI Water Resources Information System (WRIS) to which the IIMMS has been linked is an example of this. The cost of having this software linked to the system is therefore lower and

thus increases the accessibility of organisations to this software. Both are significant factors in the context of developing nations such as South Africa. In the prototype IIMMS development for this project discussions are in progress for DHI to allow the project rent free space on its server and the DHI Water Resources Information System (WRIS) software for a limited demonstration time of several months. The WRIS is an information system for storing catchment station information such as rainfall station data, water quality data time series information in formats that make it easily imported to a modelling software eg .csv, xlsx, dfs0. The system is currently being populated with data from the uMngeni as shown on the slides 20-28 of the series at this URL: *https://drive.google.com/file/d/0B3OU751jof9Ed29DRnYwblBjRmc/view*

Criterion 9. The IIMMS will have a role to play in ongoing capacity building and research and therefore the relationship between the various developers of software that forms components of the IIMMS and the research and education community in the RSA needs to be strong. Here particularly the links to Universities and national research organisations must be strong.

Progress: DHI has signed memoranda of understanding with almost all the Universities in the SADC region and in which these Universities may use DHI software free of charge for research and teaching. The WRC and the CSIR have also signed similar MoUs with DH . Prototypes of the IIMMS are being developed on DHI software at the University of KwaZulu-Natal (UKZN) under one of these MoUs. In August 2015 SANParks, DHI and Serious Games held a workshop for school children in the Kruger National Park on the subject of water allocation role playing using serious games running DHI simulation modelling. The video at the following URL-
https://plus.google.com/u/0/114329681197641337375/posts/6jfvTob3oCj presents the story of this capacity building development, which could be replicated in the uMngeni and other catchments if supported .

In August 2015 DHI -SA sent out a questionnaire to all the Universities in SADC who had MoUs with them. The response below was from one top University, the questions are in blue and replies in black:

1. ***"Has the MOU been used over the past few years?" (i.e. what is the trend - more/less/same)***

   Due to increasing numbers of students, the MOU is being more heavily utilized now than in the past. There are presently as many as 140 final year (undergraduate) Civil Engineering students and about 60 MEng and PhD students in the Water field.

STUDENT EXPOSURE: Focus on the students using the software in 2015

2. ***Undergrad: Which software packages are used and how and by how many students?***

   *MIKE 11 is used to train undergraduate students. There are currently **140 undergraduate** final year students at US. The M11 package is used by the final year students in the module: Hydraulic Engineering for a period of about 3 weeks. The software is used in tutorials and even in the exam. Approximately **50** final year students will use M11 for their final year design project. **5 to 10** students/a also use DHI software in their final year research project.*

3. ***Honours: n/a, as honours is included in the Engineering undergraduate degree.***

4. *MSc: Which software packages are used and how and by how many students?*

M11, M21, M21c, M3, M-HYDRO and West. Since 2012, ***15*** *students have used the software in their theses. In 2015 four* ***(4) MEng*** *students are using the software (1 for coastal, 1 hydraulic, 1 water quality and 1 hydrology). Please refer to the enclosed list of students who completed their MEng and PhD studies and used DHI software (****Appendix A****). Most of the students are now working in SA as I have indicated in the list where we know of their whereabouts.*

5. *PhD: Which software packages are used and how and by how many students?*

3 PHD students*. Students used M11 (water quality/hydrodynamics) and Mike21C (sediment). See enclosed list of students who completed studies during MOU period. Typically the PhD students use Mike 11, Mike21 or Mike21C*"

Source DHI -SA Questionnaire 2015 (The full response statistics from all Universities in the SADC region would be available from DHI -SA on request.)

Criterion 10. The business track record and stability underpinning the developers of the various components of the emerging IIMMS must be good. This design criterion is necessary because, in the case of the WWF led DBSA Green Fund project in particular but also other projects in the UEIP there is the strong implicit notion that the costs sunk into populating and building human capacity to be proficient in the use of the IIMMS will be supported beyond the life of the research projects.

This criteria will become increasingly important as large corporates and particularly the financial services industry invest more and more in populating and using the IIMMS. Already the UEIP consists of 236 organisations and there are probably as many more outside the UEIP that will have an ongoing interest in collective action IIMMS's being developed in the uMngeni catchment. There are at least 40 current projects related to water and or ecological infrastructure in the uMngeni.

Progress: The action to be taken following the UEIP Stakeholder workshops endorsement of this criterion is that DHI software will be chosen to underpin some of the developments in the IIMMS. The rationale for this choice is that DHI software meets the above criteria well. The size, world-wide footprint, partnerships with leading software houses and the fact that DHI was a foundation partner in the OpenMI movement is testimony to the strength, respect for and potential longevity of the DHI systems. In addition DHI software is currently used by prominent groups in the uMngeni including uMngeni Water and 3 groups within the UKZN as well as DWS through the NIWIS.

Criterion 11. The IIMMS must strive to use currently available and accessible software systems, where appropriate. The following design criterion is somewhat paradoxical but nevertheless central to the understanding of how a truly useful and durable IIMMS is likely to emerge, to serve stakeholders in what is widely acknowledged as a *wicked* OR *messy* problem. Prototypes of the IIMMS must be able to be constructed immediately and used to build insight and confidence in the emerging IIMMS and also to inform its development pathways.

Progress: The theory of change, explained in various parts of this report, Theory U, shows the imperative for developing prototype systems. The whole systems and Theory U based approaches of Scharmer are particularly clear on the merits of prototypes. The WWF is following Scharmer's Theory U in some of its endeavours world-wide to influence change. The use by stakeholders of these prototypes starts to help them to collectively build deeper understanding of the dynamic

complexities in the real and simulated world systems. So it does not matter whether the data is being disclosed by role players or not, if one thinks that there is a meaningful relationship at play between 2 entities then a link and some first guess at a flow is made. As the characterisation of the stocks and flows of water, finance, eco-system services within, into and out of the catchment starts to take shape so too does the dialogue around these matters and the system grows and starts illuminating itself. A key part of such systems understanding approaches is the "surfacing of assumptions". Such surfacing is imperative because people's assumptions guide their actions and their actions then become very much part of the system. The need to "*numerically ground*" these assumptions (albeit with a simple 1 to 5 Likert scale) is a key to advancing the conversations and reducing the propensity for emotive hyperbole to mislead thinking. The work on virtual systemic inquiry by Bellinger (see https://www.youtube.com/watch?v=YE1Tx7Dm8MQ) and Scharmer (2009) as highlighted in Dent (2012) is particularly relevant in this regard.

Criterion 12. The IIMMS should strive to serve detailed Monitoring & Evaluation of ecological functioning (eg. Links to mini-SASS) and ecological infrastructure so that small but consistent positive actions can be monitored and rewarded accurately and timeously with low transaction costs made possible *inter alia* by links to Citizen Science endeavours.

Progress: Feedback is an essential part of any learning. Monitoring is a crucial element of feedback and evaluation is imperative for learning. This criterion is also strongly linked to one of the foundational principles that were agreed on at the National Water Summit (Aug 2014) and that is the need to connect top level science with local level endeavours. This criterion also gives effect to the imperative contained in the terms of reference of this project and that is to employ Citizen Science in the IIMMS. The Prototype that is the Mathuba WIKI is testimony to the success of action to meet this design criterion. Low transaction costs of sharing information, be it verbal or digital, is a universally recognized imperative for affordable effective co-ordination, synergies and integration.

Criterion 13. The IIMMS design must strive to have a future "*growth and use*" path which is solidly grounded in institutional capacity, science, user groups and is taken seriously by the CMA stakeholders (many of whom are also UEIP stakeholders) as a focal point for contributions of third party software.

Progress: Almost all of the arguments made to support the stakeholder agreed design criteria support this criterion. Due to the critical importance of this criterion it was deemed necessary to state it explicitly. Without this criterion being met it is highly likely that the IIMMS will not function and grow beyond 2015 and as such it would not have fulfilled the stipulation that it must strive to ensure sustainability. It is significant to note that a major project in the 5th EU Water Framework (Ison *et al* 2004) that was designed to inform social learning for the integrated management of water (SLIM), as it was known, reported that the authors found it very useful to think of sustainability as an emergent property of stakeholder interaction. This latter point is a theme that is echoed very strongly by many authors on the theory of change in this report. Evidence is presented at many places elsewhere in this report to show why many of the criteria are effectively also focused on the goal inherent in this criterion.

Criterion 14. The IIMMS must strive to leverage economies of scale in most areas of its use and especially at the CMA level. These economies feed back into all institutions (state, para-state & private) that feed CMAs with information. The UEIP will be a significant source of information and knowledge for the CMA.

Progress: The flexible and open style of the IIMMS design which is emerging from the engagement processes around the agreed criteria lends itself to preserving sunk costs and that in itself is a major contributor to the economics of such information systems. Secondly, when the strategic narrative surrounding the design criteria is taken as a whole it is evident that the rationale for focusing collective action around the principles and practices that have emerged as recommendations out of the wider stakeholder engagement is compelling. Stakeholder's working together on a common and open system that simultaneously provides space for innovation, the controls for connection and creates economies of scale. There are countless examples in the IT world of such strategic *modus operandi*. The internet, Linux and the universal serial bus (USB) are perhaps the most well-known examples as are the VISA and Mastercard phenomena in the world of business. The economies of scale and low transaction costs that these create are well known.

Criterion 15. The IIMMS must strive to be suitable for use at a variety of spatial and temporal scales and be able to integrate terrestrial and in-stream processes incorporating water quality and quantity.

Progress: A glance at the projects in the UEIP and also the fact that risks, solutions, eco-systems and flows of water, finance and eco-system goods and services are to be found at a range of scales, all of which need to be integrated. The stakeholder workshop endorsed this criterion, strongly. The Mike powered by DHI suite of models that would be seamlessly invoked in this IIMMS are well suited to serve this criterion. *https://www.mikepoweredbyDHI.com/products/mike-11/water-quality https://www.mikepoweredbyDHI.com/products/eco-lab*

Criterion 16. The IIMMS must strive to have the capability to link seamlessly to inputs and outputs to freshwater and waste water treatment plants (Blue Drop & Green Drop) and all other forms of point source inputs eg. surcharging sewer mains; storm water inlets & outlets.

Progress: This criterion received the strongest endorsement by the stakeholder workshop. It is also likely to find the strongest endorsement at many other fora as key strategic endeavours by, amongst others, the SWPN, indicate. In all three prototype catchments within the UEIP the above are key areas of concern. The DHI systems employ the SWMM *http://releasenotes.DHIgroup.com/2014/MIKEURBANrelinf.htm* for urban situations that could address the above. This in addition to the WEST system *https://www.mikepoweredbyDHI.com/products/west* for waste water treatment plants, which is used extensively by the Pollution Research Group, Chemical Engineering at UKZN, who are active members of the UEIP in their close association with the eThekwini Metro.

Criterion 17. The IIMMS must strive to be an on-line tool that enables collective action.

Progress: This criterion was also very strongly endorsed at the Stakeholder workshop. On-line/cloud/web-based systems are now possible and the expertise and software required to set up genuine, multi-stakeholder, collective action supporting systems, is now available.

https://sites.google.com/site/ueipstakeholderengagement/system/app/pages/search?scope=search-site&q=collective+

Criterion 18. The IIMMS must strive to be of use to individuals, farmers and organisations (members of UEIP) who use and care about water in the Umgeni catchment.

Progress: This criterion speaks to access and functionality. It is essential that the IIMMS should have an easily accessible dashboard on critical actions that enables non-scientific stakeholders to act as part of the collective. However, this does not imply that the system must be bounded by unrealistic constraints such that the IIMMS must take no more than 5 minutes to learn and that the IIMMS - must be able to be fully understood and used productively in its entirety by one person. Just as the modern world finds airplanes, banks and hospitals of use they must be staffed by people who know what they are doing. In most cases real usefulness beyond shop window type browsing is really only possible with the help of skilled interlocutors. One of the deep seated mental blocks, that has persisted for decades and reflects a certain hubris in the realm of water, is that such skilled people are not needed in water and so called managers can metaphorically speaking "*fly their own passenger planes; run their own banks and execute their own complex medical procedures….and learn all this in 5 minutes".*
https://sites.google.com/site/ueipstakeholderengagement/projects-and-engagements

The intellectual property (IP) arguments that are bound to arise in connection with the IIMMS are probably going to present the biggest danger to this agreed criterion from being met. The notions of IP and possessiveness that surround information in the water space are well known for their crippling effect on integrated water resources management (IWRM). It may take something as powerful as SDG6 on water and especially its emphasis on IWRM to transcend this grand folly that is gripping the water realm in South Africa.

Criterion 19. The IIMMS must strive to support action by the users to protect and restore ecological infrastructure and water resources.

Progress: This criterion means that the value of ecologically wise actions on a small scale by users must be able to be quantified in some way and linked into a system that can estimate the value to the whole of these localised actions. Only then can a just reward be paid for these actions. The system must be able to trace the impact of these small actions and that requires models. Once the value of the actions, to the whole system have been quantified, all that remains is to monitor these localised actions in a timely, accurate and credible manner and reward the executor of these actions, quickly, appropriately and with very low transaction cost. The IIMMS must be designed to facilitate the above. *https://sites.google.com/site/ueipstakeholderengagement/enhancing-citizen-science*
https://sites.google.com/site/mathubaWIKI2014/forum/in-need-to-repair

Criterion 20. The IIMMS must strive to show the following:

Criterion 20.1. Who is part of collective action and water stewardship.

Progress: The Mathuba WIKI is the connecting space for much collective action activity amongst the UEIP Partners and other stakeholders. If they do not connect directly then links are provided to their websites, contact persons and what they are doing in the UEIP. In essence all the activities reflected

on the Mathuba WIKI, with its numerous hyperlinks are water stewardship in their nature. For example, the Mathuba Schools & Citizens River Health Programme, which is described in the Mathuba Mentors Manual.
https://drive.google.com/file/d/0B3OU751jof9Ea0Zma3Z6ODBIeEU/view which in turn is linked to Mathuba Citizen's Stories Page *https://sites.google.com/site/mathubaWIKI2014/story-index*

Criterion 20.2. Key issues that will stimulate collective action – outputs from other systems.

Progress: The IIMMS shows the following key issues in which the theory of change is that these activities will lead to the emergence of real change and will lessen systemic risk and improve socio-ecological infrastructure. *(https://sites.google.com/site/mathubaWIKI2014/home)*. The Mathuba WIKI forms the overall platform which makes these links possible and provides control and connectivity whilst at the same time the space to co-innovate, co-operate and co-learn. An example of the connections and growth of these ideas is the Mpophomeni Enviro-Champs working visit to Prince Alfred Hamlet near Ceres on a WWF / Marks & Spencers sponsored community engagement event. These 2 groups can in future use the Mathuba WIKI platform and Google Earth Outreach to stay in touch and share their work.

Criterion 20.3. What people and organisations can do together.

Progress: In the Mathuba Google Earth platform there are hundreds of small case studies and Iceberg Format stories which show what people are doing with respect to collective action in the catchment. These form both an information repository and an inspiration base and perform a vital task of mapping many activities to reveal an emerging picture of hope and direction. For example the water harvesting work that has been done by GIZ Exchange Students on the ASA Global Engagement Programme, URLs:
https://sites.google.com/site/mathubaWIKI2014/story-index/harvest-to-harvest
Water harvesting knowledge resource: http://www.rainwaterharvesting.org/ Water Harvesting Discussion Forum: https://sites.google.com/site/mathubaWIKI2014/forum/gardening

Criterion 20.4. Feedback on the action (e.g. What happened to River Health/E.coli levels/etc).

Progress: The Mathuba WIKI now has links to the following:

- Steve Terry's uMngeni Water *E. coliE. coli* monitoring in the Umsundusi & tributaries & what the Mathuba group has made of it on Google Earth
  https://sites.google.com/site/mathubaWIKI2014/research/data-sources/E. coliE. coli
- Mpophomeni Enviro-Champs Project
  https://sites.google.com/site/mathubaWIKI2014/system/app/pages/search?scope=search-site&q=Mpophomeni and
  https://sites.google.com/site/mathubaWIKI2014/forum/workshops-education
- Shiyabizali – Howick Waste Water Treatment Works project involving the clarity tube for measuring Total Suspended Solids
- DUCT project follow on from Eco-Champs
  https://sites.google.com/site/mathubaWIKI2014/story-index
- Mathuba Citizens stories *https://sites.google.com/site/mathubaWIKI2014/story-index*

- miniSASS – stories *https://sites.google.com/site/mathubaWIKI2014/forum/minisass* and *http://www.minisass.org/en/*
- UKZN Environmental Science Honours projects
- UKZN Environmental Science Masters projects
- Save Midmar Project *https://sites.google.com/site/mathubaWIKI2014/project-updates/groupsjoinforcestosavemidmardam*
- Palmiet Project *https://sites.google.com/site/ueipstakeholderengagement/projects-and-engagements/palmietrehabilitationproject*
- Baynespruit Project *https://sites.google.com/site/mathubaWIKI2014/project-updates/baynespruitrehabilitationproject*
- Feedback to Msundusi Catchment Management Forum which has adopted the Mathuba WIKI as a feedback mechanism.

Criterion 20.5. Alliance for Water Stewardship – standard and on-line support tool information. *http://www.allianceforwaterstewardship.org/*

Progress: A close working relationship has been established with the AWS related approaches in the WWF/GIZ/Woolworths/Marks & Spencers/AWS led partnership working in the Breede Gouritz CMA area. WWF developed a web based tool *(https://aws.wwfsa.org.za/aws/home/*) to make linkage with the AWS Standard easier for farmers and other stakeholders in the above project. The IIMMS has a link to this tool. It is recommended that whoever takes over custodianship of the IIMMS should follow these developments very closely as they hold huge potential for helping to upscale developments in the UEIP.

Criterion 20.6. Mini-SASS information *http://www.minisass.org/en/*

Progress: The Mathuba WIKI system is full of link to the minSASS website and Google Earth screen grabs of miniSASS activities.

Criterion 20.7. Green & Blue Drop information *http://www.talbot.co.za/laboratories/blue-drop-green-drop/*

Progress: Idea is to place a question mark above every municipal WTW (Blue Drop) or WWTW (Green Drop) and link the flag to the Blue or Green Drop Report for that site and to pose the question as to the sites performance. The idea is to enable the general public to be informed and to start asking legitimate questions.

Criterion 20.8. Water Risk Filter information *http://waterriskfilter.panda.org*

Table 3.3: South African locally identified data sources for Water Risk Filter

RISK CATEGORY	RISK INDICATOR	SOURCE	UNAVAILABILITY REASON
PHYSICAL RISK - QUANTITY (SCARCITY)			
1	Annual average monthly blue water scarcity in this river basin	**All Towns, supplemented with WARMS and WR2005**	**AVAILABLE**
2	Number of months per year water scarcity exceding 100% in this river basin	**All Towns, supplemented with WARMS and WR2005**	**AVAILABLE**
3	Blue water scarcity in the month in which blue water scarcity is the highest in this river basin	**All Towns, supplemented with WARMS and WR2005**	**AVAILABLE**
4	Groundwater overabstraction	**NIWIS**	**AVAILABLE**
5	Forecasted impact of climate change		**STILL INVESTIGATING**
6	Estimated occurrence of droughts	**Villhoth et al 2013**	**AVAILABLE**
7	Estimated occurrence of floods	**Stormflow greater than 2mm, South african atlas of climatology and agrohydrology**	**AVAILABLE**
PHYSICAL RISK - QUALITY (POLLUTION)			
8	General situation of water pollution around the facility	**PES**	**AVAILABLE**
PHYSICAL RISK - ECOSYSTEM THREAT			
9	Threat to freshwater biodiversity threat around the facility	**NFEPA**	**AVAILABLE**
9a	WWF priority basin	**NFEPA**	**AVAILABLE**
10	Vulnerability of water ecosystems in the country	**National Biodiversity Assessment**	**AVAILABLE**
11	Access to safe drinking water (% of population)	**Census 2011**	**AVAILABLE**
12	Access to improved sanitation (% of population)	**Census 2011**	**AVAILABLE**
PHYSICAL RISK - DEPENDENCE ON HYDROPOWER			
13	Dependency on hydropower		**NO NATIONAL DATA**
REGULATORY RISK			
14	Water strategy of local, national and upstream governments, including drought and flood management plans where appropriate	**Areas with All Town Studies complete**	**AVAILABLE**
15	Sophistication and clarity of water related legal framework	**N/A**	**Not Required. Legal Framework very good for all of South Africa**

RISK CATEGORY	RISK INDICATOR	SOURCE	UNAVAILABILITY REASON
16	Enforcement of water related legal framework	**Blue and green drop indicators (NIWIS)**	**AVAILABLE**
17	Official forum or platform in which stakeholders come together to discuss water-related issues of the basin	**All the established CMA's**	**AVAILABLE**
REPUTATIONAL RISK			
18	Cultural and/or religious importance of local water sources	**Free flowing rivers, Ramsar sites?**	**NO DATA**
19	Exposure of this country to local/national media coverage reporting on criticizing on possible water issues	MuSSA	**AVAILABLE**
20	Exposure of this country to global media coverage reporting on criticizing on possible water issues	MuSSA	**AVAILABLE**

Progress: A start has been made on the task to place a question mark above every site and place the diagram below (Figure 3.19) and a link to the WWF-Water Risk Filter website. The idea is to enable the general public to be informed and to start asking legitimate questions. *https://sites.google.com/site/mathubaWIKI2014/organisations-at-work#TOC* The-Water-Risk-Filter: WWF

Risk is a common language for finance, business, infrastructure and ecosystems. Better quantifying water risk motivates the private sector to take specific actions to mitigate the risk and act collectively, particularly when is enabled by a credible convener (such as the UEIP). WWF-International's water risk filter (WRF) *www.waterriskfilter.panda.org* has been a useful tool to engage business and finance on assessing and comparing water risks and directing responsive action. The tool is currently a global tool using global datasets to calculate relative water risk in different regions.

During this project WWF-SA, with DHI and the CSIR assessed national data sets that could be used to develop an embedded South African national water risk filter within the global tool. The resolution of the RSA tool is at a quaternary, rather than primary, catchment scale and uses nationally derived datasets, mainly from DWS and the WRC. The table in appendix 6 shows the data sets that have been selected to be incorporated into the RSA-WRF. These data sets are currently (November, 2015) being incorporated into the global tool by WWF-International. Whilst this tool will be available nationally, WWF-SA will be piloting its application in the uMngeni catchment with the UEIP.

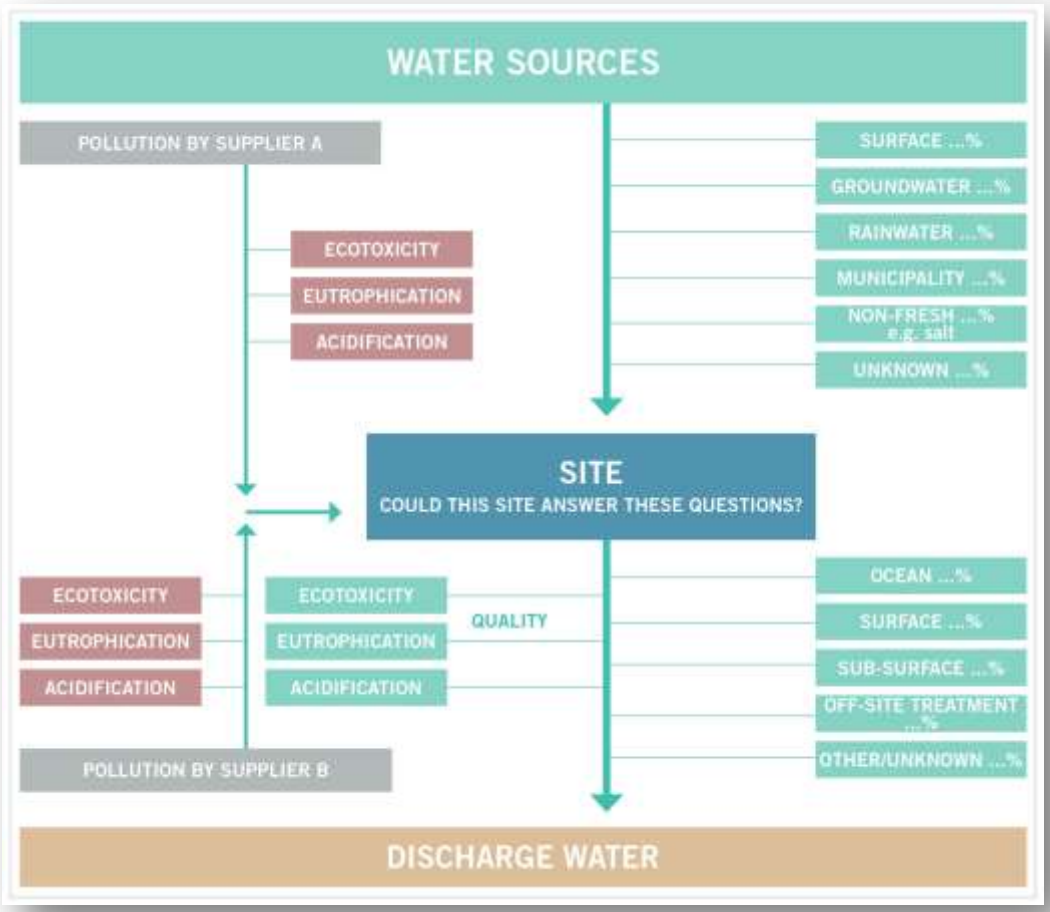


Figure 3.19: A schematic of some of the WWF Water Risk Filter requirements

Criterion 20.9. Water Action Hub information *https://wateractionhub.org/*

Progress: Plan to Register the Mathuba WIKI on the Water Action Hub when the Project Final Report has been accepted.

Discussions have been held with the following in which the Mathuba WIKI work has been presented with a view to starting future up-scaling pathways and links:

- the African leader for the 2030 Water Resources Group (2030WRG) of the World Economic Forum. *http://www.weforum.org/reports/water-resources-group-background-impact-and-way-forward*. This is the group that first convened the Strategic Water Partners Network (SWPN) in South Africa;
- the Southern African leader for the Global Water Partnership (GWP); www.**gwp**.org/ *http://www.gwp.org/gwp-in-action/Southern-Africa/*
- the South African **leader of the** International Water Stewardship Programme (IWaSP) *https://www.giz.de/en/worldwide/27890.html*
- the leaders of the RESILIM Programme *http://www.award.org.za/project/resilience-in-the-limpopo-basin*

3.7 Recommendations for On-Going Support for Private Sector Engagement.

It has been established that a cloud-based, open source (non-proprietry) platform to enable universal access and information sharing for UIEP is optimal. The IIMMS has been designed and developed in a context that seeks to deepen understanding of water valuation risk and stewardship and address the criteria discussed with stakeholders. A context that supports Water Stewardship, including the Alliance for Water Stewardship International Standard (AWS, 2014) will be useful for the UEIP, given the level of global institutional support invested in this objective measure of better production practice and collective action. Water stewardship also serves a co-generation process for knowledge and information on private sector engagement to support and restore ecological infrastructure, guided by Theory U and citizen science principles of engagement, modelling (testing) and learning.

The IIMMS platform with be handed over to the SANBI-WWF supported UEIP coordinator. Further inclusion of specialist models has been recommended and will be led by the coordinator in consultation with the existing UEIP members and the newly forming CMA, which is a logical future partner in the engagement of business.

As part of this discussion it is instructive to map progress in the IIMMS development onto the seven principles for building resilience in social-ecological systems, as articulated by the Stockholm Resilience Alliance (2015).

PRINCIPLE 1: Maintain diversity and redundancy: *Systems with many different components (e.g species, actors or sources of knowledge) are generally more resilient than systems with few components. Redundancy provides 'insurance' within a system by allowing some components to compensate for the loss or failure of others. Redundancy is even more valuable if the components providing the redundancy also react differently to change and disturbance (response diversity).*" Stockholm Resilience Alliance (2015).

The IIMMS is designed and populated to accommodate this diversity and redundancy and at the same time does not allow the redundancy and diversity to hamper speed, cost or clarity on the part of the users. The overarching, internet based WIKI structure is a key element in facilitating conformity with this principle and in contributing to refinement of collective action to support engagement of the private sector in ecological infrastructure development.

PRINCIPLE 2: Manage connectivity: *Connectivity can both enhance and reduce the resilience of social-ecological systems and the ecosystem services they produce. Well-connected systems can overcome and recover from disturbances more quickly, but overly connected systems may lead to the rapid spread of disturbances across the entire system so that all components of the system are impacted."* Stockholm Resilience Alliance (2015).

The IIMMS design is based on high levels of connectivity that enhance response speeds but also sufficient institutional dispersion to enable negative disturbances to be checked.

PRINCIPLE 3: Manage slow variables and feed backs: *In a rapidly changing world, managing slow variables and feedbacks is often crucial to keep social-ecological systems "configured" and functioning in ways that produce essential ecosystem services. If these systems shift into a different configuration or regime, it can be extremely difficult to reverse."* Stockholm Resilience Alliance (2015).

The need to facilitate feedback is at the very heart of the IIMMS design. A slow variable in the case of the IIMMS is the uptake of such a system. Uptake does not happen overnight and yet in the 18 months of this project we have seen the slow increase in contributions to Mathuba WIKI and now the number stands at 17 different institutions that have contributed to its development.

PRINCIPLE 4: Foster complex adaptive systems (CAS) thinking: *Although CAS thinking does not directly enhance the resilience of a system, acknowledging that social-ecological systems are based on a complex and unpredictable web of connections and interdependencies is the first step towards management actions that can foster resilience*." Stockholm Resilience Alliance (2015).

The IIMMS in its design and evolution mirrors a complex adaptive system that emerges from the interaction of stakeholders. The design of the IIMMS is able to accommodate the proportions of control at critical points in the system and to leave open spaces for innovations that then connect back to the whole system of connections and interdependencies, both technical and social.

PRINCIPLE 5: Encourage learning: *Learning and experimentation through adaptive and collaborative management is an important mechanism for building resilience in social-ecological systems. It ensures that different types and sources of knowledge are valued and considered when developing solutions, and leads to greater willingness to experiment and take risks".* Stockholm Resilience Alliance (2015).

The IIMMS takes strong cognisance of this principle in its design, which to some may look like a "hodge potch". This is not the case as the one golden rule for the acceptance of any component of the IIMMS is that it must connect to the system. The IIMMS is specifically designed to value different types and sources of knowledge. In terms of learning the IIMMS has been developed in an environment of continuous learning and growing which in turn builds the system. There are certain aspects of the IIMMS development which are "procedural" in nature and these form the overarching framework, for example adherence to the design criteria. However, with these in place the developers have sufficient faith in the complex adaptive social learning processes inherent in the multi-stakeholder interaction to generate the creative co-learning that has grown the system.

PRINCIPLE 6: Broaden participation: *Broad and well-functioning participation can build trust, create a shared understanding and uncover perspectives that may not be acquired through more traditional scientific processes".* Stockholm Resilience Alliance (2015).

Broadening participation is a key aim of the IIMMS, both in its design, construction and use. The Theory U approach explains the theoretical underpinnings for the processes used and which were specifically designed to build trust and create a shared understanding which has helped to prepare a nourishing environment for the presentation of multiple perspectives which are bound to arise when

36 organisations are working on water, financial flows and ecosystems and related themes in one catchment.

PRINCIPLE 7: Promote polycentric governance systems: *Collaboration across institutions and scales improves connectivity and learning across scales and cultures. Well-connected governance structures can swiftly deal with change and disturbance because they are addressed by the right people at the right time".* Stockholm Resilience Alliance (2015).

This principle has been central to every aspect of the IIMMS design and it is one of the many reasons why the IIMMS is designed to work in the internet cloud and not off a server at any institution. There are constant calls for new forms of institution to meet the demands of water related management, but what is often not made clear in these calls is that these polycentric governance systems need large amounts of low transaction cost interchange of information which requires different types of information systems. The internet; Google; WIKIs; VISA and Mastercard; Facbook and countless other polycentric activity are testimony to the effectiveness of such systems.

Woodhill (2010) writing in Blackmore (2010) on the subjects of sustainability , social learning and the democratic imperative, drawing lessons from the Australian Land Care Movement provides much for reflection to conclude this report. The IIMMS makes a distinct contribution to serving the reflexive spaces of which Woodhill speaks.

"This chapter introduces the themes of the risk society and reflexive modernization as a perspective that can help explain why modern institutions are structurally biased against the ideals of sustainable development. This provides a brief political economic context for then outlining a perspective on social learning that gives particular attention to questions of how to facilitate the design of institutions more supportive of sustainable development." Woodhill (2010; p 57)
The IIMMS supports the reflexive social learning in a risk filled society that urgently needs to facilitate market mechanism to financially support ecological infrastructure.

"The themes of the future, which are now on every-one's lips, have not originated from the foresightedness of the rulers or from the struggle in parliament – and certainly not from the cathedrals of power in business, science and the state. They have been put on the social agenda against the concentrated resistance of this institutional ignorance by entangled, moralizing groups and splinter groups fighting each other over the proper way, split and plagued by doubts. Sub-politics has won a quite improbable thematic victory" Source Beck, 1994. P 19 In Woodhill (2010; p 57)

The IIMMS provides an IT base to facilitate a similar large scale transformation in the socio-technical space that supports and facilitates ecological infrastructure focused market mechanisms.

"*Started in the mid 1980's, Australian Landcare now involves some 4 000 local level groups working to overcome land degradation*." Woodhill (2010; p 57)

"*However, the harsh reality is that these (local level , incl. landcare) approaches are* ***not*** *leading to the scale of on-ground change necessary to overcome land degradation and achieve widespread ecological sustainable land use. Farmers have been furnished with neither the resources nor the*

*incentives to make the **changes** or to take the **risks**, that achieving sustainable agriculture demands*". Woodhill (2010; p 58)

These findings by Woodhill are a strong endorsement of the 2014 National Water Summit Principle that seeks to connect high level and local level actions. The IIMMs has support for this 2014 National Water Summit Principle as one of its core criteria.

"*The problem of unsustainable land use continues largely unabated, despite these current initiatives, I argue because of a lack of attention to the deeper structural causes of the problem*." Woodhill (2010; p 58)

"… deeper structural causes of the problem are embedded in the dominant scientific, political, economic and normative institutions of modern industrial society." Woodhill (2010; p 58)

It is interesting to reflect on whether the United Nations Millenium Development Goals (MDGs) and now the Sustainable Development Goals (SDGs) are responses to these deep structural causes of which Woodhill writes. The IIMMS is a particularly appropriate system to help address the Integrated Water Resources Management (IWRM) sub-goal of SDG 6 on water.

"*Everywhere in the world, environment and development work that focuses on local level participation and empowerment eventually runs up against constraints that have to do with broader scale institutional arrangements. These constraints, for example range from a global economic system that does not adequately value natural capital to dwindling investment in public services, inequitable land and resource tenure, institutionalized corruption and the inability of global governance mechanisms to keep pace with the ramifications of globalization. Recognition of this situation has led to a growing focus on the institutional aspects of environment and development work.*" Woodhill (2010; p 58).

The UEIP is one example of this. The Strategic Water Partners Network; the Alliance for Water Stewardship; the 2030 Water Resources Group of the World Economic Forum and the "Making All Voices Count" Programme of DFID-USAID-SIDA-Open Society Foundation are others. The IIMMS contributes to all these.

"*After a decade of experience with such "localist" approaches, there is now a rapidly growing realization that much wider forces are at play that hinder the resolution of many environment and development problems solely via the local level. Ultimately, if the often remarkable efforts of local communities are not supported by broader scale institutional change, such efforts end up being in vain. In response environment and development work can be seen as entering a new 'institutional era'. The sociology of community action of the 'localist era' now needs to be complemented by political economic insights and theory of co-ordinated action at meso- and macro-scales*" Woodhill (2010; p 59).

The IIMMS contributes to making and sustaining the complementary micro, meso and macro scale linkages for co-ordinated action of which Woodhill (2010), speaks. This is the rich tapestry, incomplete but useful and inviting of engagement that the IIMMS has reached at this stage of its evolution. One would hope that the process that generated it gets further support in coming years.

4 FINANCE MECHANISMS FOR ECOLOGICAL INFRASTRUCTURE

4.1 Introduction

South Africa's Water Act (1998) has been internationally celebrated for recognising the natural environment as having legal rights to water, and the importance of protecting an "ecological reserve" to enable hydrological systems to continue to serve society. In spite of this recognition, a series of development pressures and institutional failures has seen an under-investment in water catchments in South Africa, resulting in their progressive degradation. The result has been a suite of water risks and new cost-burdens. Current investment is exposed to these risks, is complicit in their genesis and is under-investing in the types of natural environments that could mitigate them.

The reasons for investment patterns failing to impute the full costs of the natural environment are well documented. Private finance is not easily drawn to public goods, with complex risk profiles, low yields and long-term paybacks. Public finance, in turn, typically feels there are more pressing priorities for which "deliverables" are more easily established and attained (Jacobs, 1991).

> Mark Carney, Governor of the Exchequer in the United Kingdom "*We don't need an army of actuaries to tell us that the catastrophic impacts [of environmental degradation and climate change] will be felt beyond the traditional horizons of … governments, businesses and most investors"* (2015).

As global finance begins to mobilise within the African continent, the $40 billion that is currently invested annually needs to find means of supporting public goods and systemic needs, not simply up-market real-estate and shopping malls, if urbanisation is to be accompanied by development (Cartwright, 2015).

Environmental costs are real costs and if ignored they inevitably impose themselves on households, businesses and government and undermine development. They do this via concatenated physical risks linked to droughts, floods and changing asset value, liabilities and claims, the concomitant need to change investments, technologies or location and damaging perceptions of reputations and brands (Orr et al., 2009). When these costs become acute they create the incentive to invest in the natural environment. This is particularly the case where conventional engineering solutions have been exhausted; that is, where the options for new dams, new treatment plants and new inter-basin transfers no longer exist or have become too expensive (Gillham and Haynes, 2000). Ecological infrastructure refers to natural ecosystems that deliver benefits to people including to municipal services. Once it is recognised that investment in ecological infrastructure represents a meaningful way of providing water services and reducing water risks, the challenge becomes how to enable and marshal this investment. This moment, and associated challenge, is currently being confronted in the uMngeni Catchment of South Africa.

Drawing on the example of the uMngeni Catchment, this study explores how barriers to investing in ecological infrastructure might be overcome so as to enhance water quality and quantity, and

reduce flood damage. The ultimate aim is to support South Africa's White Paper on in making sure that there will always be "Some water, for all who need it, contributing towards growing prosperity and equity in our land" (DWAF, 1997).

The study draws on international and national precedents and applies these to the specific uMngeni context of a catchment under multiple stresses (Figure 4.1).

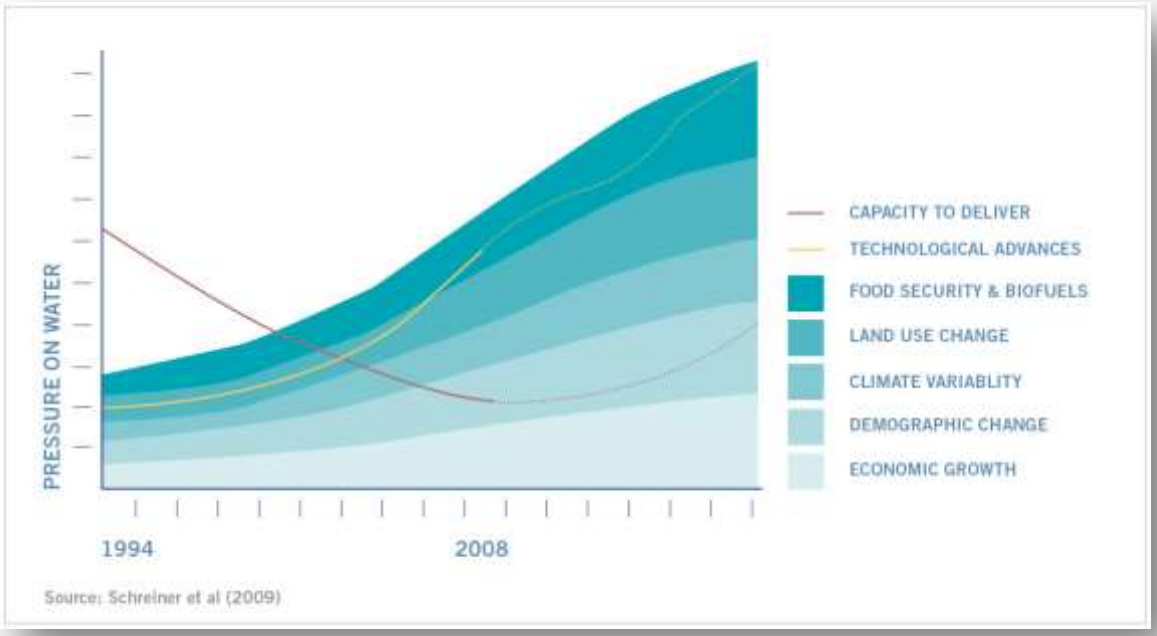


Figure 4.1: Cumulative pressures impacting on water resource management in the uMngeni Catchment

This focus of this study resonates closely with a global concern. In 1987 the Brundtland Commission famously claimed, "...The environment is where we live; and development is what we all do in attempting to improve our lot within that abode. The two are inseparable" (WCED, 1987). It was a deliberately bold statement aimed at recalibrating perceptions of the role of the environment in supporting human life and economic development. In the ensuing three decades the Brundtland perspective has convened a broad church (Davis 2010; Collier 2013; Nordhaus 2013; Max-Neef 2014), but has done little to alter flows of capital or the global economic growth model (Sagoff, 2012). Understanding this disconnect, and particularly the impediments to investing public and private funds in watershed management, is important to enable the type of financial flows that will support sustainable development.

- Section 4.2 of this report describes the socio-economic, institutional and hydrological characteristics of the catchment in more details and locates the need for ecological infrastructure finance within the catchment.
- Section 4.3 draws inference from international and local examples of successful investment ecological infrastructure investment.

- Section 4.4 adapts the available information to the specific uMngeni Catchment context to identify public, private and public-private options for accessing ecological infrastructure finance.
- Section 4.5 identifies the prerequisites that private and public funding, respectively, require for investing in ecological infrastructure.
- Section 4.6 provides hypothetical scenarios for raising public and private finance, respectively, for the creation and protection of ecological capital in the uMngeni Catchment.
- Section 4.7 concludes the report by identifying roles that World Wide Fund for Nature South Africa (WWF-SA) might play in enhancing the flows of finance for ecological infrastructure.

Investing in ecological infrastructure represents a critically missing component of South Africa's effort to provide services. This is particularly true for water services. Engineered infrastructure has been central to the water management in the uMngeni Catchment, but the existing infrastructure is functioning sub-optimally, in part due to neglect of the natural systems in which it operates. Planned engineered options are in danger of making water unaffordable.

Given that South Africa's National Water Act (1998) placed the country's water resources under the custodianship of the Minister of Water and Sanitation, public funding options represent the first recourse when seeking to invest in the types of natural environments that sustain water flows. South Africa's National Water Act (1998) and National Water Resource Strategy (2003, 2013) duly created policy and pricing mechanisms through which funds for ecological infrastructure can be raised. In addition there is also no legal impediment to allocating national and local infrastructure grants to the rehabilitation of ecological infrastructure, even if precedents for this are yet to emerge. There are a number of publicly funded programmes in South Africa that enhance ecological infrastructure through, for example, alien vegetation clearing and wetland rehabilitation, but to date these have rarely been directly integrated with built infrastructure and service delivery efforts.

Neither public nor private funds on their own are likely to be sufficient to address the extent of the degradation problem in the uMngeni Catchment – a problem that requires over R1 billion in estimated investment.[6] Much of the critical ecological infrastructure is on private land, rendering it a difficult target for public investment. Given the costs imposed by degradation, there is a case (and an incentive) for private finance to consider investments that complement public efforts to reduce water risk in the uMngeni Catchment. Options include the financing of a water bond, the provision of credit to private land owners seeking to alter land use patterns and adopt less water intensive technologies, and applying the price of insurance services to incentivise less risky behaviour.

In seeking to attract both public and private investment, proponents of ecological infrastructure have to understand the requirements of their financiers, and "package" their requests for funding appropriately. "Packaging" includes presenting a clear sense of the return realised by the investment, a plausible strategy for investing the money raised so as to generate that return and, in the case of private finance, the need for a balance sheet or revenue stream that can be used to secure the debt. Given the fundamental difficulties in allocating private finance to public goods, there is a critical role for intermediaries that can convene the required parties and create a shared sense of the problem and solution.

[6] This estimate is based on current rehabilitation costs and the need to restore 10 per cent of the catchment area in some way.

4.2 Evolving Institutional Context in Greater Umngeni

The focus of this study is on finance, and specifically how to align financial flows in the uMngeni Catchment to pressing social and biophysical needs. This alignment is only possible once the biophysical, social and institutional context of the catchment is understood (Cartwright et al., 2013). A hydrological context is introduced in section 1. The social and institutional contexts are discussed below.

South Africa took advantage of its transition to democracy in 1994 to rewrite its water legislation, drawing heavily on the normative "Dublin Principles" of Integrated Water Resource Management (IWRM).

The result was the National Water Act (36 of 1998), which declared all water a national resource, and emphasised demand-side interventions in reconciling supply and demand. The Act and subsequent National Water Resource Strategy (NWRS) (2004) prescribed a hierarchy of water use. At the top of the hierarchy is the basic right that each citizen has to 25 litres of free potable water per day (6 kilolitres per household per month) and the retention of a critical volume of water to preserve hydrological functions - the "ecological reserve". The balance of available water is allocated by a licensing system that, in its design, was intended to support economic growth and transformation.

4.2.1 Catchment Management Agency

The Act grants responsibility for local water governance to Catchment Management Agencies (CMAs) that are mandated to issue licenses in accordance with the strategic intent of the Act. Difficulties in constituting and resourcing CMAs across South Africa have seen an array of interim water governance arrangements in place and generally frustrated progress in terms of water allocation reform. In the uMngeni Catchment a "Proto CMA", staffed by the Department of Water and Sanitation (DWS) and spanning multiple catchments, was created on 1st April 2015. The Proto Pongola Umzimkulu CMA (PU-CMA) spans the uMvoti, uMzimkulu and the Greater uMngeni River basins and is in the process of establishing a representative Governing Board and becoming a formal CMA. CMAs are required to devise a Catchment Management Strategy that reflects the NWRS and local development priorities. While such a strategy does not yet exist in the uMngeni, an implementation of the Act would almost certainly involve reduced assurance of water supply to the agricultural and forestry sectors. It should also signal a greater focus on the role of ecological infrastructure in addressing prevailing quality and quantity problems.

Funding for CMAs is derived from the Water Resource Management (WRM) charge, levied on all abstractors of raw water. The WRM varies across catchments and sectors, but in 2013/14 in the uMngeni Catchment was set at 2.49 cents per kilolitre for domestic and industrial users, 2.34 cents per kilolitre for agricultural irrigation and 1.43 cents per kilolitre for forestry (DWS, 2015).

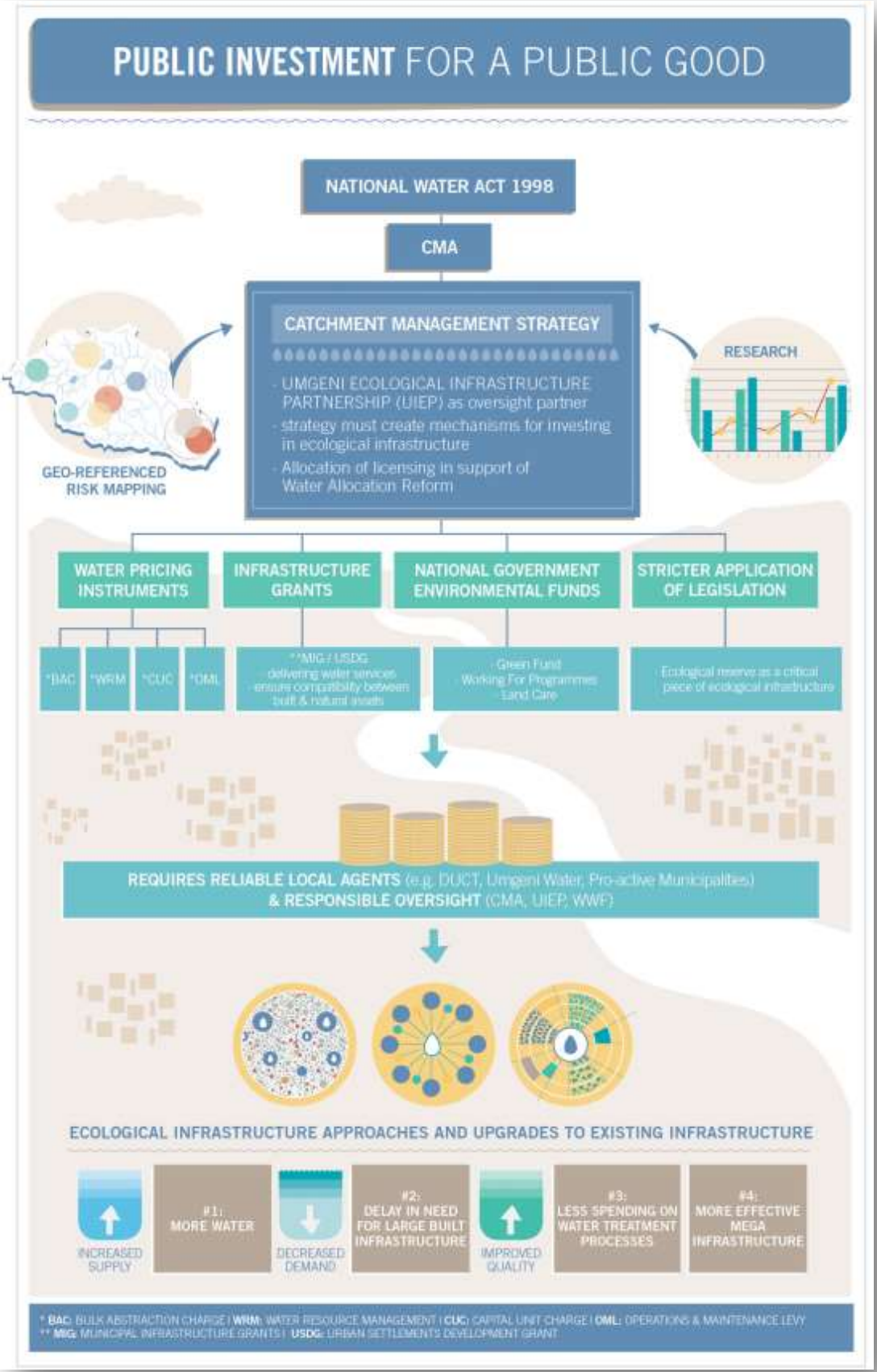


Figure 4.2: The role of ecological infrastructure in reducing water risks in the uMngeni Catchment

For the PU-CMA, the total WRM amounted to just over R41 million in 2013/14 (Reddy, 2013). Policy stipulates that the WRM should be spent within the catchment in which it is levied. The WRM allocated to the Proto PU-CMA is being used for:

- Planning and implementing catchment management strategies.
- Monitoring and assessing water resource availability and use.
- Water use allocations.
- Water quantity management, including flood and drought management, water distribution, control over abstraction, storage and stream flow reduction activities.
- Water resource protection, resource quality management and water pollution control.
- Water conservation and demand management.
- Institutional development and enabling the public to participate in water resources management decision-making (Review of Water Pricing Strategies, 2012).

The PU-CMA is supported by Catchment Management Forums (CMFs) that provide it with public input. The uMngeni Catchment has four functional CMFs, namely the Msunduzi, the Upper Umgeni, the Nagle-Inanda and the Lower Umgeni. In addition the PU-CMA may, in time, grant local responsibility for water management to Water User Associations (WUAs) (Department of Water Affairs and Forestry, 1998).

4.2.2 Umgeni Water Board

In the absence of a CMA, the Umgeni Water Board (Umgeni Water) has historically been the most influential water management institution in the region. Umgeni Water is a State Owned Enterprise that reports to the Minister of Water Affairs. The water board's mandate is set out in the Water Services Act (1997) under "primary activities" proclaimed in Section 29 of the Act, namely to provide water supply and sanitation services to other water services institutions in its service area. In the case of Umgeni water this involves supplying six municipalities (eThekwini Metropolitan Municipality, iLembe District Municipality, Ugu District Municipality, Harry Gwala District Municipality, uMgungundlovu District Municipality and Msunduzi Local Municipality) with enough water at a 98 per cent assurance of supply and in compliance with the national potable water quality standard (SANS 241 of March 2015).

Section 30 of the Act enables Umgeni Water to engage in "other activities", provided these do not impinge on its ability to undertake primary activities. Other activities include training, providing catchment management services, accepting industrial effluent for treatment and, critically for this study, performing water conservation functions. In 2013/2014 Umgeni Water handled 440 million m^3 of water from the catchment (Umgeni Water, 2014b).

Umgeni Water does not get involved in water reticulation within municipalities or in direct sales to end-users. To fulfil its mandate, Umgeni Water has assumed management of a network of dams, pumps stations and water treatment plants. The need to supply water with a 98 per cent assurance of supply, for example, saw the building of Spring Grove Dam by the Trans Caledon Tunnel Authority (TCTA).

Table 4.1 below outlines the Water Resource Management Charges relating to water that Umgeni Water abstracted from the Umgeni Catchment. It excludes water abstracted from beyond the catchment.

Table 4.1: Umgeni Water, Water Resource Management Charge Summary 2010-2014

PERFORMANCE CRITERIA/INDICATORS	UNIT	2013/14	2012/13	2011/12	2010/11
WRM	(Rc/kl)	0.0249	0.02315	0.0214	0.0194
ESTIMATED WATER EXTRACTED	(kl'000)	423,386	417,782	415,426	425,848
ESTIMATED TOTAL WRM PAID	(R'000)	R10,542	R9,672	R8,890	R8,261

Umgeni Water recoups its costs via a pre-agreed flat rate charged to the municipalities that receive its water. This flat rate is comprised of a collection of levies (see Table 4.4. for a detailed breakdown). Between 2009 to 2014 period, Umgeni Water sold between 415 and 440 million kilolitres of treated water a year, 76 per cent of which went to the eThekwini Municipality (Figure 4.6). In 2014, the water board generated revenue of almost R2.2 billion: R1.8 billion from the sale of in bulk water and the balance made up of revenue from sanitation and waste water treatment and cost recovery on Spring Grove Dam.

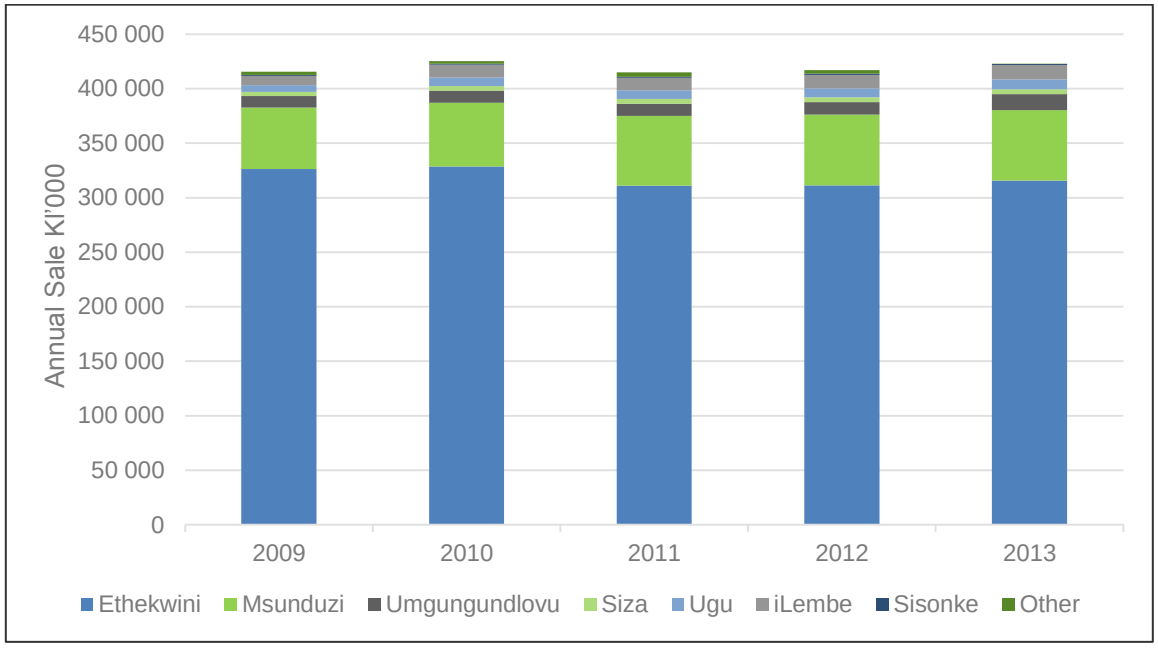


Figure 4.3: Umgeni Water Supply by Customer 2009-2013 (Data source: Umgeni Water, 2013)

What should be a simple business model for Umgeni Water has become increasingly complicated. Rising demand, illegal and informal abstraction, difficult-to-detect leakage from ageing water pipes, fiscally precarious municipalities and inadequate sanitation infrastructure combined with agricultural pollution, has made it difficult to supply enough water at affordable prices and the required confidence level. The same multiple stresses have increased the cost of water treatment. There are known point sources of pollution that are responsible for the rising nitrate and phosphate levels (DUCT, 2013). The dysfunctional sewerage systems in Mpophomeni Township, for example, contribute as much as 51 per cent of the E. coli and 15 per cent of the phosphorous load in Midmar Dam in spite of occupying a small portion of the dam's catchment area (South African Biodiversity Institute, 2015). Piggeries and dairy farms contribute to the nitrate load; timber and sugarcane

farming are both water intensive; and the erosion caused by new housing estates and informal and peri-urban settlements has accelerated sediment run-off. Treatment plants are active and the dams provide a useful sink for some of this pollution, however algal blooms and hyacinth contamination are now a periodic feature in the catchment.

Umgeni Water has no official mandate for the environmental condition of the water catchment, but under Section 30 of the Water Services Act may engage in "water conservation".

Table 4.2: Umgeni Water Group Statements of Profit and Loss (year ended 30 June 2014) (Umgeni Water, 2014)

Item	R'000
Revenue	**2 204 140**
Cost of sales	**(1 034 890)**
Changes in water inventory	*(246)*
Chemicals	*(47 181)*
Depreciation	*(92 897)*
Energy	*(136 074)*
Maintenance	*(143 313)*
Raw water	*(190 540)*
Section 30 activities	*(271 560)*
Staff costs	*(130 305)*
Other direct operating expenses	*(22 774)*
Gross Profit	**1 169 250**
Other income	28 778
Other operating and administration expenses	(596 217)
Profit from operations	**601 811**
Net finance income	**76 991**
Interest income	*122 546*
Finance costs	*(45 555)*
Share of profit from associate	3 627
Profit for the year	**682 429**

If Umgeni Water wishes to maintain its AA+ credit rating (from Fitch) it can certainly ill afford to ignore the catchment as its costs increase and the ability to charge municipalities higher water levies becomes restricted. The bulk water tariff charged by Umgeni Water has increased above inflation, a trend compounded by electricity price increases (Figure 4.7). The 16.6 per cent tariff increase in 2013 was necessitated by cost recovery for Spring Grove Dam and an 18 per cent increase in raw water costs. Both of these increases were a function of water scarcity and deteriorating water quality. While Umgeni Water is able to pass this cost on to its municipal clients, this imposes a burden on the local economy and risks users finding "off-grid" sources of water, including from boreholes and illegal abstraction.

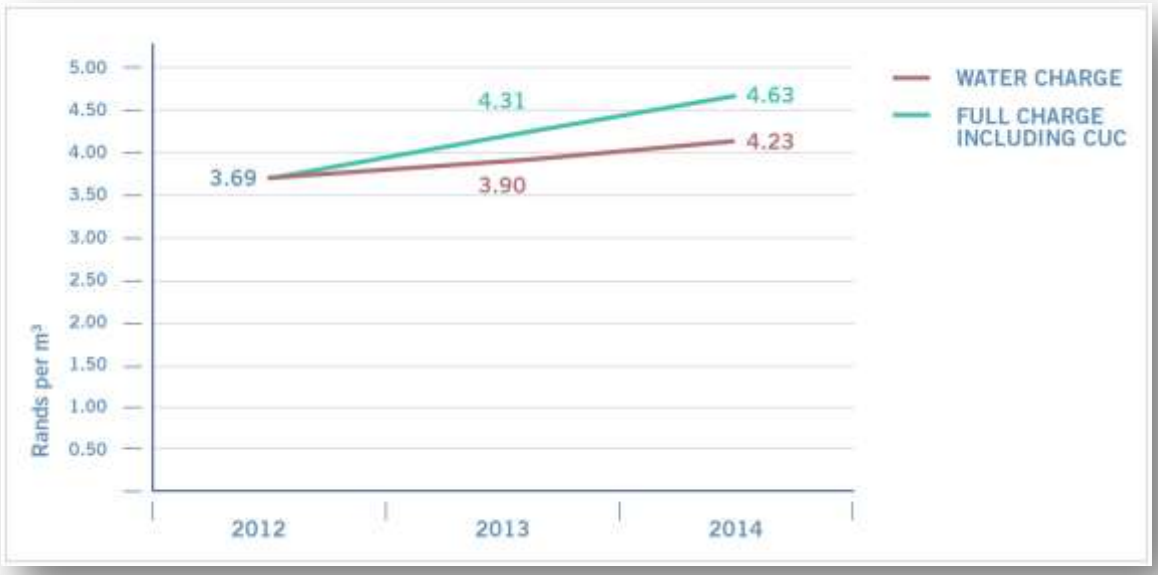


Figure 4.4: Umgeni Water Bulk Water Tariff in Rands per m^3 (2012-2014)

4.2.3 Demographic and Local Government Context

The total population for the municipalities that partially overlap the Greater uMngeni Catchment is over 4.7 million according to the 2011 Census (Statistics South Africa, 2012). Urbanisation into the city of Durban has been a feature and contributed to an 11.5 per cent population increase over the past decade. Population growth in the adjacent municipalities has been slightly lower at 10 per cent between 2001 and 2011.

A feature of catchment is the combination of urban, agricultural and "traditional land", and the marked difference in tenure and governance between privately owned and "communal" land under tribal authorities. The majority of households situated in the urbanised municipalities of Msunduzi, uMngeni and eThekwini access water via regional or local water schemes. A significant percentage of households in the remaining rural municipalities rely on direct abstraction and are highly exposed to the water quality. For example, 29.2 per cent of households in Ingwe collect water from a spring and 27.8 per cent of Ndwedwe households collect water from a stream or a river (Statistics South Africa, 2012).

The majority of households in Impendle, uMshwathi, Ingwe, Mkhambathini, Richmond and Ndwedwe make use of pit toilets, either with or without ventilation. In the more urbanised municipalities of Msunduzi, uMngeni, eThekwini and Mpofana, the majority of households have access to flush toilets connected to a sewerage system, although some of these systems are inundated (Statistics South Africa, 2012). Appendix A provides a detailed breakdown of sanitation and water services in the uMngeni Catchment.

Table 4.3: Population numbers per municipality overlapping the uMngeni Catchment (Statistics South Africa, 2012)

MUNICIPALITY	POPULATION NUMBERS 2001	POPULATION NUMBERS 2011
MSUNDUZI	552,837	618,536
IMPENDLE	37,844	33,105
UMNGENI	73,896	92,710
UMSHWATHI	108,422	106,374
INGWE	107,558	100,548
ETHEKWINI	3,090,122	3,442,361
MKHAMBATHINI	59,067	63,142
MPOFANA	36,832	38,103
KWASANI	11,848	12,898
RICHMOND	59,067	65,793
NDWEDWE	144,615	140,820
TOTAL	**4,282,108**	**4,714,390**

4.2.3.1 EThekwini Metropolitan Municipality

The City of Durban, located at the catchment's estuary, in the eThekwini Metropolitan Municipality is the beneficiary of water and land-use decisions throughout the region, and an important feature of the uMngeni Catchment. With a population of over 3.5 million[7], the municipality relies exclusively on Umgeni Water for its potable water.

EThekwini Municipality's Environmental Planning and Climate Protection Department has long recognised the importance of its ecological infrastructure for its water provision and for its urban economy. In 2003 (a year in which the municipality's total operating budget was R6.5 billion and total capital budget was R2.78 billion) the municipality estimated the value of goods and services that it received from the natural environment to be worth R3.1 billion (ETK BEPP, 2014).

The eThekwini Municipality generates a margin on the water that it purchases from Umgeni Water and sells to households and businesses. In 2012/2013, eThekwini Municipality's revenue from water sales amounted to R2.6 billion. With this revenue the municipality maintains and extends the local reticulation network. Together with additional income derived from the sanitation services and penalties, eThekwini Municipality's water and sanitation department made an overall profit of R164 million in 2012/2013, making it one of the few municipalities in South Africa that recovers all costs on water services.

Table 4.4: EThekwini Municipality Water Revenue 2012/2013 (eThekwini Municipality, 2013)

ITEM	NOTES	(R'000)
EXPENDITURE		
Bulk Water Purchase	From Umgeni Water	1,337,959
eThekwini Water Management Expenditure	Total Department Cost	3,171,412
REVENUE		
Service Charges Water	From Sale of Water	2,622,062
eThekwini Water Revenue	All Revenue	3,335,940

[7] 3.44 million in 2011 (Statistics South Africa, 2012)

eThekwini Municipality's Built Environment Performance Plan (BEPP)[8] is clear on the precarious state of water supply: "The situation is sufficiently severe that water restrictions are inevitable once rainfall returns to normal[9]… even with [Springrove Dam's] additional capacity eThekwini will still suffer from a water supply shortage…. From the point of view of current water supply, there is insufficient supply to deal with any further development as envisaged in the Spatial Development Framework and Spatial Development Plans."

The BEPP also highlights the sewerage problem. The backlog for basic sanitation in eThekwini Municipality, as of June 2013, was 21,750 houses – a backlog that the Municipality's BEPP estimates will take 23 to 28 years to redress. Linked to this, the backlog for low-income housing in eThekwini alone is estimated to be 317 - 421 thousand units (1.7 million people). Meeting the sewerage backlog necessitates new sewerage treatment capacity. Problematically, the license for this additional capacity cannot be issued by DWS until the "Ecological Reserve" has been established. Given water scarcity, it seems inevitable that effective treatment would have to incorporate, "A combination of direct re-use of treated sewage effluent for potable water supply and some quite extensive cross-catchment pumping" (ETK BEPP, 2014). These options significantly increase the cost of sanitation under conventional water treatment models.

Neil Macleod, former head of eThekwini Water, concurs with the general problem but highlights the often-neglected role of the natural environment in addressing the problem, when he says, "Durban's defence against poor water quality is rapidly being eroded by the state of the uMngeni Catchment. Our current strategies aimed at securing water of sufficient quality and quantity to address the vulnerability of our people and the economy need to be reviewed" (Macleod, 2012).

Given the hierarchy of water use imagined under the National Water Act, any attempt to address water risks in the uMngeni Catchment will necessarily involve the specific needs of the city of Durban. In terms of financing ecological infrastructure this may be an advantage as eThekwini Municipality already marshals a significant infrastructure budget, is creditworthy with a credit rating of A1+ (AA- over the long term) and has an existing ecological infrastructure programme.

4.2.4 Conservation Organisations within the Catchment

There are a number of conservation related parastatal and NGO organisations working on ecological infrastructure projects within the Greater uMngeni Catchment.

Ezemvelo KwaZulu-Natal Wildlife is a parastatal responsible for the conservation and management of protected areas in KwaZulu-Natal. One of these areas, the uMngeni Vlei Nature Reserve, is a Ramsar protected wetland and the source of the uMngeni River (Ezemvelo KZN Wildlife, 2008).

The Dusi-Umgeni Conservation Trust (DUCT) was established in 2005 in response to the water quality crisis in the Msunduzi and uMngeni Rivers. DUCT employs over 200 people in "River Care Teams". Each team takes responsibility for a section of the river and provides an integrated monitoring, reporting and rehabilitation service. The approach costs roughly R40,000 per kilometre of river per month (Still, 2015).

[8] Built Environment Performance Plans (BEPP) are a National Treasury requirement intended to ensure spatial and fiscal coherence of the local infrastructure spend in Metropolitan Municipalities
[9] Rainfall "normalized" in 2015.

DUCT's activities have reduced the extent of phosphate and nitrate contamination (estimated by the CSIR to impose a costs of R400 million a year in this catchment), and reduced siltation rates that affect the functioning of dams and bulk infrastructure (CSIR, 2010). The NGO has the advantage of being able to work across government departments and spheres of government, and conduct independent monitoring while experimenting with different catchment management techniques.

DUCT is widely acclaimed for championing the importance of local action and saving municipalities and water users considerable money. The alien vegetation clearing conducted by DUCT is thought to have increased in-stream flows by 6 per cent in KZN (CSIR, 2010). In spite of this, the NGO operates on a modest budget that constrains its reach. The total income received by DUCT in the 2015 financial year was marginally over R17 million (Duzi-Umgeni Conservation Trust, 2015). Nearly two thirds of this income was received from the Durban Green Corridor programme which is funded by the National Lottery and KwaZulu-Natal Department of Economic Development, Tourism and Environmental Affairs. Relatively small contributions were received from private donors and from the Dusi Canoe Marathon. The remaining revenue (R5,827,907) was derived from various non-profit and government sources including projects such as the Richmond Project, WWF-Nedbank Green Trust and the Global Green grant (Duzi-Umgeni Conservation Trust, 2015).

The Wildlands Conservation Trust operates similar ecological infrastructure projects in the region. For example, Wildlands has adopted a Community Ecosystems Based Adaptation (CEBA) approach to its work, highlighting the connections between local communities and healthy ecosystems. Projects include the restoration of ecosystems through afforestation, recycling activities and alien clearing, community stewardship of priority conservation areas and "greenpreneurship" projects that provide cash and food vouchers to community members that grow trees and collect recyclable material (Wildlands Conservation Trust, 2015). Wildlands has been successful in partnering with private sector companies and securing their financial support. In 2013, Wildlands reported total revenue of over R90 million (Wildlands Conservation Trust, 2013).

The Umgeni Ecological Infrastructure Partnership (UIEP) was established to coordinate ecological infrastructure investments in the catchment, with the ultimate aim of improving water security and natural resource management. The UEIP was established by the following stakeholders: the South African National Biodiversity Institute (SANBI), the eThekwini Municipality's Water and Sanitation Department together with the KwaZulu-Natal (KZN) Regional Office of the DWS, Umgeni Water and the Water Service Authorities of the uMgungundlovu District and Msunduzi Local Municipalities. The public-private partnership is currently made up of 36 government and civil society organisations including WWF-SA. To date the UEIP has focussed on research and mobilising of stakeholders in the catchment (eThekwini Municipality, 2015; Kasavel, 2013). It remains to be seen how the partnership will interact with the Proto-CMA as this institution begins to fulfil its mandate.

4.2.5 Water Pricing

The manner in which water is priced and paid for represents an important component of the catchment's institutional landscape. Once the water pricing structure is understood, it can be applied to raise money for ecological infrastructure.

The table below shows the range of prices paid for raw bulk water by different sectors in the different catchment areas in South Africa in 2012 (DWS, NIWIS on line). Currently different sectors pay vastly different prices for raw water and there is significant variation around the country. Some of the more arid areas (Limpopo, Lower Orange) have some of the lowest prices. Raw water charges in the Mvoti to Mzimkulu (which overlaps with the greater uMngeni) were relatively low in 2012 as shown in the table below. The policy framework and norms and standards for bulk water pricing are currently under review by DWS (November, 2015).

Table 4.5: Raw bulk water charges to different sectors in catchment areas in South Africa, 2012. Note the Mvoti to Mzimkulu area overlaps with the Greater uMngeni Catchment. (Source: DWS National Integrated Water Information System)

CATCHMENT AREA	COST c/m3 DOMESTIC & INDUSTRY	AGRICULTURE	FORESTRY
BERG	10.35	2.17	1.03
BREEDE	4.88	1.39	0.48
CROCODILE WEST & MARICO	13.75	2.33	0.81
FISH TO TSKISI	21.45	1.9	0.7
GOURITZ	22.23	1.48	0.79
INKOMATI	24.51	1.13	0.87
LIMPOPO	4.89	3.08	0.98
LOWER ORANGE	3.79	0.73	ND
LOWER VAAL	39.6	0.56	ND
LUVUVUHU & LETABA	7.97	0.01	1.09
MIDDLE VAAL	44.25	1.89	ND
MVOTI TO MZIMKULU	7.86	2.23	1.3
UMZIMVUBU TO KEISKAMMA	21.37	3.27	1.25
OLIFANTS	4.93	1.62	0.91
OLIFANTS DOORN	8.47	1.01	0.79
THUKELA	6.72	2.11	0.51
UPPER ORANGE	5.48	0.65	ND
UPPER VAAL	48.03	2.68	1.06
USUTU TO MHLATUZE	22.12	2.77	0.49
MEAN AVERAGE	**16.98**	**1.74**	**0.69**

http://niwis.dwa.gov.za/DashboardEngine.aspx?DashboardID=niwis%5CWaterTariffs%5CRawWater%5CRawWater&breadcrumbs=menu_watertariffs_rawwater_str

Roughly half of the catchment's water is used by Umgeni Water and subject to regulated prices.
The regulated prices between Umgeni Water and municipalities and between municipalities and end-users, offer important opportunities for raising money and changing behaviour and land use. The various levies paid by Umgeni Water appear in Table 4.6. below.

Umgeni Water is required to pay for its water abstraction. It passes this cost, with an increment for the DWS, on to municipalities in the flat rate that it charges them. The flat rate also includes:

- A capital unit charge (CUC) that forms part of the flat-rate water levy paid by municipalities for their water. In 2013/14 the CUC levied by Umgeni Water amounted to R170 million, which was paid over to DWS.
- A Water Resource Management Levy (WRM) paid to DWS for the functioning of the CMA and protection of the catchment. Umgeni Water has been paying this levy since 2003. In the absence of a CMA the money has accrued to the national DWS.
- The Water Research Commission (WRC) levy required under the Water Research Act (Act No. 34 of 1971) that funds the work of the WRC. The WRC has a long and credible history in South Africa of promoting co-ordination, co-operation and communication in the area of water research and development; establishing water research needs and priorities, stimulating and funding water research according to priority; promoting effective transfer of information and technology; enhancing knowledge and capacity-building within the water sector. The WRC money is paid annually to the DWS (4.6).

Table 4.6: Umgeni Water WRC Levy Payments 2009-2014

Item	Unit	2014	2013	2012	2011	2010	2009
Total water sold	(Kl'000)	440116	423386	417782	415426	425848	415956
WRC levy	(Rc/kl)	0.049	0.046	0.041	0.041	0.039	0.035
Total amount generated for WRC Levy	(R'000)	R21,566	R19,476	R17,129	R17,032	R16,608	R14,558

Table 4.7: Umgeni Water Levy Summary 2013/ 2014

Item	Levy (R/kl)	Total cost to Umgeni Water (R'000)
Abstraction charge (from the uMngeni Catchment)	0.2609	108,982
Operations and maintenance cost of dams (in the uMngeni Catchment)	0.1045	43,644
Charges in other catchments		27,747
Water Resource Management Levy	0.023	10,167
Total Raw Water Costs for Umgeni Water		**190,540**
Water Research Commission Levy	0.049	20,468
Capital Unit Charge (Spring Grove Dam)	0.408	170,400

The balance of water not used by Umgeni Water is taken for agriculture (8 per cent) or forestry (11 per cent) or is required for the ecological reserve (22 per cent) or lost to leakages, evaporation and theft (9 per cent). Forestry activities pay a Stream Flow Reduction levy[10]. Agricultural users access water through a licencing system and pay a raw water abstraction levy, the WRM and the WRC levies.

[10] Schreiner and Hassan (2011) estimate that South Africa's 1.4 million hectares of plantation forests used R1.4 billion cubic meters of water per annum.

4.3 Learning From Precedents of Ecological Infrastructure Finance

The hydrological benefits of ecological infrastructure include flood buffering, sediment capture and a groundwater reserve, while providing unpolluted water in reliable flows. Global recognition for the value of ecological infrastructure in managing water risks has grown, but this has not been matched by clarity as to how this perspective might be harnessed and translate into investment. More specifically, using ecological infrastructure to reduce water risks is likely to require both public and private investment (given that both are complicit in existing practices of degradation) but the question of how to raise this finance, and how to invest it sensibly, requires further attention. As Deutz (2015) notes, "The ecology is simple – we know how to map and model the impacts of conservation and agricultural investments on freshwater flows and nutrient loads in rivers. The tricky part is actually sorting out the financing."

Water catchments have conventionally been considered public goods. The inability of any single investor to extract exclusive benefit from an investment is a classic "commons" problem. South Africa's water legislation recognises this, and proposes the types of common resource management arrangements required to avert a "tragedy of the commons" (Hardin, 1968; Ostrom, 1998). In creating public finance mechanisms that enable robust common property resource management, the National Water Act is intended to overcome the collective action dilemma and ensure the catchment integrity required to provide water.

As is the case elsewhere in the world, however, public sector investment in catchment management in the uMngeni is inadequate. The DWS has struggled to raise the required funding, the funding that has been raised has not always been well spent and government's own infrastructure budget has at times contributed to degradation. Some farmers are adopting stewardship programmes, but in the absence of a guiding framework these efforts remain piecemeal. Private sector investment in property development and industrial agriculture has, at times, contributed to erosion, nitrate run-off, sedimentation and loss of riparian zones and wetlands.

These problems are by no means unique to the uMngeni Catchment. International and local precedents have begun to address the challenges and enhance public and private sector investment in water catchments. The emerging precedents form part of an ongoing effort to reposition the role of the economy and the finance sector in relation to the natural environment, in a manner that was imagined by the Brundtland Commission three decades ago (Figure 4.5). Where they are adapted to the uMngeni context, they provide useful guidelines.

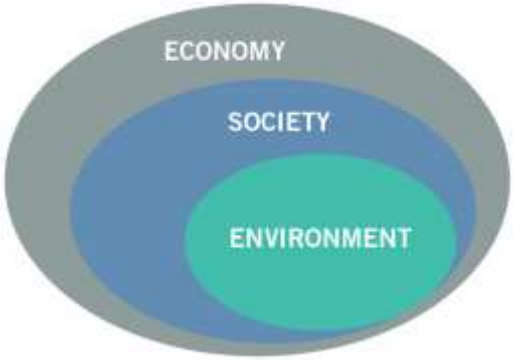
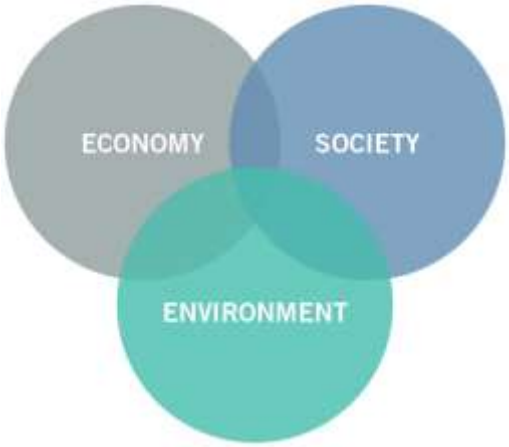
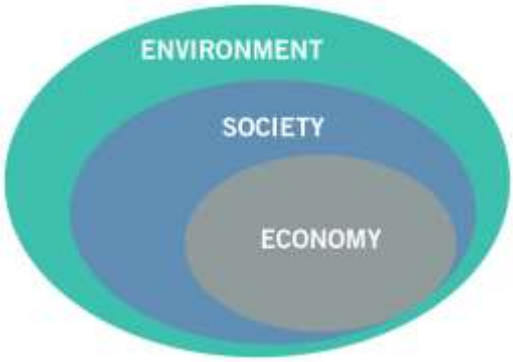
	The conventional (historical) view of the relationship between the environment and the economy depicts the environment as a subsidiary of the economy, and something that needs to be managed by the economy and society, so as to avoid disasters and extract maximum benefit. This perspective assumes that the rising price of environmental goods and services, as they become scarce, will act as an adequate deterrent to their destruction.
	The sustainability, or "triple bottom line" approach to the environment seeks a balance between economic, social and environmental needs – a balance that has proven mostly elusive – so as to extract maximum benefit over the long term.
	The ecological perspective emphasises society's and the economy's fundamental dependence on the environment and environmental stability. This perspective looks to address societal needs within environmental limits and fashion economic activity around environmental conditions. In practise this often requires "right sizing" the economy to reflect its status as a subsidiary of the environment.

Figure 4.5: Shifting perspectives of the relationship between the economy, society and the natural environment.

A 2013 survey maps the trends in public, private or public-private catchment investment, respectively (Bennett and Carroll, 2014).[11] $12.3bn of public and private finance was channelled towards ecological infrastructure solutions to the global water crisis in 2013. The money was used to rehabilitate or protect more than 365 million hectares of "water-critical ecosystems" worldwide (Bennett and Carroll, 2014).

[11] The survey relies on voluntary responses to an emailed request and almost certainly misses the investments made by individual farmers and smaller corporate entities. As such, it under-reports total investment, but as a measure of year-on-year trends the Bennett and Carroll survey for Forest Trends is useful.

The number of surveyed programmes that benefit from this investment has increased exponentially since 1990, and totalled 330 in 2013.

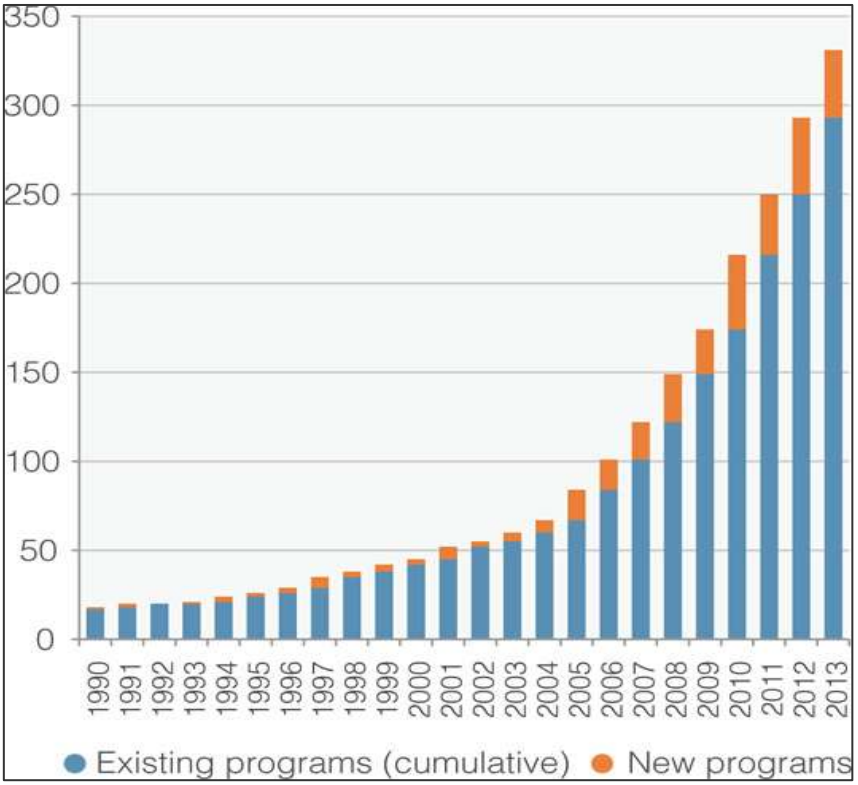


Figure 4.6: Increasing investment in watershed services, globally (1990-2013) (Source: Bennett and Carroll, 2014)

African countries have struggled to attract investment in catchment-specific ecological infrastructure. This can be attributed more generally to the inability of African countries to attract investment due to low per capita incomes, the governance deficit required to marshal this type of investment in complex public goods, the perception that water is not yet a critical constraint and that there are more worthy investments than watershed management.

Figure 4.7: Value of Global Investment for Watershed Services by region, 2009-2013 (Source: Bennett and Carroll, 2014)

A review of the manner in which international experiences of companies such as Vittel and cities such as Munich and New York have overcome catchment-wide water risks provides some inference that is useful for the uMngeni Catchment. A full description of these examples is contained in Appendix B, but the following inferences from Bennett and Carroll's Forest Trends' survey (2014) is possible:

- Much of the investment accrued to water governance institutions and programmes. The availability of a supportive socio-institutional environment is considered important to the efficacy of both ecological and built infrastructure.
- Investment is most likely when one or two influential water users confront critical water risks. The example of Vittel, whose brand was dependent on pristine water and who could not easily relocate, is illustrative. Similarly, the city of Munich had few options but to oversee catchment restoration. In the uMngeni Catchment large agri-industries, Umgeni Water and the City of Durban find themselves in a similar position of dependence on the catchment health.
- Public subsidies represent the vast majority of investment and global projects and this investment is dominated by China. Much of the Chinese investment has been as a complement to mega water infrastructure projects, and is aimed at increasing the functionality of these projects. Ecological infrastructure as a complement to built infrastructure is critical to prevent sedimentation of dams, to enhance the efficacy of treatment plants and to mediate stream flows. Given the state of catchment perturbation around large cities and intensive farming regions, it is seldom the case that ecological infrastructure can address all water risks, making a combination of interventions necessary.
- Collective action funds were the fastest growing sub-component to investments in ecological infrastructure in 2012-2013. The trend is testimony to the increasing incentive that private sector companies confront to invest in the reduction of their own water risks. This investment is contingent upon water legislation that enables private sector companies to secure water rights (or reduce their risk) and is more difficult where water is considered a national resource. The literature on these collective action examples highlights the importance of intermediaries that are capable of creating a shared sense of the problem and joint commitment to the solution. Intermediaries are also important for ensuring that funds spent appropriately and for monitoring of impacts.
- Water quality trading markets grew in 2013. This market includes offsets in which polluters were allowed to invest in catchment rehabilitation (Bennett and Carroll, 2014). The ability to engage in water quality trading is subject to the policy environment, and only successful where monitoring and enforcement capacity is stringent.
- Ecological infrastructure solutions to water risk, where effectively managed, were cheaper than many conventional engineered solutions. They also generated co-benefits including local work opportunities, biodiversity and bio-diverse habitats, tourism opportunities and carbon sequestration.

4.4 Options for Investing in Ecological Infrastructure in the Umngeni

Any attempt to restore ecological infrastructure in the uMngeni Catchment will require the reallocation of resources from activities that destroy ecological capital to those that protect and create ecological capital. Exactly what constitutes this capital in the uMngeni Catchment is the focus of the parallel SANBI study.

South African projects that remove alien vegetation and re-establish riparian buffers deploy a variety of modalities, but cost between R4,000 and R25,000 per hectare over the duration of the project.[12] A project aimed at enhancing flows in the Kouga River (Eastern Cape) through the removal of alien vegetation cost R5,200 per hectare in the first year and R351 in subsequent years (Hoskings and Du Preez, 2006 in Vawda et al 2011, p.199). Adopting the lower-end of this estimate and assuming that 10 per cent of the uMngeni Catchment requires some degree of investment to enhance the value of ecological infrastructure, an investment of roughly R1 billion in ecological infrastructure could be easily absorbed in the uMngeni Catchment. This estimate ignores the cost of fixing damaged water and sanitation infrastructure that is critical to the viability of ecological infrastructure investments. While estimates vary, it is immediately clear that the scale of investment is likely to require both public and private contributions.

In the Kouga example, the cost of water from alien clearing (R0.56/ m^3) was a quarter of the price of untreated bulk water (R2.60/ m^3) (Hoskings and Du Preez, 2006). The question remains, however, as to how to source the required investment.

4.4.1 Public Funds

Given the nature of South Africa's water legislation, public entities and particularly the National Treasury and the Department of Water and Sanitation represent the most obvious sources of finance for water catchment stewardship. A number of public sector instruments are available for raising ecological infrastructure funds.

4.4.1.1 Policy enforcement:

The National Water Act, if fully implemented, would obviate the need for many of the celebrated private sector solutions from outside of South Africa. The legal requirement for an "ecological reserve", for example, imposes a short-term opportunity cost on companies and individuals that currently use this water, but is predicated on the understanding that sustained hydrological flows are economically essential. Simply calculating and enforcing the ecological reserve would require some existing users to forego some of their water, but would constitute a powerful investment in ecological infrastructure in the uMngeni Catchment.

[12] Adjusted from estimates by Myles Mander and from the Working for Water Programme. The upper end of this range includes three phases of follow up, the use of herbicides, biomass removal and, on occasion, afforestation.

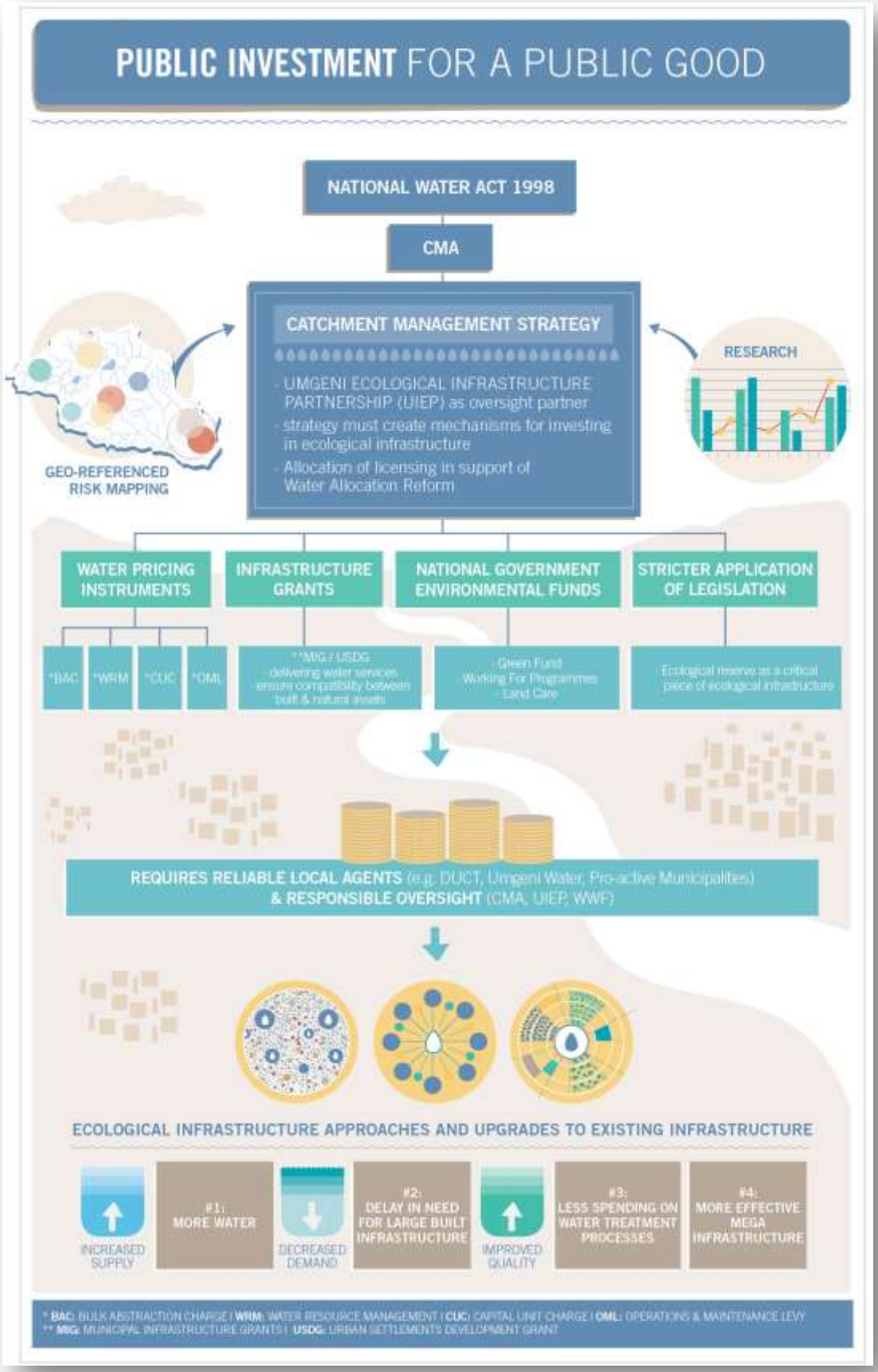


Figure 4.8: Public investment options for ecological infrastructure in the uMngeni Catchment

4.4.1.2 Pricing instruments:

South Africa's water policy goes beyond simply recognising the need for an ecological reserve and includes powerful pricing instruments. In terms of the Section 56(1 and 2) of the National Water Act, the pricing strategy may set water use charges so as to pay for required infrastructure. This idea was entrenched in South Africa's Water Amendment Act (2014) and the 2015 releases of the "Water Pricing Strategy" and the "Norms and Standards for Tariffs" (charged by municipalities) by DWS. Collectively these policy documents seek to standardise bulk and municipal water pricing in South Africa, and ensure that water prices reflect the country's scarce water resources and the full cost of water services.

The advantage of a regulated water price is that it enables pricing to be used as an instrument to change behaviour and raise capital. The 2015 National Pricing Strategy for Water use Charges, released by DWS makes provision for four components of infrastructure costs to be included in the water price: operations and maintenance, depreciation and refurbishment, Future Infrastructure Build Charge (FIBC) to be charged to all users in South Africa, and the Capital Unit Charge.

The levying of a WRM charge to finance CMAs was designed to overcome collective action problems and to recognise that systemic, catchment-wide stewardship is necessary for the sustainable provision of water. The critical short-term need in the uMngeni Catchment is to ensure that the proto PU-CMA matures and fulfils the role envisaged for it in the National Water Act. A legitimate and functional PU-CMA could use the regulated water price to raise capital for ecological infrastructure and influence land use decisions that in turn will influence demand for water. The notion of recovering an ecological infrastructure cost from the user is specifically mentioned in the 2012 Water Pricing Strategy Review process, which states: "An appropriate component of the costs of rehabilitating and maintaining relevant natural infrastructure, with the aim of securing and enhancing the water-related ecosystem services provided by this infrastructure, may be charged to water users in the catchment" (Department of Water Affairs, 2012).

The existing water price charged in the uMngeni Catchment can be disaggregated into "on budget charges" and "off budget charges", both of which could be applied in raising ecological infrastructure capital:

- "On budget charges" are, in theory, required to provide a Return on Assets (ROA) for the direct fiscal allocations granted to water services. The ROA principle is intended "to cover the social opportunity cost of capital (partially covering the financial cost) to government for publicly funded infrastructure, to be used for funding augmentation planning studies, new schemes or betterment of existing schemes for social purposes or dam safety betterment" (Department of Water Affairs, 2012). This charge, levied via the abstraction charge, could be increased to generate money for ecological infrastructure.

- "Off budget charges" usually refer to the cost of raising capital in the market. They include interest paid on loans and levies that do not accrue back to the central fiscus. Unlike "on budget charges" these cost increments can be ring-fenced for use in the catchment in which they are raised. The Capital Unit Charge (CUC) levied by Umgeni Water, which contributed R170 million towards recovering the finance costs of the Spring Grove Dam in 2013/14, is the most obvious example. The idea that a new CUC levy could be raised to enable the

financing of ecological infrastructure has been raised by TCTA under the "Strategic Infrastructure Project (SIP) 18" discussions and under SIP 19.[13]

Similarly, the Water Resource Levy is paid by all abstractors of raw water and amounted to R41 million in 2013/14. This money will accrue to the Proto CMA and will be used in water governance and catchment stewardship. If the CMA is to assume responsibility for catchment-wide water governance, it is rational and imperative that stewardship money be marshalled to support the public good of ecological infrastructure.

Any increase in water levies would, of course, impose an unwelcome cost on water users and the economy. The case has to be made and demonstrated that ecological infrastructure projects provide water, reduce water risks and secure existing investments more cheaply than conventional capital projects, in order to justify such cost increments.

The human right to water is protected in the 'basic human needs' provision of the National Water Act and this regulated allowance per person per day (25 litres) would not be included in price increases. The status quo of failing engineered and ecological infrastructure combined with drought in KZN and other provinces, means that the poorest water users are often officially and unofficially paying the most for water.

4.4.1.3 Infrastructure grants:

Similar to the idea of the water price being used to finance ecological infrastructure, is the notion that spending water and sanitation infrastructure grants on the natural environment as a cost-effective means of delivering water services – an idea successfully applied by the cities of Munich and New York (see Appendix B). The City of New York invests $100 million a year in protecting "upstate watersheds" to secure enough water for its citizens and to avoid much more expensive water treatment plants (Sustainable Cities, 2015).

Proponents of ecological infrastructure argue that functional ecosystems often provide the same level of service (water purification, flow mediation, storage) as engineered infrastructure, at a lower cost and with the opportunity to create more local labour for unemployed people. In this sense ecological infrastructure needs to be considered as a central part of South Africa's efforts to redress the infrastructure backlog (Cook et al., 2010; SANBI, 2014). Given the critical fiscal constraints on DWS, the department would do well to experiment with innovative cost-saving measures of delivering water services, including restoring ecological infrastructure.

Fourteen per cent of South Africa's total infrastructure budget goes on water and sanitation – R37.3 billion in 2014/15 (McPhain, 2015), but currently this investment is not aligned to, or complemented by, efforts to manage natural resources. The DWS has bespoke grants for Regional Bulk Infrastructure (RBIG), Regional Water Infrastructure (RWIG) and Accelerated Community Infrastructure Programmes (ACIP), but the implementation of these have so far only used traditional

[13] Strategic Ingfrastructure Projects (SIPs) were proposed as are priority programmes of action run out of the Presidency. SIP 18 was to be a 10-year plan to address the estimated backlog of adequate water to supply 1.4 million households and 2.1 million households to basic sanitation. The project was intended to the involve provision of sustainable supply of water to meet social needs and support economic growth. Projects will provide for new infrastructure, rehabilitation and upgrading of existing infrastructure, as well as improve management of water infrastructure. SIP 19 was proposed as an ecological infrastructure programme but never formalised. All SIPs have suffered from the fiscal crisis and a lack of implementation.

engineered water solutions that are unwieldy to manage, expensive, require scarce skills to operate successfully, are labour un-intensive over their full lifetime and subject to declining efficiency as the natural environment in which they operate degrades. Perhaps most critically, the relative lack of labour intensity associated with engineered water infrastructure, results in South Africa's infrastructure spend generating low economic multipliers, something that has not received enough attention in South Africa's scramble for services but which accounts for the poor economic returns on the country's infrastructure spend. The same is true for local government infrastructure grants. In South Africa, MIGs are the central "conditional grant" paid from National Treasury to Local Governments to address the service delivery backlog. This source of grant could (accepting that ecological infrastructure is a valid type of infrastructure) be partly directed to catchment restoration.

MIG guidelines stipulate that these grants can be spent on, *"Capital Investment – including project management costs, basic infrastructure that is used by the poor, building new infrastructure and rehabilitating existing infrastructure, upgrading existing infrastructure to basic levels, project feasibility and business plans and ensuring sound operational arrangements for infrastructure"* (DPLG, 2004).

In 2010, the Urban Settlement Development Grant (USDG) replaced the MIG in Metropolitan Municipalities such as eThekwini Municipality. The USDG goals include, "Household access to basic and reticulation services for poor communities; improved rates of household employment through skills development in the delivery of infrastructure; improving the sustainable livelihoods of poor households within the municipal jurisdiction."[14] It is possible and necessary to motivate for ecological as a complement to engineered infrastructure under these guidelines.

National Treasury does not dictate to municipalities how MIGs or USDGs should be spent, as long as that expenditure is within the conditions of the grant, allocated to items that fall within local government mandate and (because it is a grant) contribute to poverty alleviation or social redress. The Department of Cooperative Governance and Traditional Affairs (CoGTA) assists municipalities in compiling a list of priority infrastructure needs used to determine the MIG allocation. There are no precedents for allocating MIGs and USDGs to ecological infrastructure. In the context of South Africa's public finance legislation and technocratic approaches to service delivery (Mangcu, 2013) it would take a shift in perspective for COGTA to recognise the importance of catchments in water provision and an innovative and courageous municipal manager to motivate for such an allocation. There remains a critical need, then, for precedents that could withstand Treasury scrutiny. A central component of these precedents involves demonstrating that a USDG or MIG allocation to ecological infrastructure could deliver reliable and quantifiable water services, at an equivalent cost, while generating higher economic multipliers and employment than conventional infrastructural approaches. Given the relatively low multipliers achieved on South Africa's existing infrastructure spend, a WRC study testing this potential is warranted.

Drawing-in existing infrastructure budgets would significantly increase the resources for ecological infrastructure. The MIG allocation to KZN is over R3.5 billion per annum. The Msunduzi Municipality,

[14] Draft 2014-15 Conditional USDG Grant Framework. National Treasury, Jun-2014

for example, receives over R160 million per annum while eThekwini Municipality's budget for water, waste-water and storm-water in 2015/16 is over R2 billion.

As a minimum the infrastructure money that is currently spent by both DWS and local municipalities, would do well to include expenditure that ensured complementary ecosystem goods and services. The longevity, efficacy and operating costs of dams and water treatment plants, for example, is enhanced by surrounding natural environment that mediates flows, reduces sedimentation and prevents the breach of critical water contamination levels. The return on investment of a dam such as Spring Grove is affected by the speed with which the dam impounds water and the rate at which it is filled with sediment (an expensive and as yet unsolved problem). Both of these factors can be influenced by the nature of the upstream habitat. Given the amount of money that is spent on water infrastructure, ensuring a fraction of the total infrastructure budget is spent on adjacent ecological infrastructure is financially rational.

4.4.1.4 Natural Resource Management Funds:

A notable feature of public funding for water services the world over is that it tends to focus on the storage and delivery infrastructure and ignore the natural systems that provide water (Lipper and Neves, 2011). In the process it creates liabilities – drying and stranded assets. This is particularly true during times of fiscal constraint. South Africa has sought to counter this tendency with a suite of programmes outside of DWS that focus on environmental stewardship. The exact amount that is spent on ecological infrastructure and biodiversity is the subject of a Department of Environmental Affairs study that will be released in 2016 (Cumming, personal communications, 2015). Ecological infrastructure funds are allocated to national departments, provincial departments, parastatals and the national Green Fund that is administered by Development Bank of Southern Africa (DBSA). The proportion of this spend that can be considered as ecological infrastructure investment is roughly R931.5 million (Table 4.8). A more detailed breakdown of this money is contained in Appendix C.

Table 4.8: Government spend on ecological infrastructure for the 2013/2014 financial year

PROJECT EXECUTANT	TOTAL EXPENDITURE R MILLION
Total National and Provincial Spend on Ecological Infrastructure	R 931.5
National Government spend	R 644.5
Provincial Government spend	R 287.0
Estimated KZN Portion of Provincial Government Spend on ecological infrastructure	R 37.3

The total amount spent by parastatals and the Green Fund for the 2013/14 financial year is shown in Table 8. Parastatals included in this estimate include SANBI, EKZNWildlife, South African National Parks (SANParks), and two catchment management agencies: Breede-Overberg Catchment Management Area, and Inkomati Catchment Management Agency.

Table 4.9: Parastatal and Green Fund spend on ecological infrastructure for the 2013/2014 financial year

PROJECT EXECUTANT	TOTAL EXPENDITURE R MILLION
Parastatals	R 3,603.5
Green Fund	R 45,314.4

The Expanded Public Works Programme (EPWP), established to correct labour market failures by providing labour intensive services, is the mostly widely known ecological infrastructure programme in South Africa. Precise numbers are difficult to come by, but the EPWP has a budget of over R80 billion. Roughly R2 billion of this money is available for natural resource management and environmental services through the "Working for" programmes and roughly 15-20 per cent of this is spent in KZN.[15]

- Working for Water – R280 million per year
- Working for Wetlands - R56 million per year
- Working for Fire – R206 million per year
- Working for the Coast – R127 million per year
- Working for land – R106 million per year

The focus of these programmes is on poverty alleviation, but their programmes could be more closely aligned to much-needed environmental outcomes. A few high-level studies have been conducted on the job creation and cost savings yielded by the EPWP. The Council for Scientific and Industrial Research (CSIR), for example, estimated that the Working for Water programme has saved as much as R400 billion since its inception in 2004 (CSIR, 2010). This is largely based on an annual increase in water that is worth an estimated R35 billion a year. The Working for Water programme has cleared over two million hectares of alien invasive plants in its 10 years of operation. In spite of this, questions have been raised about the efficiency of the programmes based on the relatively small portion (5-20 per cent) of the total budget accruing to workers involved in physical alien clearing (CSIR, 2010).

The Department of Environmental Affairs' Green Fund is a three-year R800 million facility that supports initiatives that contribute towards environmental conservation and South Africa's transition towards a green economy. In 2013/14, the Green Fund received R250 million from the Department of Environmental Affairs and supported three thematic areas: project development, capacity building, and research and development. Approximately R45 million of Green Fund money has been spent on ecological infrastructure related projects via programmes run by Wildlands Conservation Trust, South African National Parks, eThekwini Municipality and Edakeni Muthi Futhi Trust (Department of Environmental Affairs, 2014).

4.4.2 Private Funding

South Africa's financial markets are deep and have been considered to be well regulated and effective in connecting savers with investors. South African banks are compliant with Basel 3 guidelines and by international standards survived the Global Financial Crisis well, due to prudent asset to debt ratios. Collectively South Africa's finance sector manages over R6 trillion in assets. The

[15] It should be noted that these figures have been extrapolated for 12 months based on 9 months worth of actual expenditure.

allocation of these savings is subject to strict investment mandates and national legislation (Figure 9).

The Bertha Centre estimates that 41 per cent of South African funds are "Invested for Impact", meaning they target some form of public good over-and-above shareholder profit (Giamporcaro, 2014). In spite of this, South Africa's financial sector has been criticised for its inability to support much-needed social infrastructure and the green economy, and for its investment concentration in relatively few companies (Mashatile, 2015). It is also true that the finance sector has been complicit in financing environmental degradation and structural poverty, most notably through the mining sector, but also through support for some agriculture and forestry.

South Africa, as elsewhere, appears to experience a disconnect between finance companies that comply with Environmental, Social and Governance (ESG) and Socially Responsible Investment (SRI) requirements on the one hand, and increasing environmental degradation and obdurate poverty and inequality on the other. This has given rise to increasing calls to "Invest to create the future we want" (AIRR, 2014), an approach that would require them to look forward in assessing risk and opportunities (as opposed to using the past as a proxy for the future) so as to expand their own markets.

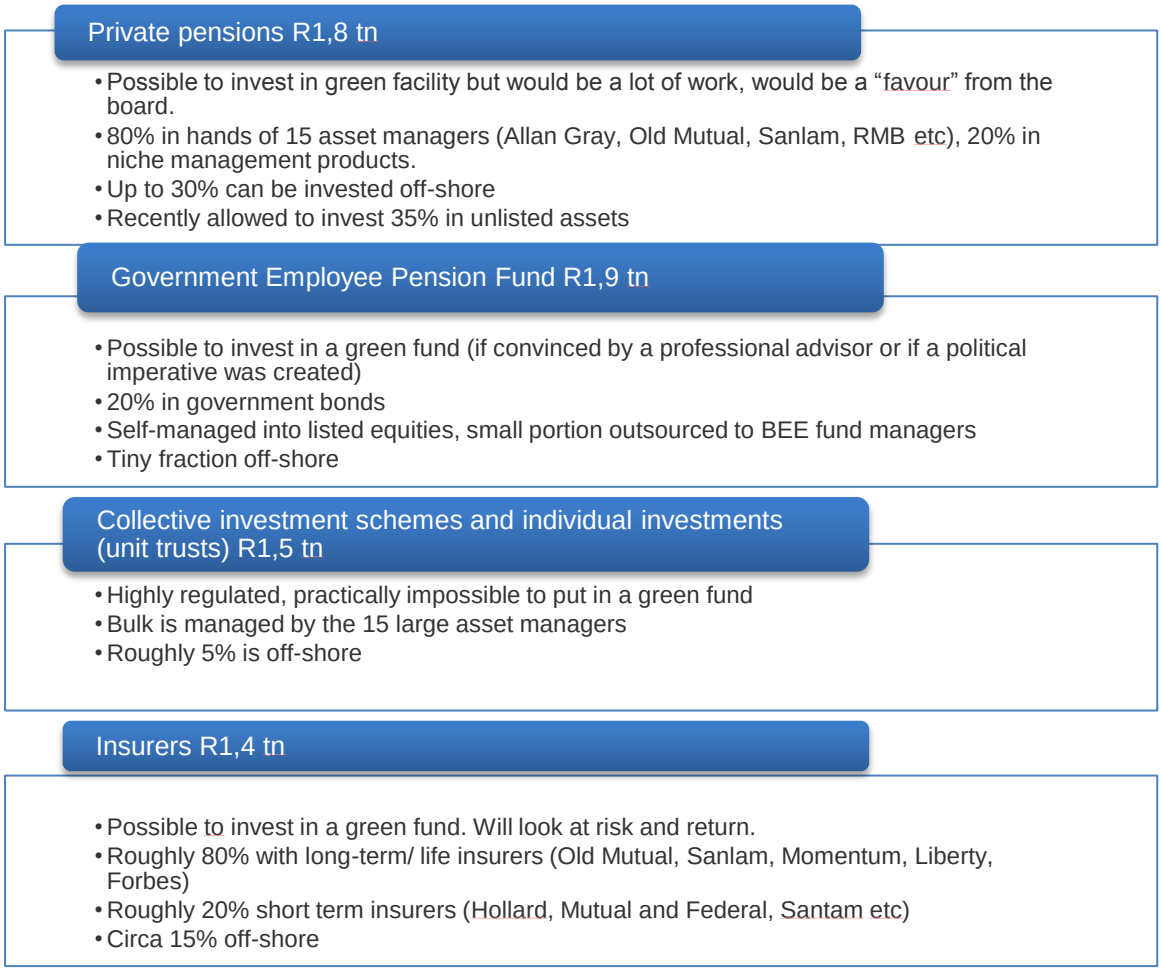


Figure 4.9: Breakdown of South Africa's financial sector by source of money and legal mandate.

For the purposes of enhancing private sector investment in the uMngeni Catchment, it is worth considering how different players in South Africa's finance sector might be engaged so as to increase investment in ecological infrastructure.

4.4.2.1 Institutional investors:

Institutional investors typically manage people's savings and pension money in line with an investment mandate that is prescribed by trustees and asset consultants (such as Mercer, Towers Watson, Alexander Forbes) and compliant with national legislation. This segment of South Africa's finance sector is conservative, in line with the weighty responsibility of stewarding people's pension money and savings. Two recent South Africa developments have seen institutional investors looking for more diversified portfolios. The first is the renewed possibility of National Government "prescribing assets" to force fund managers to buy government bonds. The policy of prescribed assets is, understandably, viewed by the private sector as restrictive and regressive, but the perceived reluctance to allocate funds in support South Africa's transition has seen the idea recalled in policy debates (Mashatile, 2015). In a related development Regulation 28 of the Pensions Act has been reformed to permit holders of pension fund money to invest up to 35 per cent of their portfolios in non-listed assets (up from 5 per cent). The rationale cited for the shift is that pension funds don't require high levels of liquidity and should be able to support a long-term economic transition. South Africa's Government Employees Pension Fund, which manages R1.5 trillion of pensioners' money, has led much of this recent innovation, increasing its stake in, "Economic Infrastructure, social infrastructure and the green economy" from 2 per cent to 8 per cent. Other institutional investors have set up "alternative" companies or initiatives such as Old Mutual's Future Growth, Sanlam's Alternative Investments and Nedbank's Fair Share aimed at exploring new markets and a greater social and environmental responsibility.

Institutional investors have invested in some of the liabilities that they, insurance companies and society are now paying for (Otto-Mentz, personal communication, 2015)[16]. Finance sector employees will increasingly be required to understand and impute environmental risks in their investment decisions. Environmentalists wanting to tackle this problem cannot, however, proceed with naivety about financial sector legislation. Institutional funds are under increasing pressure to comply with environmental, social and governance (ESG) criteria. They cannot simply be given to environmental projects, no matter how worthy, but rather have to be invested within specific mandates that relate to risk and returns. Taking advantage of the inevitable shift in global finance will require new risk metrics, new capital allocation decisions and the creation of new investment-worthy asset classes. This will include both privately and publicly owned ecological assets, and an express recognition of the role of ecological infrastructure in creating value.

4.4.2.2 Banks:

South Africa's "Big Five" banks are all active in the uMngeni Catchment (section 2). Banks occupy a more difficult position with regards to ecological infrastructure in that they typically engage short-term positions and require rapid return on debt. Section 2 established that banks had insulated their loan books from short-term environmental risks in the uMngeni Catchment: where drought or floods impacted agricultural productivity, banks had been able to restructure the debt and interest rate terms in their favour. The same research revealed a poor translation between the environmental

[16] Vanessa Otto-Mentz is the head of sustainability at Santam Insurance.

goals and targets of bank's national headquarters and the activities of bankers in the uMngeni Catchment.

This research has highlighted the importance of a shared vision for how finance might contribute to a more functional catchment with better business and finance opportunities. Even though the network of credit varies greatly across the catchment, loan books present real leverage over land-use practices (McKenzie and Cartwright, 2015). There is the need for the finance company positions on sustainability that are strategized and articulated at national headquarters to find traction in the lending decisions taken at local branch offices. It is in banks' own collective interests to play a more proactive role in ensuring the protection of the natural environment that underpins their businesses. As a minimum, banks should stop financing activities that undermine the hydrological asset base on which their other businesses depend but there is also potential new business in the financing of remedial measures that benefit farmers and the broader catchment. Examples include slurry ponds, riparian buffers and water efficient technologies, including better irrigation schemes, on-site water purification and solar pumps for irrigation and dairy farmers.

4.4.2.3 Insurance industry:

South Africa's insurance industry has underwritten some of the water related risks that it now has to pay out on (Section 2; Otto-Mentz, personal communication, 2015). The industry has begun articulating the need for more systemic approaches to managing risk, and in particular the curtailing of investments that generate liabilities. This awareness is the result of rising claims and fears regarding the viability of the insurance sector in the face of multiple concatenated risks over which it has little control (Figure 4.10).

It is, then, unsurprising that insurance companies are leading the effort to find new risk reduction measures, including insurance products that link forecasting models, a forward-looking capital regime and short-term policies. In South Africa, the South African Insurance Association (SAIA) is coordinating this effort. In the case of water risks, SAIA would benefit from a proof of concept presented by conservation organisations and local municipalities of how functional ecological infrastructure reduces the impact of floods, droughts and water contamination, and of how ecological infrastructure is an essential complement to functional built infrastructure.

4.4.2.4 Corporate Social Investment:

An interesting footnote to South Africa's investment landscape is the roughly R8 billion that companies spent on Corporate Social Investment (CSI) in 2014. The single greatest contribution was made by Anglo American (R640 million), and over 42 per cent of the total CSI spend in South Africa went towards education (Trialogue, 2015). The environment appears a long way down the list of categories that CSI managers seek to support. The preference is for, "Line of sight to poor communities" and particularly communities that form part of the institution's target market (Rockey, personal communication, 2014).[17] Environmental projects tend to be low profile, difficult to monitor or evaluate and long-term, and for these reasons do not attract much CSI funding. The exceptions are WWF-SA, the Cape Leopard Trust, the Cape Parrot Trust and the increasing amount of money that is being allocated in an attempt to protect rhinos from poaching – much of which involve iconic species and not habitats.

[17] Nick Rockey is a director at Trialogue, a company that monitors South African CSI.

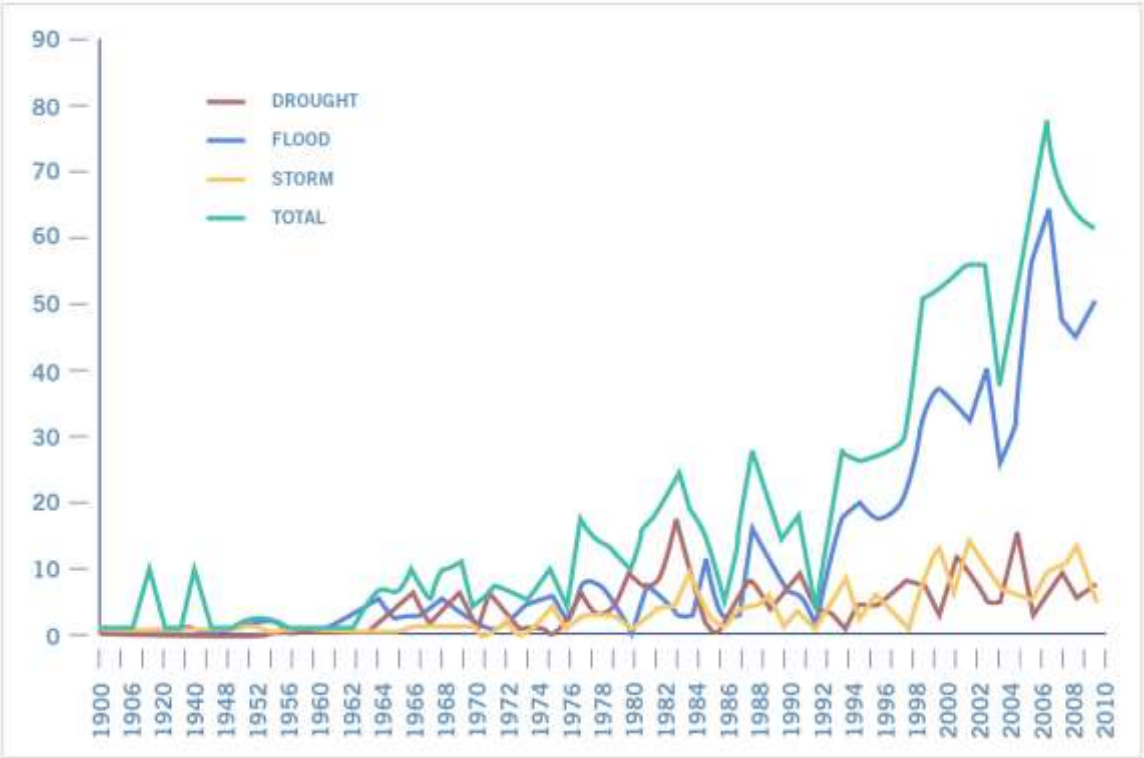


Figure 4.10: Disaster related insurance claims in South Africa 1900-2010

CSI funding will remain a small portion of the required amount. However, the Trialogue analysis suggests there is potential for environmental projects, including those investing in ecological infrastructure, to present their case more strongly in terms of jobs, education, livelihood support and water security. As DUCT has shown, CSI funding can provide opportunities to test alternative models of risk reduction and service delivery. In the case of DUCT, the experimentation that has been enabled through CSI funded projects has demonstrated the value of ecological infrastructure and "River Care Teams", and highlighted this approach for future investment.

4.4.3 Public-private and Blended Finance

While South Africa's water legislation places the burden of responsibility for initiating water risk reduction measures on the public sector, the scale of activity required in the uMngeni, coupled with the need to act on both public and private land, implies that most solutions will involve a combination of public and private finance. Against the backdrop of fiscal constraint and heightened risk of drying or stranded assets, precedents such as the Rustenburg Water Trust and the collaboration between Msunduzi Municipality and DUCT, have begun to emerge to manage and mitigate water crises.

The theory of blended technology finance suggests a continuum of funding types as new ideas become increasingly familiar and "bankable" (Figure 11). In practise, this degree of coordinated and integrated finance is rare.

Water bonds: Bonds are perceived to be lower risk for investors, due to their fixed period, fixed investment mandate, agreed-upon rate of return and government underwriting. The World Bank, which raises funds from fixed income investors, reported a rapid growth of its "green bonds".

Green bonds have grown from $4 billion in 2010 to $37 billion in 2014 (World Bank, 2015).

Green bond loans support climate change adaptation and mitigation and has been invested in 100 transactions in 18 different currencies. The greatest proportion of the World Bank bonds ($3.5 billion) involves transport infrastructure, but water bonds account for $1.3 billion of the "green bond" market issued by the World Bank. Notably the World Bank has no water bond projects in Sub-Saharan Africa. The lacuna suggests the inability of local water authorities to compile creditworthy proposals or to present adequate balance sheets. In South Africa this may be a function of the delays experienced in establishing CMAs, but also speaks to the inability of many water users to afford the finance of water infrastructure based on the World Bank's user-pays models.

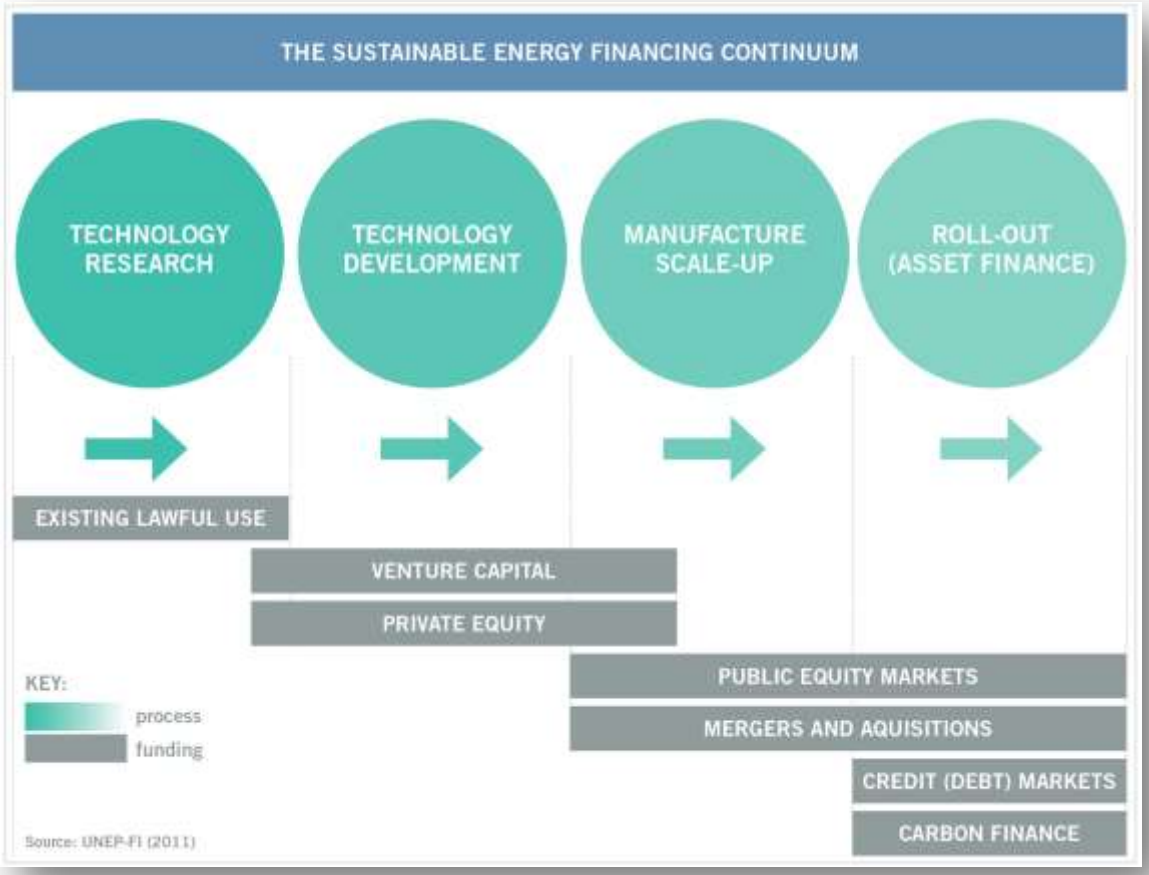


Figure 4.11: The theoretical continuum of finance as new programmes and products become "bankable" (adopted from the energy sector)

In South Africa, municipalities and state-owned entities are becoming increasingly active in the bond market. Both eThekwini and Umgeni Water have issued bonds. Given their credit ratings (A1+ and AA+, respectively) balance sheet and revenue model of either eThekwini Municipality or Umgeni Water, there would be no difficulty in raising finance for a further bond that could be spent on reducing water risks through (among other things) ecological infrastructure.

Basic calculations show that servicing a R500 million bond might be difficult based on improved water yields alone, however. If that bond was expected to yield at 9 per cent, and if this was to be serviced through the money raised on the Abstraction Levy (R0.26/kl) and the Capital Unit Charge (R0.41/kl), the interventions on which the money was spent would have to yield an additional 15 per cent of water for Umgeni Water (relative to 2014). This additional volume of water is unrealistic, highlighting the importance of simultaneously yielding more water and saving money on water treatment and delaying mega-infrastructure investment.

Table 4.10: Basic analysis of required "return" in additional water in order to service a R500 million Rand bond through water sales

ITEM	AMOUNT
Bond amount	R500 million
Rate	9%
Combined Abstraction levy and CUC	R0.67/ kl
Amount of additional water that has to be realized to finance bond	67,074,080 kl
% Additional yield on 2014 water volumes	15%

Alternatively, based on a bond yielding 9%, the aggregate water price charged by Umgeni Water would have to increase 12 per cent above the 2014 net price, simply to service the bond.

The basic calculations highlight the importance of the rate at which the bond is expected to yield. Should the rate be set at 5 per cent, the amount of additional water required is 8 per cent, or the water price charged to municipalities would have to increase by 7 per cent. It may be that international bond financiers could provide the capital required more cheaply than local institutional investors. An effective water bond would get financiers to recognise their exposure to water scarcity and quality risk in the catchment and secure a bond rate that represented a joint solution to a shared problem – i.e. a lower rate than a conventional bond because of the systemic benefit that institutional investors will receive from the effort to address a problem that is affecting the value of their existing investments in the catchment.

It is important to differentiate between water bonds (issued by a government organisation) and water funds which have been established to support investment into ecological infrastructure in South America and Kenya (TNC, 2015). Water funds have been supported by corporate CSI investment and do not require a financial return. They may be of the order of several millions of rands and support landscape restoration schemes in the catchment. Water bonds are recommended in this study as they can be developed at the scale of investment required, can represent blended private and public sector investment, be directed at ecological and engineered state owned assets critical in the water value chain, and result in additional multipliers such as improved fiscal accountability in parastatals. The table below highlights the differences between water bonds and water funds.

Table 4.11: Characteristics of water bonds and water funds as they are currently practiced in international examples.

	WATER BOND (EG. UMGENI)	WATER FUND (EG. TNC)
ORGANISATIONAL HOME	Parastatal	Charity trust
PURPOSE - MANDATE	Legal mandate	Stakeholder mandate
FINANCIAL MECHANISM	PP capital loan	Endowment fund
REPAYMENT CONDITIONS	Water tariffs with gov underwriting (1st risk)	No direct financial RoI
INCOME	Water tariffs – bulk services	Donations (corporates/DFI/donors)
INVESTMENT FOCUS	Ecological and engineered infrastructure	Green infrastructure
UPSTREAM DEPENDENCIES	CMAs	Communities
DOWN STREAM VALUE CHAIN	Local government investors	Corporates, towns
M&E GOVERNANCE	Auditor general	Private and self regulation

The Land User Incentive Programme (LUI): The Natural Resource management LUI is a sub-set of the EPWP that engages corporate and private land owners to support them to employ teams of workers that do alien clearing, donga rehabilitation, afforestation of degraded lands and habitat stewardship. South Africa's environmental legislation creates a legal obligation on landowners to remove scheduled alien vegetation from their properties (NEMBA discussion in Section 2.4.1). One of the rationales for this legislation is the water required by this vegetation, but the legislation has proven a difficult to enforce.

The LUI scheme offers corporate landowners the chance to draw down state subsidies for alien removal based on the commitment of their labour, equipment and fuel. In KwaZulu Natal, Wildlands Conservation Trust, for example, received R33 million of LUI money in 2013 to spend over five years in a range of municipalities on afforestation and grassland management. In another example, SAB Ltd, contributed R1.5 million in a partnership with WWF that was supported by the LUI.

The LUI has been applied in concert with WWF's Water Balance Programme that has seen corporate water users invest in improving catchment health, mainly focused on alien plant clearing (Gordon, personal communication, 2015). The Water Balance Programme represents a form of CSI that contributes to landscape restoration, job creation and perceptions of corporate water users in a specific catchment.

Development Finance Institutions (DFIs): South Africa's two large DFIs, the Industrial Development Corporation (IDC) and the DBSA are both active in the country's green economy, but in very different ways.

The IDC is owned by the South African government but raises all its own capital from international DFIs such as the European Investment Bank and KfW Development Bank (owned by the German Government) and the International Finance Corporation (IFC). The IDC has raised a R5bn bond with the Public Investment Corporation (PIC) to extend loan and equity positions to independent power producers (IPPs) in South Africa's renewable energy roll-out.

Given that the IDC raises its own money and has no depositors it is unable to offer concessionary loans. Typically, IDC loans reach projects at similar rates to that of commercial bank finance. Loans are, however, less than 10 per cent of IDC's commitments, with equity (usually in the form of "preferential shares") making up the balance. The IDC is obliged to cover the cost of its finance, but being owned by government it is (in theory) able to justify a lower yield where an employment or transformation impact is anticipated from an equity or loan commitment. The IDC's green economy focus is on renewable energy, fuel-based green energy (especially where this energy involves some form of pollution abatement), energy efficiency and biofuels. The IDC tends not to consider loans of less than R1 million or equity commitments of less than R5 million. The IDC's two green economy flagships are currently energy related – the Green Energy Efficiency Fund (GEEF) and the financing of Independent Power Producers.

The DBSA, unlike the IDC, does receive a fiscal allocation from the National Treasury and as a result offers a suite of grants and finance. The bulk of the DBSA's disbursements go to infrastructure and capacity building within local government. Direct job creation associated with this infrastructure allocation came at a (very high) cost of R418,000 per job in 2011 (DBSA, 2012).

The DBSA's green economy flagship is the R800 million Green Fund that it manages on behalf of the Department of Environmental Affairs (DEA).

Equally critical to the green economy is DBSA's Job's Fund started in 2011, a Treasury initiative that has funded 90 projects with R4.7 billion in grant funding and leveraged R6.8 billion in private funding. The programme has created over 55,000 permanent jobs, 40,000 work opportunities and trained over 112 thousand people, at a fiscal cost per job that is impressive by South African standards. The only ecological project supported by the Jobs Fund to date involves training of Wildlife Officers, but there is scope for expansion. The Jobs Fund is available to public, private and NGO partners via four windows:

- Enterprise Development
- Infrastructure Investment
- Support for Work Seekers
- Institutional Capacity Building.

Ecological infrastructure projects that are able to demonstrate work creation potential for the currently unemployed are potential beneficiaries for Jobs Fund money, for both training and to subsidise work creation. This is more likely to be successful where the work being done is shown to reduce water risks.

4.5 Prerequisites for Increasing Investment in uMngeni Ecological Infrastructure

Water in South Africa is a national resource, under the ownership and custodianship of the Minister of Water Affairs and Sanitation. The nature of South Africa's water legislation implies that some of the market-based water trading and payments for environmental goods and services, that are celebrated internationally, do not apply. The corollary is that many of the ecological infrastructure finance arrangements targeting water, will require a degree of public funding. Private funding will be

necessary, however, where privately owned land and infrastructure is involved and to complement the available public funds.

Whether seeking public or private investment, efforts to enhance the flow of money to ecological infrastructure will require certain prerequisites and preconditions, if they are to succeed. Understanding these requirements is central to the broader effort to restore water catchments:

- ***Shared Sense of the Problem***: Recognition that water services and water security cannot be provided exclusively through engineered infrastructure, but are dependent on complementary ecological and built infrastructure is necessary for any effort to raise ecological infrastructure finance. This shared sense of the problem and solution needs to be made legible to the financial community using the type of evidence that they can apply. This includes ecological infrastructure being considered alongside built infrastructure in the allocation of Department of Water and Sanitation infrastructure budgets (RBIG, MWIG and ACIP) and in the spending of Municipal Infrastructure Grants and Urban Settlement and Development Grants and the raising of CUC and FIBC levies. It is further useful to identify areas most at risk so as to direct investment to the area of greatest return, which is the focus of the parallel SANBI study (maps in Section 1), and for businesses and banks to start formulating a better informed picture

- ***Implementation of the supporting legislative environment***: South Africa has a highly supportive National Water Act and increasingly supportive financial legislation, both of which encourage investment in ecological infrastructure. Precedents that link these pieces of legislation and demonstrate the financial benefits of investing in ecological infrastructure are now required.

  A critical next step in this regard involves establishing and resourcing a CMA and supporting the CMA in the drawing up of a Catchment Management Strategy that identifies ecological infrastructure investment options.

- ***Proof of concept and a better articulated evidence base***: It is widely accepted that the uMngeni Catchment is environmentally compromised (Nevin, 2015), but little work has been done in translating how different types of environmental degradation translate into costs, in identifying who carries the burden of these costs, understanding when they impact or the environmental, social and institutional pathways that degradation follows to result in costs.

  This study identifies finance opportunities and the importance of ecological infrastructure finance in avoiding expensive water risks. More work could be done in understanding which companies and communities confront prohibitive water quality, and "drying assets" or "stranded assets". The same work should identify how forward looking investment strategies could be good for businesses and governments. The Catchment Management Strategy is scheduled to be written in 2016. Furthermore, it is critical that the strategy begins to attribute specific risks to specific activities and type of degradation, and particularly that the strategy quantifies the relationship between ecological infrastructure degradation and water risks.

Some of the evidence required to construct a proof of concept already exists, but has not been communicated in a manner that makes it useful to the finance community. Peer reviewed research shows that alien invasive species are using more water than indigenous species (Le Maitre et al., 2015; Gorgens and Van Wilgen, 2004; Cullis et al., 2007), and that this has been part of a concerning trend since the 1930s. Predictably, the results vary across species and regions, but show that frequently alien invasive vegetation produces between 345 - 1,200 m^3 per hectare per year less run-off. Everson et al (2007) produced evidence following deforestation of alien plantations show an increase in mean run-off from 2.2 per cent to 7.2 per cent. Forsyth et al. (2012) went further by ranking alien clearing priorities in terms of water security. Yet, because of the difficulty of accruing benefits from better management of the commons, this research appears to have very little influence on the finance community or bulk infrastructure water managers' decisions. Translating this biophysical research into the cost and benefit of water management options, how different types of ecological and built infrastructure perform in terms of cost and water benefits and the timeframes over which benefits arise, and for whom is important.

Investors and water managers interviewed in this study were aware of the options, but were deterred by the lack of precedents and perceived uncertainty that is associated with ecological infrastructure solutions. This is a reasonable position for people with fiduciary responsibilities that are not always well understood by the conservation community, but it reflects poorly on the manner in which peer-reviewed water literature is being translated and presented to decision makers. Natural systems are inherently more complex, and less certain than built systems (Vant and Bromley, 1994; Rock et al., 2009). Attributing returns to alien clearing, for example is innately more difficult than calculating such returns for a dam or treatment plant. Both financiers and conservationists need to find ways of drawing on the evidence to take better water investment decisions. Even where such investment in legally mandated - such as through the WRM that is levied by CMAs (or DWS), it is worth establishing location-specific evidence as to what might reasonably be expected from different interventions in terms of water quality and quantity.

In the initial phases, it may be necessary to conduct a demonstration project in a sub-catchment that raises attention, collates the evidence on impacts and costs of investing in ecological infrastructure and familiarises investors with the novel set of considerations.

- ***Absorption capacity***: It may transpire that spending money well, and on time, is more difficult than raising money for ecological infrastructure. Ecological infrastructure is a compelling concept for anybody involved in the earth sciences, but there are few precedents in South Africa beyond the poverty alleviation EPWP models, especially if the concept involves more than alien removal. The location-specific combinations of alien removal, afforestation, riparian buffer establishment, sand mine rehabilitation, treatment plant upgrades, water efficient technologies, slurry ponds, pipe repair and both reticulated and biodigesting sanitation that may constitute ecological infrastructure, remain to be defined and implemented. Even if half of the required money is made available (R500 million), new skills, new programmes of work and new institutional arrangements will be required to ensure this money is spent effectively. DUCT, the Jobs Fund, the Change a Life Paddling Academy and Wildlands Conservation Trust have demonstrated that new local partnerships

can be effective. However, engaging and operationalizing these partnerships in formal programmes is something that South Africa has struggled with since the demise of the "civics" in the early 1990's, and will inevitably take time (Mangcu, 2003).

The pending Catchment Management Strategy should provide the framework within which this institutional and technological innovation takes place, but both public and private sector investors will want to see an investment and management plan with clear indications of how particular investments will contribute to reducing risk and generating a "return".

- ***A sense of "return"***: All investors, whether public or private, but particularly private, want to know how their money will generate a return. In the case of private investment this is critical, as investors' money needs to be returned to them with interest. Ecological infrastructure generates a "return" in at least four possible ways:

    1. by providing more water that can be sold;
    2. by reducing the money required to spent on water treatment in order to ensure the water complies with required quality standards (see New York example in Appendix B);
    3. by enabling the construction of new mega-infrastructure projects aimed at water supply or water treatment to be postponed or deferred;
    4. by increasing the functional efficiency of existing water infrastructure by either reducing siltation, reducing the pollution load, reducing flood damage or reducing the energy required to operate mega-water infrastructure.

  Provisional calculations suggest that the amount of additional water generated by ecological infrastructure is insufficient to finance a water bond through the sale of this water. The implication is that finance, whether public or private, will have to draw on multiple "returns" in order to make it viable.

- A***wareness of manner in which finance is allocated:*** Greater awareness within the conservation and water community of the manner in which public and private finance is allocated is necessary to make projects "bankable" and to attract resources to good projects.

  Conservationists have begun to produce economic values for the environment (following Costanza et al., 1997) but have seldom influenced the flow of finance at the local level (Cartwright, Savage and Steyl, forthcoming). To attract finance there is a need to develop a portfolio of implementable "shovel-ready" projects that can make good use of the finance to deliver the required return, whether social, ecological or financial. In many instances this will require complementarity between built and ecological infrastructure. Some of the most "bankable" ecological infrastructure projects are likely to be those that enhance the value of dams, treatment plants, and flood buffers. Seeking out these complementarities may be the easiest place to begin making the case for ecological infrastructure, but will require a non-exclusive approach from conservationists.

- E***stablish a link between solutions and community benefits***: A link between ecological infrastructure and community benefits – employment, new recreation areas or cleaner

water, enhances the investment case for ecological infrastructure. Whilst often driven by corporate interests, or, in the case of the uMngeni Catchment, the needs of a large city at the end of the catchment, upstream community involvement is essential to sustained success. A water catchment is too extensive and complex a system to manage or monitor without community support.

- **Trusted intermediaries:** The international literature (and the uMngeni Catchment's own experience) is clear on the need for impartial conveners and monitors of the process that raise, allocate and account for finance in watershed management. The novelty and the complexity of investments in ecological infrastructure, and the very different parties that are required to be involved, with expertise and networks linked to public and private finance and an understanding of the role of ecological infrastructure in the water system, create the need for trusted intermediaries such as WWF or the UEIP.

4.6 Illustrative Funding Scenarios

To highlight how investment in ecological infrastructure might be enhanced in the uMngeni, two scenarios are outlined below. The scenarios are intended to be illustrative but plausible, based on current conditions and institutional mandates.

4.6.1 Public Funding Scenario

DWS communicates nationally and locally on the state of water risks in the uMngeni Catchment and raises the spectre of stricter enforcement of water regulation so as create the credible threat that focuses attention on managing these risks.

The PU-CMA is registered with money paid for the WRM levy, and draws up a Catchment Management Strategy that recognises the importance of the natural environment in water security, and draws on available research to make a case for investing in ecological infrastructure. The strategy includes a geo-referenced risk mapping exercise that identifies areas at greatest risk of water quality and quantity degradation.

A portion of the WRM for the uMngeni Catchment (R5 million) is used to restore riparian buffers and wetlands and for alien vegetation removal in critical areas, as a "proof of concept" of the role ecological infrastructure. The project draws down funding from Treasury's Job's Fund. Following the Pricing Review process in 2015, a special CUC levy is charged to raise R50 million over five years for the same purpose to supplement the national levying of the FIBC. Water Research Commission money is used to enhance the evidence base with regards to the value and role of this ecological infrastructure in providing water services.

National Treasury is engaged so as to expand the definition of "infrastructure" to recognise the critical role played by ecological infrastructure in providing municipal services. The same engagement allows municipalities to invest strategically outside of their borders in order to secure water services. EThekwini Municipality launches a precedent setting project in which USDG funds are used in conjunction with the RWIG to provide water services through ecological infrastructure (alien clearing and riparian restoration).

The services of organisations such as DUCT are included to provide integrated solutions in the riparian zone, include local communities and plan locally appropriate combinations of ecological infrastructure and upgrades to municipal sanitation infrastructure. Composting toilets and community biodigesters are used to redress the sanitation backlog and enable quicker sanitation services to be provided without the need for costly bulk water infrastructure or treatment plants.

A portion of the budget for the Mooi-uMngeni inter-basin water transfer project is released to invest in ecological infrastructure, thereby delaying the need for the project by at least 5 years, and saving money.

4.6.2 Public-Private Scenario

WRC research confirms existing evidence that investing in ecological infrastructure yields water at 25 per cent to 50 per cent of the cost of built infrastructure, and makes existing investment in water treatment more effective (Schreiner and Hassan, 2006).

eThekwini Municipality (or Umgeni Water), concerned by water insecurity and the rising cost of water, issues a R500 million, 10 year, water bond aimed at upgrading its own water treatment infrastructure, plugging leaks, and enhancing ecological infrastructure. National Treasury agreement allows some of this money to be spent outside of eThekwini Municipality based on the understanding that eThekwini Municipality's water is derived from the complete catchment.

Institutional investors under continued pressure to diversify their portfolios are quick to buy the bond, and in the process create a new ecological infrastructure asset class. This could also be financed by the money held on behalf of mining companies for *ex poste* mine rehabilitation. Capital raised in the bond is spent in concert with public RIG and MIG grants for water infrastructure. Together these source of 'blended' finance are sufficient and reinforcing to improve water security and delivery.

R100 million of the issued money is allocated to on-the ground organisations with specific responsibilities for upgrading ecological infrastructure and involving local communities.

The bond is serviced by agreeing to an inflation based increase in water tariffs charged by Umgeni Water to eThekwini. (If it is Umgeni Water raising the bond, then the bond is serviced by reduced need for water treatment plants and by delays in bulk water storage investments).

Stricter enforcement of water policy by the CMA creates incentives for water innovation, and greater recognition of the importance of functional catchments in water provision. Banks create new products that incentivise investment in ecological infrastructure and water saving technologies. The insurance industry draws on WRC research to apply punitive measures on activities and clients that undermine ecological infrastructure and amplify water risks.

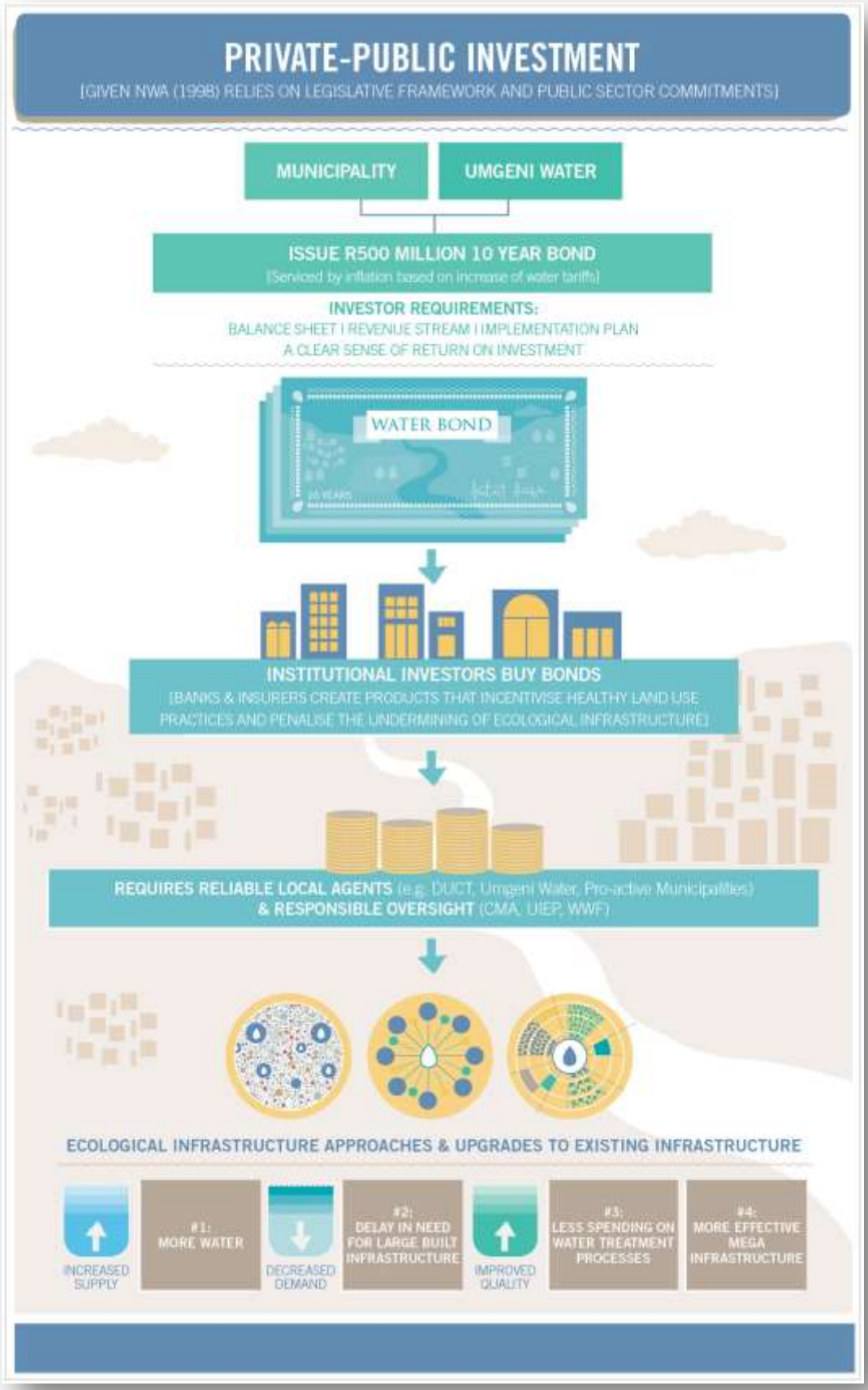


Figure 4.12: Private-public options for investing in ecological infrastructure in the uMngeni Catchment

4.7 Conclusion

South Africa's water crisis is "not a debate" (Pienaar, 2015). In the uMngeni Catchment inherently variable rainfall has been compounded by increasing demand, urbanization, water contamination and ageing infrastructure (Nevin, 2015) and the problem is particularly acute for the city of Durban located at the end of the catchment and for water intensive businesses that are vested in the region. While legal and institutional contexts differ, the lesson from cities such as Sao Paolo, New York, Munich are important for cities dependent on the uMngeni Catchment such as Durban and Pietermaritzburg.

> *"Cities are increasingly learning to put their money in a winning strategy. Natural infrastructure offers urban areas a flexible way to manage water that benefits ecosystems, people and municipal bank accounts"* (Sustainable Cities, 2015).

Rock et al., (2009), while focusing on technology transitions, suggest that landscape pressures are seldom sufficiently aligned or strong enough to direct major social transitions on their own, pointing instead to the importance of socio-political landscapes in supporting transitions to sustainable resource use. The uMngeni Catchment is already highly engineered, and water use in the region is subject to a political economy. Aligning the prevailing socio-political landscape, which includes banks and public entities such as uMngeni Water, with the underlying ecological resource, is necessary to manage water risks.

The lively national commentary on South Africa's prevailing drought is quick to cite the need for more dams, more treatment plants and greater allocation of the budget to maintaining ageing water infrastructure. It is accompanied by efforts exhorting people to use less water. What is very seldom mentioned is the contribution of ecological degradation to the problem and the potential for investment in ecological infrastructure to be a part of the solution. This is in spite of a pressing fiscal crisis that renders new mega-infrastructure programmes improbable and South Africa's National Water Act being internationally celebrated for its recognition of the critical role played by functional ecosystems in water provision.

The updated National Water Resource Strategy (NWRS, June 2013) places a greater emphasis on catchments and ecological infrastructure in an attempt to facilitate its recognition in the national infrastructure spend. The strategy cites the need for the, "Strategic investment in maintenance & rehabilitation of water ecosystems…the maintenance of National Freshwater Ecosystem Priority Areas (NFEPAs)… protection] of riparian & wetland buffers and critical groundwater recharge areas."

This study estimated that investment of over R1 billion is required in ecological infrastructure the uMngeni Catchment. Once the conceptual and economic merit of investing in ecological infrastructure is acknowledged, the challenge becomes how to attract and invest this capital effectively. There are, of course, collective action difficulties that make mobilizing such investment difficult. The nature of South Africa's water legislation precludes some of the conventional market based "payments for ecological services" that are celebrated elsewhere in the world. At the same time, it creates instruments that enable such payments and investments.

The study identifies a suite of key interventions (each of which requires supporting actions) in harnessing the potential of ecological infrastructure to reduce current water risks in the uMngeni Catchment:

- Maturation of the Catchment Management Agency and enforcement of the ecological reserve as a critical piece of ecological infrastructure.
- National Treasury recognition that ecological infrastructure represents a legitimate component of service delivery infrastructure and that investing on this infrastructure is necessary to address service delivery backlogs, ensure higher economic multipliers on the national infrastructure spend and create socio-ecological compacts.
- The ability to use portions of the various infrastructure grants to invest in ecological infrastructure to secure water services and support the functioning of engineered water infrastructure.
- The application of existing water pricing instruments, most obviously the Capital Unit Charge (CUC) and Water Resource Management (WRM) levy and the proposed FIBC, to raise money for ecological infrastructure as envisaged in various water pricing reviews (Department of Water Affairs, 2012).
- The raising of a water bond aimed at financing a 10 year programme of intervention that realizes more water, reduces water treatment costs, delays the need for inter-basin transfers and complements the functioning of engineered water infrastructure. The raised capital would necessarily have to be spent on a portfolio of sanitation infrastructure (including off-grid toilets and bio-digesters), new water treatment technologies that enable the recycling of effluent water ("toilet to tap") and ecological infrastructure.

Crucial to any financial, technical or ecological solution to water risks in the uMngeni Catchment is the socio-institutional infrastructure to enable sensible and sustained programmes of action. While the idea of ecological infrastructure is compelling, actually spending money raised accountably, and in a manner that generates a legitimate "return" in water services and reduces water risks, may be very difficult. The contributions of municipalities' own river care efforts and of organisations such as DUCT need to be acknowledged and where possible scaled if ecological infrastructure is to provide more than a partial solution to the existing crisis. The ability of these organisations to create the type of work that unemployed people can access should make them particularly attractive in the South African context. The multiple contributions that are required, however, demand a proactive and well-capacitated CMA supported by institutions such as UEIP that are able to adopt a catchment-wide perspective and marshal the allocation of ecological infrastructure investment while ensuring that it makes a systemic contribution. As a first step, the pending Catchment Management Strategy needs to move beyond the conventional recourse to engineered solutions with all their fiscal and technical limitations, and endorse a specific role of ecological infrastructure in the management of the catchment.

The options for financing ecological infrastructure that are identified in this report, deliberately avoided normative appeals for capital allocations that are beyond the mandate or remit of the catchment's stakeholders. On the contrary, the focus is on rational incentives for investing that require only small innovations to existing practices. Where these innovations are forthcoming and the capital raised is responsibly allocated to create ecologically functional catchments, the evidence from South Africa and abroad is that it will be shown to generate not only a profitable and cost-effective investment, but also the type of investment that will catalyse virtuous cycles of fiscal

efficiency, more water, less money and electricity spent on treating water, employment and new assets capable of serving communities and the tourism industry.

Three decades after the Brundtland Commission launched it call for sustainable economic development, and nearly two decades after the launching of South Africa's National Water Act, the time is right to demonstrate the centrality and value of ecological infrastructure in providing water, and for global flows of finance to align itself to this value.

5 KEY CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

Water security in Great uMngeni Catchment, as with many others, is threatened by failing built-infrastructure, increasing demand, increasing impacts from changing land-use and degrading ecological-infrastructure. This study examined the role of the private sector in the catchment, aiming to answer:

How can private finance and market mechanisms most strategically deliver collective action for the enhancement of ecological infrastructure within the uMngeni catchment?

South Africa's water policy recognises the importance of functional water catchments in the provision of water. However, public and private investment for catchment stewardship has not been broadly established. The inevitable result has been catchment degradation that has amplified the impacts of drought, floods and water contamination.

In the uMngeni Catchment a combination of water stresses has created the need for action in order to sustain agricultural activity and meet rising demand from the growing population of cities such as Durban and Pietermaritzburg. Investing in ecological infrastructure – natural ecosystems that deliver water services – represents a critical and cost-effective means of reducing risk and ensuring water security. However, given the highly engineered state of the catchment, dove-tailed investment into the built environment is also necessary.

5.2 Approach

This project was carried out in conjunction with a sister SANBI project which the state of ecological infrastructure in quaternary catchments, where should protection and rehabilitation of ecological infrastructure be focussed and how could public-sector spending be coordinated better in order to achieve water security (Jewitt et al, 2015). The two projects were conducted in collaboration and shared biennial steering committees with the UEIP, which represents more than 30 key private, public and research institutions in the Greater uMngeni with an interest in collaborating to protect and enhance ecological infrastructure.

Three separate disciplinary studies were conducted as part of this research drawing on economic, IWRM, modelling, computing and water management expertise. The projects were conducted in a participatory manner via workshops, meetings and interviews with key stakeholders, including banks, farmers, insurers, and water institutions. Financial and economic data were generally not available to the project due to its confidential and proprietary status. However, significant insights into the economic interface with the private and public sectors were obtained, and these informed our characterisation of the uMngeni and discussion of possible collective governance and finance innovations.

At the start of the study, the idea of systemic risk (to private finance invested in the catchment and to insurers) was expected to provide adequate motivation for collective action in the finance sector to drive behaviour change in impacting sectors such as agriculture. However, interviews with farmers and representative of financial institutions indicated that institutional interventions that did not result in a direct return on investment or quantifiable reductions in individual risk exposure were not 'bankable' within the current institutional frameworks. More specific measures were needed.
The project team have therefore recommended a suite of measures which could bring about system-wide shifts in norms and practice in the private sector to enhance the protection and restoration of ecological infrastructure. These measures in turn are dependent on concurrent changes and strengthening in the public sector, in particular, the establishment of a functional CMA, the revision of water pricing and capacity building within the environmental sector to enable implementation. These most critical public –sector changes are currently underway.

5.3 Tools to Enable Collective Action from the Private Sector.

Research into the drivers of collective action, pre-requisites and available tools showed an integrated information and management modelling system (IIMMS) should enable the following to actively support collective action and engagement of the private sector:

- symmetry of knowledge amongst market role players,
- transparency of information between market role players,
- ease of connectivity between sub-systems and market role players,
- enabling market role players to gain insights into the value proposition of any initiatives,
- lowering of transaction-costs for market role players of exchanging communications and information.

The UEIP platform and partnership itself is an essential institutional 'tool' to effectively enable key stakeholders to act together in ecological infrastructure. The role of the UEIP appears to be emerging as an important convening, learning and sharing platform. Signatories cannot move beyond their mandates in their actions linked to the UEIP strategy, but this does not diminish the value of the UEIP to inform and enable key individuals within the member institutions to act in a more coordinated manner.

> *"UEIP Strategy" means the strategy compiled and adopted from time to time by the Parties to implement the integration of the restoration and management of ecological infrastructure into the relevant strategies for the delivery of water and sanitation services from the Greater uMngeni River Catchment;.." UEIP MoU 2014*

Understanding water risk is a key motivator for the private sector to act to address water issues. The project contributed towards the first down-scaling of the WWF's international Water Risk Filter to a national spatial model for South Africa. This will be launched in collaboration with Sanlam in March 2015.

The formally defined process of water stewardship is a key mechanism to support private sector engagement from producers to retailers in the supply chain. The recent development of the Alliance for Water Stewardship standard is a tool to support measurable progress towards better water practices, including on-site and collective action to protect and restore ecological infrastructure. The project contributed towards the development of the first on-line support tool for the AWS standard that includes links to relevant water information for private sector users.

Design criteria for a broader IIMMS were evaluated with catchment stakeholders and two elements have been developed on open-access platforms for use by all stakeholders. These include the MathubaWIKI site and the uMngeni Stakeholder Engagement google site. Expert models were identified that can be incorporated to support aspects of catchment IIMMS. Broader inclusive monitoring is made possible by citizen science techniques, such as those that have been successfully piloted in the Duzi-uMngeni Conservation Trust (DUCT).

In summary, the study contributed towards the development of the following on-line, open access tools in support of private sector engagement with ecological infrastructure:

https://sites.google.com/site/ueipstakeholderengagement/home
https://sites.google.com/site/mathubawiki2014/home
http://waterriskfilter.panda.org/
https://aws.wwfsa.org.za/aws/home/

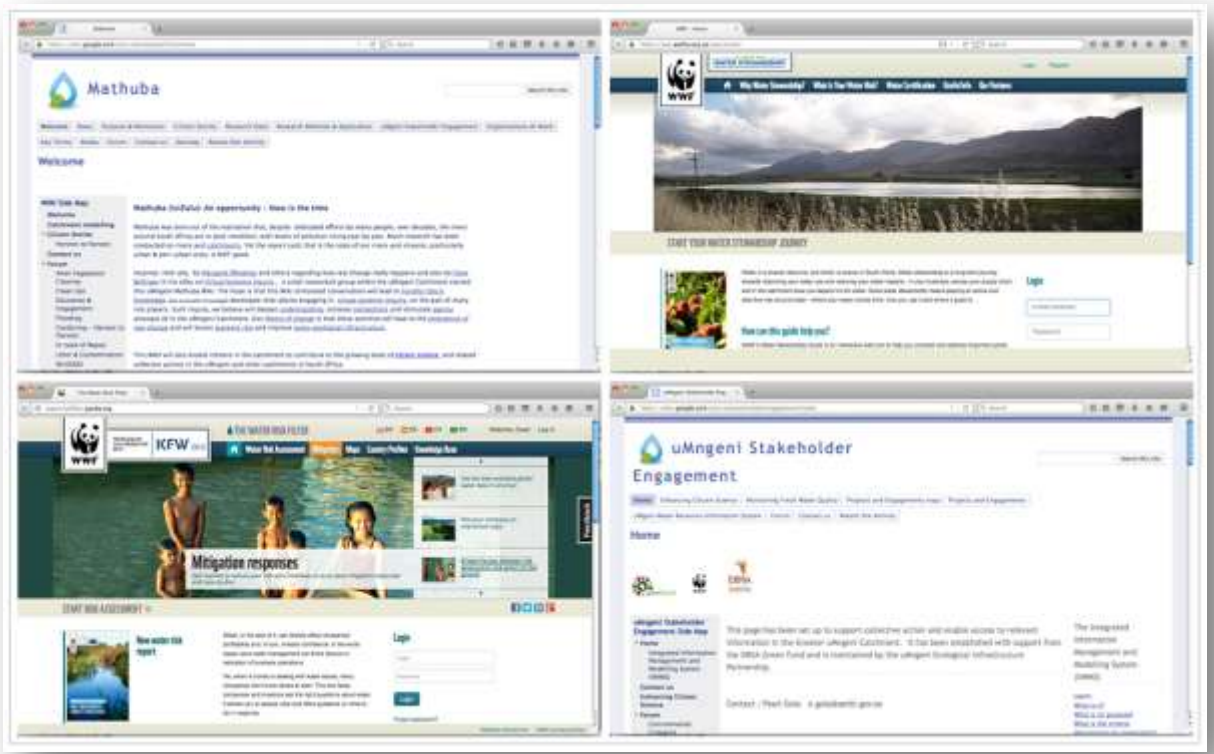


Figure 5.1: Four of the on-line tools contributed to by this project to improve private sector action.

5.4 Private Finance Sector Levers

Short-term finance and insurance has unrealised influence in supporting behaviour and land-use change and in encouraging new water-efficient technologies. Innovative finance incentives are proposed for ecological infrastructure that have worked on other issues (such as energy). These include new loan preconditions, and preferential loan rates and insurance rates for:

- water saving technologies (such as more efficient irrigation technologies or monitoring technologies);
- businesses that are formally engaged in applying better production practices with the Alliance for Water Stewardship Standard;
- households that are using optimal water-energy efficient practices and technologies in new human settlements (water tanks, composting toilets, low-flush toilets, etc).

In addition, land valuation and credit worthiness could take more specific cognisance of catchment care and restoration on agricultural land and the level of infestation of aliens, aligned to NEMBA. Again, this can be measured by compliance against the AWS standard and quatified as a liability in clearing costs for land-owners.

Listed corporates in the catchment are generally not engaged in water disclosure or signatories to the CEO Water Mandate (with the exception of Mondi Plc). These mechanisms exist and fund trustees and shareholders can be better informed on how to hold listed companies to account in terms of their corporate water responsibilities.

Increasingly retailers are more aware of better production standards. Some who are procuring from the catchment, such as Woolworths, are driving change in their requirements for better water management and efficiency. Other standards, such as FSC, need to be better aligned with the AWS standard to driver improved production in the upper catchment which houses much of the critical ecological infrastructure for water security.

5.5 Private Sector Direct Investment into Ecological Infrastructure.

South Africa's water policy precludes some of the private sector water initiatives that are celebrated elsewhere in the world, but the need for partnerships between private land owners and public entities remains. Institutional investors are willing to purchase a water bond issued by any municipality or water utility that has the requisite balance sheet and revenue stream. Institutional investors that own or underwrite vulnerable assets in the catchment are particularly enthusiastic about the potential to reduce their exposure to drought, floods and water contamination. Similarly, banks see opportunity for developing new financial products to oversee the installation of technologies such as biodigesters and grey water systems that would reduce contamination and ensure more efficient use of the available water.

Without fiscal support, the 2 per cent to 10 per cent increase in water yield that can be realistically expected from ecological infrastructure interventions, is unlikely to generate enough revenue (roughly R45 million per annum) to service privately financed ecological infrastructure at commercial

rates. Equally, however, public resources directed at ecological infrastructure will have to be complemented by private finance if the full need in the uMngeni Catchment is to be redressed.

A blended public-private investment into both engineered and ecological infrastructure via a parastatal is recommended in section 4. Such a water bond could be issued by either eThekwini Municipality or Umgeni Water (or in time by the regional CMA) in order to support an investment in ecological infrastructure. Using the regulated water price is encouraged by policy and could change behaviour and land use and raise capital in support of ecological infrastructure.

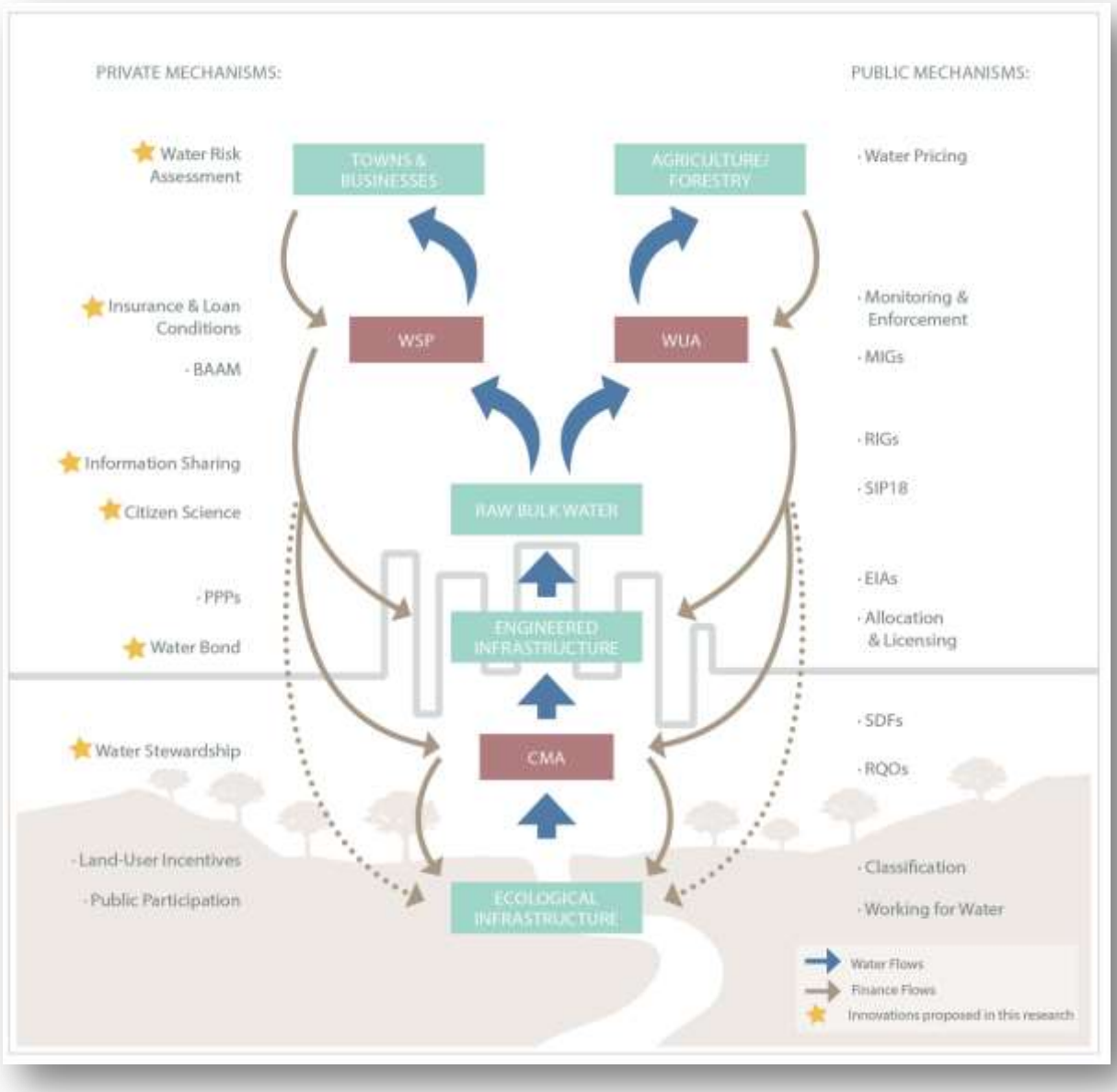


Figure 5.2: Summary of private and public mechanisms that influence the flow of resources from ecological infrastructure to end-users in the catchment.

Public sector finance can be raised through existing pricing instruments such as the Capital Unit Charge and the Future Infrastructure Build Charge, or by allocating national and local government infrastructure budgets to the reconstruction of ecological assets. In both instances this finance would be enhanced by National Treasury recognition that ecological infrastructure is an important component of South Africa's service delivery infrastructure, and that spending fiscal resources on ecological infrastructure is not only necessary, but can be fiscally efficient and produce important co-benefits. As a minimum new, engineered water infrastructure needs to be complemented by adjacent and upstream investment in ecological infrastructure to prevent siltation, floods and contamination from undermining the performance of engineered infrastructure.

The challenge for public and private finance will be to ensure that raised money is spent effectively so as to ensure a suite of complementary "returns". The study identifies four ways through which ecological infrastructure can generate a return: by providing more water, by reducing the required expenditure on water treatment, by delaying or deferring mega-infrastructure projects such as inter-basin transfers, and by rendering existing water infrastructure more efficient.

Generating this return will require both ecological infrastructure and new water and sanitation technologies, including new water treatment capacity, biodigesters and composting toilets (that are able to treat and return sewerage water to the catchment), and heightened on-the-ground monitoring.

5.6 Summary of Key Findings

1. **How can different market mechanisms be co-ordinated to leverage collective action at the catchment level?** Market mechanisms for engagement from the private sector into protecting and enhancing ecological infrastructure include the adoption of the AWS production standard, implementation of loan and insurance incentives. Coordination can be centred in dedicated forums, such as the UEIP, sector representation groups, such as FSC and SAIA, and supply chain focal points, such as retailers. Coordination is most effectively achieved through these groupings.

2. **What is the role of private finance in bringing greater cohesion to these efforts?** The study identifies means by which blended public and private sector finance might be drawn into effective ecological infrastructure programmes. A principal mechanism to mobilise private funding would be the issuance of water bond by either Umgeni Water or Ethekwini Metro. Lending terms and conditions to farmers and water users in the catchment (and nationwide) could be more directly aligned to the requirements of both the NWA, in terms of compliance with the Class and resource directed measures for the sub-catchment, and NEMBA, in terms of implementing alien clearing on privately owned land. Figure 5.2 summarised the innovations initiated and proposed as part of this research study in the private sector: water risk assessments at the scale of individual businesses and towns; new pre-conditions for loans and insurance that link to ecological infrastructure and better production practices; open access information sharing and citizen science application; water bonds, and water stewardship at the catchment level.

3. **What sort of governance systems are best suited to drive this collective action?** The UEIP is an important convening, learning and coordination platform for public and private stakeholders. The private sector do not typically engage in Catchment Forums, which tend to be more community –based, and dedicated platforms such as the UEIP appear to be a favourable environment for business. Tools such as the Water Risk filter, the UEIP stakeholder google site and MathubaWIKI enable easy information sharing among interested parties and encourage transparency. Learning platforms are critical in the complex environment of catchment collective action, particularly where they encourage action-research and quick testing of collective prototypes.

5.7 Recommendations to Enable and Build Private Sector Engagement.

5.7.1 Policy Level

Policy level recommendations emanating from this project include:

- Recognition of ecological infrastructure as credible infrastructure for public and private investment in Treasury, CoGTA, and DWS.
- The initiation of the proposed SIP19 in order to better coordinate public ecological infrastructural planning and budgeting.
- Recognition of water stewardship in DWS policy and inclusion in Catchment Management Strategies and a mechanism to actively engage the private sector in catchment management.

Recognising the role of ecological infrastructure in South Africa's broader infrastructure programme would enable the funding of ecological infrastructure with infrastructure grants, and would decrease the cost of providing water services. As a minimum, the returns on engineered water infrastructure should be enhanced by investing in the adjacent natural environment. The up-front cost savings, reduced maintenance expenditure, employment potential and higher economic multipliers make ecological infrastructure a critical component of South Africa's R4 trillion infrastructure investment envisaged in the National Development Plan.

5.7.2 Catchment Scale

The primary parties responsible for initiating the UEIP namely Ethekwini Municipality, SANBI, UW and KZN DWA; together with the UMDM, MLM, DUCT and WWF-SA; will continue to take responsibility for ensuring that the parties continue to meet and that the UEIP succeeds in finding and implementing ecological infrastructure solutions to the water and sanitation challenges of the region (UEIP, 2013).

There is an urgent need for a precedent-setting project that demonstrates the cost saving potential, and other benefits, of ecological infrastructure in the provision of water services. It is recommended that the UEIP support a coalition of willing 'risk takers' and leaders in this area to pursue the issuance of water bond to market. This will include either UW or Ethekwini Metro, DWS, the CMA, WWF-SA, SANBI, CoGTA, Treasury and a private investment fund.

Crucial to any financial, technical or ecological solution to water risks in the uMngeni Catchment is the socio-institutional capacity to enable sensible and sustained programmes of action across the entire catchment.

Overseeing effective investment in ecological infrastructure requires new understanding of assets, risk and value and will require new partnerships between financiers, water utilities, local communities and trusted intermediaries. Broader application of the water risk filter in the catchment and in key sectors, with specific recommendations for mitigation actions, will be facilitated.

6 APPENDIX A: WATER AND SANITATION STATISTIC FOR THE UMNGENI CATCHMENT

Table .A1: Sources of water per municipality in the uMngeni Catchment (Statistics South Africa, 2011).

MUNICIPALITY	HOUSEHOLDS	REGIONAL /LOCAL WATER SCHEME (%)	BOREHOLE (%)	SPRING (%)	RAIN WATER TANK (%)	DAM/POOL / STAGNANT WATER (%)	RIVER/ STREAM (%)	WATER VENDOR (%)	WATER TANKER (%)	OTHER (%)
Msunduzi	163993	89.7	1.2	0.9	0.7	1.1	0.6	1.1	2.4	2.4
Impendle	8203	29.6	12.6	14.6	3.1	4.6	13.4	4	13.5	4.6
uMngeni	30490	68.7	12.6	2	1	5	3.7	0.5	5.2	1.5
uMshwathi	28124	45.2	10.1	4.6	2.1	8	16.9	2.6	7.2	3.2
Ingwe	23073	19.6	13.7	29.2	2.1	6.4	17.4	0.9	8.4	2.3
eThekwini	956713	90.5	1.5	0.3	0.3	0.5	0.5	1.5	2.1	2.8
Mkhambathini	14964	38.8	14.7	5.3	0.9	7.5	17.7	2.4	10.6	2.1
Mpofana	10452	54.4	14.6	1.6	0.7	7.5	9.9	0.7	9.2	1.4
KwaSani	3673	43.7	10.1	18	1.3	8.4	9.3	0.6	6.9	1.7
Richmond	16440	55.1	8.6	5.2	1.2	6.2	10.5	0.7	8.6	4
Ndwedwe	29200	42.5	8.4	9.4	2.2	4.1	27.8	0.9	2.1	2.7
TOTAL	**1285325**	**84.5**	**2.8**	**1.5**	**0.5**	**1.3**	**2.5**	**1.4**	**2.8**	**2.7**

Table A2: Toilet facilities per municipality in the uMngeni catchment (Statistics South Africa, 2011).

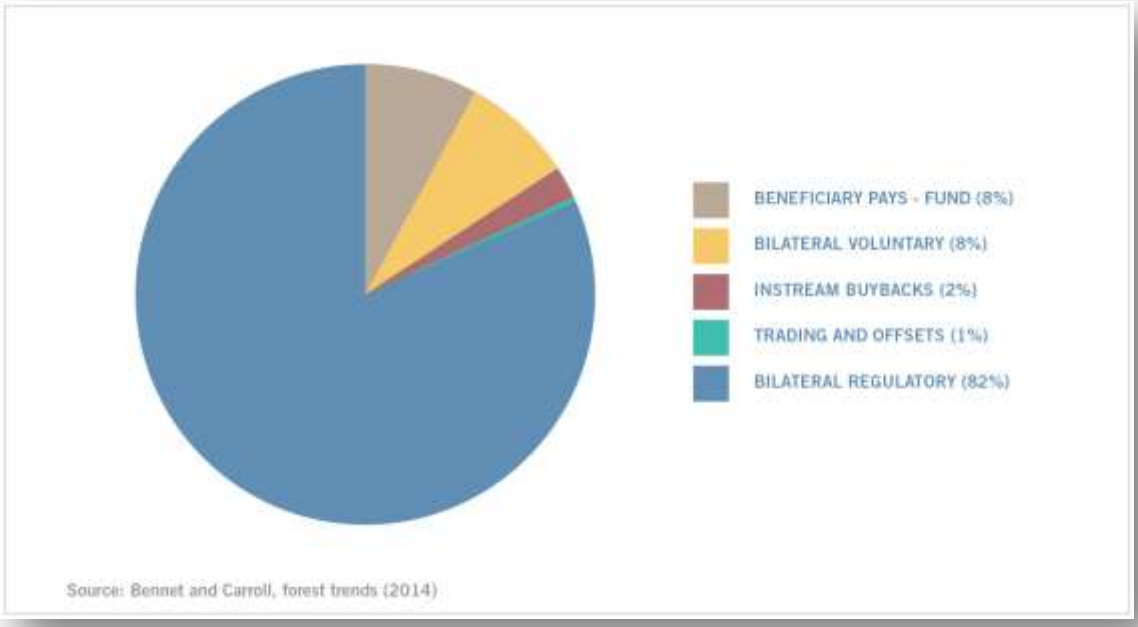
MUNICIPALITY	HOUSEHOLDS PER MUNICIPALITY	NONE (%)	FLUSH TOILET - CONNECTED TO SEWERAGE SYSTEM (%)	FLUSH TOILET - WITH SEPTIC TANK (%)	CHEMICAL TOILET (%)	PIT TOILET WITH VENTILATION (%)	PIT TOILET WITHOUT VENTILATION (%)	BUCKET TOILET (%)	OTHER (%)
Msunduzi	163993	2.0	51.6	5.2	3.3	17.3	16.8	1.0	2.7
Impendle	8203	1.6	4.8	3.3	6.3	27.8	45.5	1.2	9.5
uMngeni	30490	1.6	54.8	19.6	0.7	3.0	16.7	0.9	2.6
uMshwathi	28124	6.3	13.5	7.7	12.6	38.6	17.3	0.6	3.4
Ingwe	23073	3.2	7.4	3.2	5.3	31.0	37.7	0.4	11.9
eThekwini	956713	2.1	63.4	4.9	7.4	5.2	11.3	2.7	3.0
Mkhambathini	14964	7.4	8.9	9.0	2.7	43.2	24.8	0.6	3.5
Mpofana	10452	10.1	53.1	6.2	1.5	8.4	16.1	0.6	4.0
KwaSani	3673	1.6	26.4	26.0	1.7	17.6	15.8	8.5	2.4
Richmond	16440	3.0	12.6	7.7	18.4	30.9	22.4	0.5	4.4
Ndwedwe	29200	6.8	4.7	3.2	29.6	20.2	28.0	1.3	6.2
Total	**1285325**	**2.4**	**56.4**	**5.4**	**7.3**	**9.2**	**13.7**	**2.3**	**3.3**

7 APPENDIX B: INTERNATIONAL EXAMPLES OF WATER CATCHMENT INVESTMENT

Private sector investment

The 2014 Forest Trends survey by Bennett and Carroll reveals that investment by private water users remains a small portion of the total. Companies in the food and beverage sector contributed $8.8m to watershed protection initiatives in 2013. Interestingly, 88 per cent of buyers in the industry acted voluntarily (compared to an average of 31 per cent of overall private sector investment). Private (and public-private) water utilities' engagement grew to $8.9m in 2013 but this is still relatively small compared to the risk to which the companies are exposed. Private sector energy companies spent $9.3m, mainly spurred by regulatory requirements and the need to ensure water flows to hydro-electric plants. The agriculture, forestry and fisheries sector reported low participation, of only US$35,000 in 2013, although this figure almost certainly ignores the actions of private land-owners.

Bennett and Carroll (2014) observe that the under-investment by water utilities and agriculture and energy, "Suggests that nexus risks and dependencies (i.e., vulnerabilities related to shared resource dependencies between our water, energy, and food systems) are not being fully managed" (Bennett and Carroll, 2014, p.v). This may be true, but the inability to manage these risks effectively almost certainly reflects structural difficulties that private companies experience (with their shareholder mandates and private focus) in investing in watersheds.



Bilateral agreements: By far the greatest portion of private sector investment is in the form of bilateral agreements between a (typically downstream) water user compensating one or more parties for activities that deliver hydrological benefits. The motivation for these bilateral agreements

varies, but is typically driven by the realisation that investing in the natural environment offers a cost-effective response to degradation, pollution, or flooding.

For example, Wessex Water (a water company in South West England) successfully invested in catchment management in order to improve raw water quality (reducing levels of nitrates, phosphates and sediment). In 2005, the company realised that declining underground water quality that had been thought to be a generic problem was actually emanating from a few agricultural point sources (De Vial, 2011). As a result Wessex Water was exceeding drinking water pesticide limits set by the European Union and Defra. Conventional treatment plants were considered too expensive and too energy (and carbon) intensive. Instead Wessex Water engaged landowners with a programme of data collection devising agricultural management plans. Where a farm needed specific assistance, (e.g. to "prime" a change in practice) Wessex Water offered both finance and advice.

In Kumamoto City, Japan, citizen concerns about declining ground water quantities were amplified by a proposed semiconductor manufacturing facility belonging to Sony. Following facilitation from a local NGO, Sony agreed to offset groundwater withdrawals by paying agricultural producers to flood fallow rice fields. Farmers were compensated for their management costs at an initial rate of 11,000 Yen (roughly $110) per hectare. It also agreed to buy rice from the farmers involved in the scheme. By 2010, 52 farmers had joined the scheme, accounting for 320,000m^2 of rice fields. By 2007, Sony had achieved groundwater recharge of some 7 million tonnes (NSDTA, 2011).

Perhaps the most documented private sector investment in a catchment stewardship was that made by the bottled-water company Vittel, now owned by Nestlé. The Vittel bottling plant confronted a water quality crisis following a shift in farming practices that saw local farmers switch from a hay-based to a maize-based cattle ranching system. Rising nitrates in the water (above 4.5mg per litre) posed a risk to the classification of Vittel's water as natural mineral water (no treatment is allowed). The owners of Vittel examined their options and decided to work with upstream farmers. In 1992, Nestle formed Agrivair, responsible for negotiating and implementing the programme. Six hundred acres of sensitive habitat was purchased (at above market prices) and long-term conservation contracts were signed with local farmers to ensure more sustainable dairy farming techniques and to improve farm facilities. The result has been a reduction in non-point source ground water pollution. An independent study concluded that "...The Vittel experience is most likely to be replicable in places where land cannot be purchased and set aside for conservation, and where the risk to business is high while the link between ecosystem health and farming practices is well understood and expected benefits are sufficiently high to justify the investment" (IIED, 2006, [p.5).

Instream buy-backs: Instream buyback programs involve governments or NGOs that act in the public interest by buying or leasing water use rights that are not used but instead set aside to ensure a minimum level of flows and protect wildlife and habitats. They can be effective in catchments where water is considered a private good, such as in the United States and Australia. The Murray Darling River "Restoring the Balance" programme is the most often-cited example.

Garrick et al (2009) identify three enabling conditions, which are required:

- Establishment of rights to, and limits on freshwater extraction;

- Recognition of the environment as a legitimate water use;
- Authority to transfer existing water rights for an environmental purpose.

Water quality trading: Trading and offset mechanisms allow water users that are struggling to comply with their regulatory obligations to manage their impacts on watersheds by compensating others for off-site activities that improve water quality, availability, or other water-related values. Compensatory activities may be packaged as a credit or some other unit traded in an established "market," defined by watershed boundaries. While controversial amongst conservationists, the mechanism has been active in the United States for 40 years is attributed with more cost-effective compliance with water quality standards. The release of the Environmental Protection Agency, in the United State's, policy and guidance on water quality trades has given some legitimacy to this instrument (EPA, 2015).

In order to be successful, a water quality trade requires a nutrient cap – this may be set nationally (as in the United States' Clean Water Act, 1972) or locally (Lake Taupo, NZ, the Waikato Regional Council set nitrogen discharge caps). Experience to date suggest that this works best when:

- Catchments are large are more suited to trading – smaller watersheds are more suited to bilateral trades or treatment at source.
- A clear quality standard is in place and is enforced.
- Large differences in pollution control costs are evident due to different technologies or different sectors.
- Trusted third party entities oversee trade.
- Legitimate options, such as ecological infrastructure remediation, exists for off-setting pollution.

Increasing private sector investment in catchments is being led, internationally, by the insurance industry. UNEP-FI has been one of the global proponents of investing in ecological infrastructure as a, "better way" of ensuring disaster risk reduction (UNEP-FI, p. 11). This is a strategic initiative for the United Nations body that operates at the interface between the environment and the global insurance industry, given that it is this industry whose business model is threatened by environmental degradation. In 2013, global economic losses due to natural disasters amounted to USD 131 billion, which represents almost 2% of GDP. Of these losses, USD 37 billion were insured (down from a 10- year average of approximately USD 55 billion.) The insurance industry plays a critical role in providing financial protection and security to at- risk communities to support, and preserve the gains of, social and economic development (UNEP-FI, 2015).

Public investment

In keeping with the "public good" understanding of water catchments, publicly funded schemes comprise the greatest proportion of investment. The entity responsible for public schemes can be municipalities, national governments or dedicated catchment agencies. As Bennett and Carroll's Forest Trends' report notes, "In some ways these are the least radical programs – basically variations on the old theme of using tax revenue to pay for conservation" (p. vii).

The most common problem with publicly funded water management schemes in developing countries is the short-fall in revenue collection. This sees public entities focussing on cost recovery for the infrastructure that stores, purifies and distributes water while ignoring the catchments that underpin water supplies.

Lipper and Neves (2011) identify three problems with the predominance of public funding for catchment management:

- Inability to attract complementary private sector funding
- Weak connection between the money raised and the addressing of problems on the ground for people paying
- The sustainability of public funds over time.

EU-Watershed protection: The most commonly referenced, tax-funded subsidy programme promoting the protection of watersheds is found in the European Union, under the Common Agricultural Policy (CAP) and the Water Framework Directive (WFD). The European Union spends some EUR58.1bn on its Common Agricultural Policy, under which "protecting water quality is a key issue".

The provision of the CAP subsidies is contingent upon land users maintaining riparian buffers and reducing sewage sludge (among other things). Non-compliance can lead to reduced payments. The European Agricultural Fund for Rural Development provides financial incentives for farmers voluntarily going beyond the requirements of legislation to promote biodiversity conservation on their land (for example, wetland restoration, reduced pesticide use, the 'naturalisation' of drains and ditches or more extensive grazing regimes) (MARS, 2014).

National schemes for watershed protection are frequently bundled with other conservation goals/schemes, but are generally funded from central government revenue, and have annual budgets allocated to the schemes. Porras *et al* (2008) studies various national watershed management schemes in developing countries and found that eight cases were funded through reallocation of general budget and five cases additionally received donor funding, including loans from the World Bank.

China's Sloping Lands Conversion Programme is one of a number of programmes instituted by the State Council of China following devastating floods in 1998; the SLCP is a national government programme, founded in 1999, through which farmers must set aside erosion-prone farmland within critical areas of the watershed of the two largest rivers in China: the Yangtze and Yellow river (sometimes called Huanghe River) (since then it has been scaled up and now reportedly covers much of the country. Compensation is given in cash and in-kind ("fairly generous" at US$300/hectare).

Total investment is US$4.3 million per year. The programme was piloted in 1999 and has been fully implemented since 2002. In 2005, it was reported that silt run-off from lands reforested under the Sloping Land Conversion Programme is 22–24% less than from comparable farming lands in the same area (Changjin and Chen 2005). (Porras *et al*, 2008).

Other government funded watershed programmes involve tax incentives. In the United States farmers can deduct the costs of soil/water conservation from taxable income). Some schemes offer tax credits for riparian buffers. The State of Virginia, for example, applies a riparian buffer tax credit scheme, for buffers of at least 35 feet wide (but no more than 300 feet) which are intact for 15 years; in Canada, the region of Manitoba offers a property tax credit to encourage farmers to upgrade their management of lakes and shores and encourage those who have done so, for a five year commitment to protect a strip of agricultural land along a waterway. In most cases, however, the benefits of taxes for the environment are small relative to the size of the problem being addressed (Smith et al, 2006).

Urban municipalities concerned about their water security account for some of the most-notable watershed stewardship programmes, providing important lessons for a city such as Durban. Between 1974-1992, Munich Waterworks noticed a slow but significant increase in nitrates and pesticides in drinking water, which originated from springs about 40km from the city. Although below the regulatory requirements, the City decided to undertake a targeted ecosystem approach to improving water quality. Since 1991 it has worked with upstream farmers to encourage a switch to organic agriculture to protect its water supplies. The city makes per-hectare payments to compensate for foregone income, and also encourages enrolment in organic farming associations by covering the costs of agricultural inputs and technical support. Munich has also purchased land in critical parts of the catchment and established a protection zone in pumping areas. The majority of farmers in the catchments participate, with an estimated 3,800 hectares enrolled. Payments to farmers amount to roughly over one million dollars a year (or €830,000) and $22 million to date (Bennett and Carroll, 2012). Together with payments from the CAP, those farmers that converted could earn EUR10,000/ha/year. A flexible framework allowed farmers that could not convert to full organic but adopted practice changes that supported improved water quality could gain EUR200/ha/year. The results were “inspiring”– 80% of the agricultural area is now organic, and the quality of water has been improved, at an estimated cost of EUR0.0005/m^3 rather than the cost of filtration, estimated to be EUR.23/m^3 (Grolleau, McCann, 2012). Magnussen et al, (2015) contend that the cost-effectiveness of the programme lay in the use of organic farmers’ unions’ expertise and experience to convince farmers to convert to organic; savings are made on enforcement costs as monitoring/verification are done by third parties; eligibility for European subsidies as well as local ones; time limits as studies show that after 7-8 years organic farming is more profitable, therefore the risk of farmers dropping out was low.

New York City’s drinking water is unfiltered. The federal Safe Drinking Water Act, allows water to be unfiltered if a water system provides safe water, and New York has long taken advantage of the clean water provided by the Catskills-Deleware catchment to provide unfiltered water. In the 1980s and 1990s the quality and quantity of this water came under pressure. A filtration plant for the Catskills-Delaware watershed was estimated to cost $4-6bn, so instead the city decided to implement a catchment management plan in 1997. The plan involved co-operation between state and federal officials, environmental organizations, and some 70 watershed towns and villages. Under the strategy the City was required to invest approximately $1.5bn over 10 years to restore and protect the watershed. The programme consists of a land acquisition and stewardship, partnership programmes where landowners in the Catskills supply catchment are paid to implement measures which reduce diffuse pollution, 275 miles of protected stream buffers and 307 site-specific

forest management plans created on private lands, wastewater managements (working with entities outside the city to improve sewerage and storm water management measures. Financing comes from additional taxes on residents' water bills and from bonds issued by the City (Postel and Thompson, 2005). A UNEP study found the success of the initiative could be attributed to stakeholder involvement in a participatory process guided by local leadership; early buy-in from farmers and other stakeholders who traditionally mistrust regulators and ensuring economic development policies are connected to sustainable management polices (UNEP, undated).

Public-Private

Some of the most innovative catchment management finance schemes reflect water's status as both a public and private good and involve a combination of public and private finance. Water funds, for example, typically pool multiple investors' contributions in a basin (government, NGOs acting in the public interest and water users) to financially incentivise coordinated interventions across a landscape.

A collective action fund was first envisaged by the late Juan Black for Quito, Ecuador and following his death, a fund has been run in Quito, Ecuador since 2000 to ensure a clean, regular supply of water to the city's 2 million inhabitants. Fund money is spent on rehabilitating protected areas. The fund has been used as a model for other similar funds.

The number of active water funds, globally, has grown in recent years. The Nature Conservancy has been a key proponent and now runs 32 such funds. Water funds work best when different water users share a common interest in resolving a specific problem. Water funds that have invested in ecological infrastructure have been effective in avoiding water treatment costs and claim to have enabled sustained investment in catchments. They, "Complement efforts carried out by different governments to protect natural resources in order to guarantee sustainable development through coordinated action by the state, the community, non-governmental organizations and private companies" (TNC, 2012, p. 16).

First African Water Fund. This fund was established to project the Tana River, which drives half of Kenya's hydropower electricity and provides 95 per cent of Nairobi's water. Since the 1970s agricultural development on the riverbanks, and the conversion of wetlands to agricultural uses has resulted in rainfall washing sediment into rivers, affecting the water supply, hydropower and agricultural productivity. The Nature Conservancy (TNC) and partners* including the International Centre for Tropical Agriculture (CIAT), launched the fund in March 2015. The fund is a public-private scheme uniting big business, utilities, conservation groups, government, researchers and farmers. Downstream water users (e.g. Coca Cola, East African breweries) will pay upstream "guardians" to implement measures to protect the watershed, including tree planting along river banks, terracing on very steep slopes, soil conservation schemes and drip irrigation within the catchment areas. The measures are expected to significantly curb soil erosion and cut soil sediment concentrations in half, depending on the location in the catchment and time of year (CIAT, 2015). TNC suggests that a US$10m investment is likely to return US$21.5m in economic benefits over a 30-year lifetime. A steering committee includes representatives from the Conservancy, Kenya's primary power utility (KenGen), Nairobi City Water and Sewerage Company, Tana and Athi Rivers Development Authority,

International Center for Tropical Agriculture (CIAT), Kenya's Water Resources Management Agency and United Nations agencies in Nairobi, as well as the water technology company Pentair, East African Breweries, Coca-Cola and Firgoken Horticulture. A clear business case has thus far been published for the establishment of the fund (CIAT, 2015; TNC, 2015).

In Bogota, TNC partnered with the local water utility and with the bottling plant of SAB Miller's Bavaria Brewery. The brewery concluded that it was more cost effective to get the water quality they needed by paying into a fund, which would pool resources from other water users and make conservation investments upstream. Not having to construct a filtration system saved money, which could be used for other investments (Deutz, 2012). The fund was launched in May 2009, and in October a two-year cooperation agreement was signed in which EAAB (water supply and sewerage company), SAB and TNC kick started the fund with an initial $650,000 (Aguilar-Barajas et al, 2015).

References

Aguilar-Barajas, I, Mahlknecht, J, Kaledi, J, Kjellén, M, Mejía-Betancourt, M, 2015, Water and Cities in Latin America: Challenges for Sustainable Development (Earthscan Studies in Water Resource Management), Routledge, London.

Bennett, G and Carroll, N. (2014) Charting New Waters, State of Watershed Payments, Trends, December 2013,

Boyd, Olivia, China's split personality on water conservation, China Dialogue, 29 January 2013, https://www.chinadialogue.net/article/show/single/en/5647-China-s-split-personality-on-water-conservation

Deutz, A, (2012) Investing in water funds, The Guardian Online, 13 March 2012, http://www.theguardian.com/sustainable-business/trust-funds-water-conservation-increased-supply, accessed June 2015.

Duhon, M, Young, J, and Kerr, S, Nitrogen Trading in Lake Taupo: An Analysis and Evaluation of an Innovative Water Management Strategy, Motu Economic and Public Policy Research, http://ageconsearch.umn.edu/bitstream/115353/2/Duhon%20Paper.pdf

Electric Power Research Institute, The Ohio River Basin Water Quality Trading Project, http://wqt.epri.com/pdf/EPRI_WQTinfographic.pdf

European Union, Agriculture and Water, 20 April 2014, http://ec.europa.eu/agriculture/envir/water/index_en.htm

Garrick, D., Siebentritt M.A., Aylward, B., Bauer C.J., Purkey, A. (2009), Water markets and freshwater ecosystem services: Policy reform and implementation in the Columbia and Murray-Darling Basins,. Ecological Economics, 69 (2009), 366-379, http://cjbauer.faculty.arizona.edu/sites/cjbauer.faculty.arizona.edu/files/Garrick%20et%20al%20Ecol%20Econ%2009.pdf

Goldman, R.L., Benitez, S., Calvache, A., and Ramos, A. 2010. Water funds: Protecting watersheds for nature and people. The Nature Conservancy, Arlington, Virginia. http://www.naturalcapitalproject.org/pubs/TNC_Water_Funds_Report.pdf

Greenhalgh, S and Selman, M, Comparing Water Quality Trading Programs: What Lessons Are There To Learn?, *The Journal of Regional Analysis & Policy,* 42(2): 104-125, 2012, http://www.jrap-journal.org/pastvolumes/2010/v42/v42_n2_a2_greenhalgh_selman.pdf

Hall, M, New Zealand Water Quality Trading Markets, *Lessons from Lake Taupo,* PowerPoint presentation, 2014, http://www.conference.ifas.ufl.edu/aces/presentations/Dec%2011%20Thursday/2%20Session%206C/Hall%20Madline.pdf

IIED, Watershed Markets, Uganda, http://www.watershedmarkets.org/casestudies/Uganda_beer_for_wetlands.html

Le Maitre, D; Gush, M and Dzikiti, S. (2015) Impacts of invading alien species on water flows at stand and catchment scales. AOB Plants, vol. 7. Available at: http://aobpla.oxfordjournals.org/content/7/plv043.full

Lipper, L and Neves, B (2011) Payments for environmental services, What role for sustainable agricultural development, ESA Working Paper No 11-20, December 2011, FAO, http://www.fao.org/3/a-an456e.pdf

Magnussen, K, Hasler, B, Zandersen M (2015) Ecosystem Services: In Nordic Freshwater Management, Nordic Council of Ministers, January 2015.

Maia, J.; Giordano, T.; Kelder, N.; Bardien, G.; Bodibe, M.; Du Plooy, P.; Jafta, X.; Jarvis, D.; Kruger-Cloete, E.; Kuhn, G.; Lepelle, R.; Makaulule. L.; Mosoma, K.; Neoh, S.; Netshitomboni, N.; Ngozo, T.; Swanepoel, J. (2011): Green jobs: an estimate of the direct employment potential of a greening south african economy. Industrial development corporation, Development Bank of Southern Africa, Trade and Industrial Policy Strategies.

MARS (2014) A space for water in the Common Agricultural Policy, 4 June 2014, http://freshwaterblog.net/2014/06/04/a-space-for-water-in-the-common-agricultural-policy/

Maylon, S, (2015) Africa's first Water Fund to tackle rising threats to food security, water and energy supplies -, CIAT Press Relese, 19 March 2015, http://www.ciatnews.cgiar.org/2015/03/19/africas-first-water-fund-to-tackle-rising-threats-to-food-security-water-and-energy-supplies/#sthash.CAIaK9fF.dpuf

Monbiot, G, Putting a price on the rivers and rain diminishes us all, The Guardian, 6 August 2012, http://www.theguardian.com/commentisfree/2012/aug/06/price-rivers-rain-greatest-privatisation

NSTDA, Thai Professionals Present Case Studies of "Environmental Detoxification in Japan", 3 March 2010,

http://www.nstda.or.th/eng/index.php/about/executives/itemlist/tag/NSTDA?start=50, accessed June 2015.

OECD, World Water Council, Water: Fit to Finance? Report Of The High Level Panel On Financing Infrastructure for a Water-Secure World, April 2015, http://www.worldwatercouncil.org/fileadmin/world_water_council/documents/mailing/mail_wwf7_documents/WWC_OECD_Water-fit-to-finance_Report.pdf

Porras et al. 2008. All that glitters: A review of payments for watershed services in developing countires. Natural Resource Issues No. 11. International Institute for Environment and Development. London, UK.

Postel, S, and Thompson, BH, Watershed protection: Capturing the benefits of nature's water supply services, Natural Resources Forum 29 (2005) 98–108, http://www.conservation.ca.gov/dlrp/watershedportal/Documents/Watershed%20ProtectnNat%20Res%20Forum05.pdf

Segilman, D (2015) Innovative Mechanisms To Protect Watersheds, Presentation to American Waterworks' Association Water in Action Conference, 30 April 2015, http://www.pnws-awwa.org/uploads/PDFs/conferences/2015/Technical%20Sessions/Thursday/Innovative%20Mechanisms%20to%20Protect%20Watersheds_Three%20Case%20Studies.pdf

Shortle, J. (2012) Water Quality Trading in Agriculture, OECD, 2012, http://www.oecd.org/tad/sustainable-agriculture/49849817.pdf

Smith, M., de Groot, D., Perrot-Maître, D. and Bergkamp, G. (2006) Pay – Establishing payments for watershed services. Gland, Switzerland: IUCN. Reprint, Gland, Switzerland: IUCN, 2008, https://portals.iucn.org/library/efiles/documents/2006-054.pdf

Stanton, T, Echavarria, M, Hamilton, K, and Ott, C, State of Watershed Payments, An Emerging Market Place, Forest Trends, June 2010, http://www.forest-trends.org/documents/files/doc_2438.pdf

Sun, C. (2013) Watershed Services In China, China Water Risk, 8 March 2013, See more at: http://chinawaterrisk.org/opinions/watershed-services-in-china/#sthash.miiKUEZv.dpuf

The Nature Conservancy (2012) WATER FUNDS, Conserving green infrastructure A guide for design, creation and operation, 2012, http://www.nature.org/media/freshwater/latin-america-water-funds.pdf

The Nature Conservancy (2015) Nairobi Water Fund: Investing in Water (2015) http://www.nature.org/ourinitiatives/regions/africa/explore/nairobi-water-fund.xml

The Nature Conservancy, Latin America, $27 million to protect water sources for 50 million people, http://www.nature.org/ourinitiatives/regions/latinamerica/latin-american-water-funds-partnership.xml

UNEP, NEW YORK CITY'S WATERSHED MANAGEMENT PROGRAM, UNEP.

United States Farm Services Agency, Conservation Reserve Program Website, http://www.apfo.usda.gov/FSA/webapp?area=home&subject=copr&topic=crp, accessed July 2015.

Vant, B, Palmer J. (2013) Managing nitrogen in the Lake Taupo catchment, Waiology, Nov 2013, http://sciblogs.co.nz/waiology/2013/11/13/managing-nitrogen-in-the-lake-taupo-catchment/

Wessex Water, Catchment management managing water – managing land, https://www.wessexwater.co.uk/uploadedFiles/Corporate_Site/Catchment%20management.pdf

8 REFERENCES

3GF and the 2030 WRG (2015) Perspectives on Green Growth Partnerships:- Strategic Water Partners Network South Africa. 2030 Water Resources Group, WEF.

Achorn, E., (2004) Integrating agent-based models with quantitative and qualitative research methods. Presented at the Association for Active Educational Researchers International Education Research Conference, Melbourne, Australia. http://www.aare.edu.au/04pap/ach04769.pd (accessed 4 January 2013)

African Infrastructure Risk and Resilience (AIRR) (2014) Summary of Proceedings from 27 October, 2014. Hosted by Santam, UNEP-FI and NBS-SA.

AgriSa (2015) Action needed to address drought conditions in SA. Statement issued by AgriSA, October 2015. Available at: http://www.agrisa.co.za/urgent-action-needed-to-address-drought-conditions-in-sa/

AWS Standard (2014) Alliance for Water Stewardship International Standard . URL http://www.allianceforwaterstewardship.org/aws-standard-system.html#aws-standard

Beck, U. (1994) The reinvention of politics: towards a theory of reflexive modernization. In: Beck, U, Giddens, A and Lash, S. (eds) Reflexive modernization: Politics, tradition and aesthetics in the modern social order. Polity Press, Cambridge.

Bennett, G and Carroll, N. (2014) Charting New Waters, State of Watershed Payments, Trends, December 2013,

Blackmore, C. (2010) Social Learning Systems and Communities of Practice. 1st Ed . Springer. ISBN 978-1-84996-132-5

Bots, P. W. G., R. Bijlsma, Y. Von Korff, N. Van der Fluit, and H. Wolters. (2011). Supporting the constructive use of existing hydrological models in participatory settings: a set of "rules of the game." *Ecology and Society* 16(2): 16.

Bristow, K.L. (2013). Research Leader, Co-operative Research Centre for Irrigation Future, CSIRO Australia

Burch, D. and Lawrence, G., 2013. Financialization in agri-food supply chains: private equity and the transformation of the retail sector. *Agriculture and Human Values,* 30(2), pp. 247-258.

Carney, M. (2015) Breaking the tragedy of the horizon - climate change and financial stability. Speech given at Lloyds of London, 29 September, 2015.

CasCastella, J.-C., Trung, T. N., and Boissau, S. 2005. Participatory simulation of land-use changes in the northern mountains of Vietnam: the combined use of an agent-based model, a role-playing game, and a geographic information system. *Ecology and Society*, 10 (1) 27.

CEO Water Mandate (2012) Guide to water-related collective action. The Pacific Institute. www.pacinst.org/reports/water_related_collective_action

CISL & UNEP-FI, 2014. *Stability and Sustainability in Banking Reform: Are Environmental Risks Missing in Basel 111? CISL Working Paper,* s.l.: Cambridge Institute for Sustainability Leadership.

Collier, P. (2013) *Plundered Planet*. Penguin Press. London, pp. 271.

Colvin, J.D. 2013. Personal communication. Director, Learning to Live with Climate Change (LLCC) Programme , The Open University, UK.

Cook, J., Cylke, O., Larson, D. & Nash, J., 2010. *Vulnerable Places, Vulnerable People: Trade Liberalisation, Rural Poverty and the Environment.* s.l.:Edward Elgar Press.

Costanza, R; d'Arge, R; de Groot, R, Farberk, S; Grasso, M; Hannon, B; Limburg, K Naeem, S; O'Neill, R; Paruelo, J; Raskin, R; Suttonkk, P & van den Belt, M (1997) The Value of the World's Ecosystem Services and Natural Capital. Nature 387, p. 253-260.

CSIR (2010) The Working for Water Programme is Working, CSIR Study Finds. Available at: http://www.csir.co.za/enews/2010_mar/15.html

Cullis JDS; Görgens AHM; Marais C (2007) A strategic study of the impact of invasive alien plants in the high rainfall catchments and riparian zones of South Africa on total surface water yield. Water SA 33, p.35–42.

Davis M. (2010) Who Will Build the Ark? *New Left Review*, 61, pp. 29-46.

Defining the principle of who and what really counts. *Academy of Management Review*, 22(4): 853-886

Dent, M.C. (2012) Case study of South Africa's movement towards participatory agent-based social simulation modeling for sharing the benefits of water. Presented at International Symposium on Managing benefit sharing in changing Social Ecological systems. University of Namibia, Windhoek, Namibia

Dent, M.C. (2012) Catchment management agencies as crucibles in which to develop responsible leaders in South Africa Water SA Vol. 38 No. 2 April. http://dx.doi.org/10.4314/wsa.v38i2.18 Available on website http://www.wrc.org.za

Dent, M.C., Hurry, L.B. and Reinhardt, T. (2013) Mathuba Schools and Citizens River Health Program:- towards a learning architecture for sustainability. The Sustainable Water Resource Handbook – Volume 4. Chapter 10; pg 133-139, Alive2Green, Cape Town.

Department of Agriculture and Forestry, 2013. *A Profile of the South African Sugar Market Value Chain,* s.l.: Available at www.nda.agric.za.

Department of Water Affairs (2013). Revised Water Pricing Strategy for Raw Water III Draft for Comment [Online] Available at: https://www.dwa.gov.za/Projects/PERR/documents%5CRevised%20Pricing%20Strategy%2027-09-2013.pdf

Department of Water Affairs and Forestry (1998a). Water Law Implementation Process. A Strategic Plan for the Department of Water Affairs and Forestry to Facilitate the Implementation of Catchment Management in South Africa. ISBN 0-620-22733-8

Department of Water Affairs and Forestry (1998b). National Water Act No 36 of 1998. [Online] Available at: https://www.dwa.gov.za/Documents/Legislature/nw_act/NWA.pdf

Department of Water Affairs and Forestry (2007). Establishment of a Pricing Strategy for Water Use Charges [Online] Available at: https://www.dwa.gov.za/IO/Docs/Water%20Resource%20Finance/Pricing%20Strategy.pdf

Department of Water Affairs and Forestry (2012). Establishment of a Pricing Strategy for Water Use Charges. Pretoria.

Department of Water Affairs and Forestry, 2008. *Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas.* [Online] Available at: https://www.dwaf.gov.za/Documents/Other/EnvironRecreation/wetlands/DRAFT_3_Wetland%20and%20Riparian%20Delineation%20Guidelines%202008.pdf [Accessed 22 April 2015].

Department of Water Affairs and Forestry, 2008. *Water Reconciliation Strategy for the KwaZulu-Natal Coastal Metropolitan Areas: Water Quality Review Report, DWAF Report No. PWMA 11/000/00/2609,* Pretoria: Department of Water Affairs and Forestry.

Department of Water Affairs, 2014. *Proposed uMkhomazi Water Project Phase One,* s.l.: s.n.

DPLG (2004). The Municipal Infrastructure Grant 2004-2007: from programme to projects to sustainable services. [Online]. Available at: www.cogta.gov.za

DUCT, 2015. *Dusi Umgeni Conservation Trust Available.* [Online] Available at: www.duct.org.za [Accessed 4 May 2015].

Duzi Umgeni Conservation Trust (2015). DUCT Audited Annual Financial Statement 2015. [Online] Available at: http://www.duct.org.za/files/DUCT_2015_AFS.pdf

Duzi Umgeni Conservation Trust (2015). Proposed Partnership to Address Sewerage Leakages and the Pollution of the Msunduzi River. Presentation to the Infrastructure Services Portfolio Committee, 3 February 2015.

DWAF, (2004) Internal strategic perspective:- Mvoti to Mzimkulu water management area. DWAF Report No : P WMA 11/000/00/0304 pg 7

Engineering News, 2014. *Absa, FDA offering rebate on energy efficiency, renewable energy loans.* [Online] Available at: http://www.engineeringnews.co.za/article/absa-fda-offering-rebate-on-energy-efficiency-renewable-energy-loans-2014-09-16 [Accessed 12 April 2015].

Environmental Affairs, Department of Government Notice R. 598 National Environmental Management: *Biodiversity Act (10/2004): Alien and Invasive Species Regulations*, 2014

Epstein, G. & Jayadev, A., 2005. The Rise of Rentier Incomes in OECD Countries: Financialization, Central Bank Policy and Labor Solidarity. In: G. Epstein, ed. *Financialization and the World Economy.* Northampton, MA: Edward Elgar.

eThekwini Municipality (2013). Adjustment Budget 2012 / 2013. [Online] Available at: http://www.durban.gov.za/Resource_Centre/reports/Budget/Documents/ETHEKWINI%20MUNICIPALITY%20ADJUSTMENTS%20%20BUDGET%20-%202012.13.pdf

eThekwini Municipality (2014) Built Environment Performance Plan (ETK BEPP)

eThekwini Municipality website (2015) uMngeni Ecological Infrastructure Programme. Source: [Online] Available at: http://www.durban.gov.za/City_Services/development_planning_management/environmental_planning_climate_protection/Projects/Pages/Investment-in-Ecosystem-Services.aspx

Ezemvelo KZN Wildlife (2008). uMngeni Vlei Nature Reserve - Integrated Management Plan. [Online] Available at: http://www.ramsar.org/sites/default/files/documents/pdf/wurc/SouthAfrica_Management-Plan_uMgeni-Vlei-Nature-Reserve.pdf.

Financial and Fiscal Commission, 2013. *Exploring alternative finance and policy options for effective and sustainable delivery of houses in South Africa,* Midrand: s.n.

Folke, C., Hahn, T. Olsson, P. and Norberg, J. 2005. Adaptive governance of social–ecological systems. *Annu Rev Environ Resourc* 30: 441–73.

Forestry South Africa, 2012. *Forestry Facts Pamphlet.* [Online] Available at: http://www.forestry.co.za/uploads/File/Industry%20News/2014/Sep%202014%20-%20Forestry%20Facts%20Pamphlet%202012.pdf [Accessed 23 February 2015].

Forestry South Africa, 2013. *Far more than fire cover.* [Online] Available at: http://www.forestry.co.za/far-more-than-fire-cover/ [Accessed 12 April 2015].

Forsyth GG; Le Maitre DC; O'Farrell PJ; van Wilgen BW (2012) The prioritisation of invasive alien plant control projects using a multi-criteria decision model informed by stakeholder input and spatial data. Journal of Environmental Management 103, p.51–57.

Frame, B. and Brown, J., 2008. Developing post-normal technologies for sustainability. Ecological Economics 65(2008) 225 – 241

Funtowicz, S. O. and Ravetz, J. R., 1993. Science for the Post-Normal Age. Futures 25: 735–755.

Gardner, D., 2003. *Getting South Africans under shelter: An overview of the South African housing sector,* Johannesburg: Housing Finance Resource Programme.

Giamporcaro, S (2014) The African Investing for Impact Barometer 2014, Bertha Centre, University of Cape Town.

Gillham, S and Haynes, M. (2000) Demand Management, a Possible Alternative to Augmentation. Umgeni Water unpublished paper.

Goodman, L., 1961. Snowball sampling. *Annals of Mathematical Statistics ,* 32(1), p. 148–170.

Görgens AHM; van Wilgen BW (2004) Invasive alien plants and water resources in South Africa: current understanding, predictive ability and research challenges. South African Journal of Science 100, p.27–33.

Green Fund Annual Report (2014). 2013/2014 Green Fund Annual Report. [Online] Available at: http://www.sagreenfund.org.za/wordpress/wp-content/uploads/2014/12/GF-Annual-Report-2013-2014-Website.pdf.

GroCane, n.d. *www.grocane.co.za.* [Online] Available at: http://www.grocane.co.za/profile.htm [Accessed 6 April 2015].

Guyot, P., and Honiden, S., 2006. Agent based participatory simulations: Merging multi-agent systems and role-playing games. *Journal of Artificial Societies and Social Simulation*, 9 (4) 8. http://jasss.soc.surrey.ac.uk/9/4/8.html (accessed 15 December 2013

Hardin, G (1968) "The *Tragedy of the Commons*." Science 162, pp. 1243–1248

Harford, T., 2012. *Adapt. Why all success starts with failure.* London: Abacus.

Harrington , C, 2015. Strengthening Collaborative Water Governance in the uMngeni River Catchment, KwaZulu-Natal, South Africa. In Press WWF Report

Haxeltine, A., Whitmarsh, L., Bergman, N., Rotmans, J., Schilperoord, M., and Kohler, J., 2008. A Conceptual Framework for transition modelling. International Journal of Innovation and Sustainable Development, 3 (1/2), 93-114.

Hay, Breen & Nkhata, 2014. *Securing the Water Resources of the uMngeni River Basin: Setting the Scene, Second Draft, 10 January 2014,* s.l.: Accessed from Duncan Hay.

Hepworth N D, Warren N, Farrow, T. and Sage, R. 2015. Market based instruments for Water Resource Management: a review of evidence on water trades, payments, credits and offsets and implications for stewardship. Common Futures/WWI/WWF International

Holley C, Gunningham N, Shearing C (2012) The New Environmental Governance. London. Earthscan.

Hoskings and Du Preez (2006) cited in Vawda, M; King, N, Muller, M (2011). Pricing of Water for Cost Recovery, Economic Efficiency and Social Equity, in B. Schreiner and R. Hassan (2011) Transforming Water Management in South Africa. Springer.

Ingonyama Trust Board, n.d. *Ingonyama Trust Board.* [Online] Available at: http://www.ingonyamatrust.org.za/?page_id=6 [Accessed 16 February 2015].

Isakson, S., 2013. *Financialisation and the transformation of Agro-food Supply Chains: a political economy.* s.l., s.n.

Ison, R. L., Steyaert, P., Roggero,P. ,Hubert,B. and Jiggins,J. editors. 2004. Social learning for the integrated management and sustainable use of water at catchment scale. Final report. SLIM project. http://slim.open.ac.uk/objects/Outcomes/SLIM%20Final%20Report.pdf (accessed 15 January 2011)

Ison, R., 2013. Personal Communication. Professor, Systems for Sustainability Monash Sustainability Institute, Monash University and Professor of Systems Open Systems Research Group (OSRG), Communication and Systems Department Faculty of Maths, Computing and Technology, The Open University, UK

Jacobs, M. (1991) The Green Economy: environment, sustainable development and the politics of the future. Pluto Press, London.

Janet Edmonds Consulting, 2015. *Draft Report: Scoping Assessment of Freshwater Resource Impacts, Sustainability Mechanisms and Stewardship Opportunities in the Major Agricultural Sectors in the Upper Umgeni and Upper Umvoti Catchments, KwaZulu-Natal ,* s.l.: s.n.

Jewitt, G., Hughes, C., de Winnaar, G., Mander, M., Zunckel, K., Dini, J., Pringle, C., Bredin, I., &

Kasavel, K. (2013). Umgeni Ecological Infrastructure Partnership launched, Urban Earth news article. [Online] Available at: http://urbanearth.co.za/articles/umgeni-ecological-infrastructure-partnership-launched.

Kastenhofer, K., 2011. Risk Assessment of Emerging Technologies and Post-Normal Science. Science, Technology and Human Values, 36(3) 307-333

Kramer, R (2007) Leading change through action learning. *The Public Manager,* 36 (3):38-44

Krippner, G., 2011. *Capitalizing on Crisis: The Political Origins of the Rise of Finance.* Cambridge: Harvard University Press.

Lin, J., Ganesh, A. & Singh, M., 2012. *Microbial Pathogens in the Umgeni River, South Africa: WRC Report No KV 303/12,* Pretoria: Water Research Commission.

Lipper, L and Neves, B, Payments for environmental services, What role for sustainable agricultural development, ESA Working Paper No 11-20, December 2011, FAO, http://www.fao.org/3/a-an456e.pdf

Lotze-Campen, H., 2008. The role of modelling tools in Integrated Sustainability Assessment (ISA). *International Journal of Innovation and Sustainable Development*, 3 (1/2), 70-92.

Macal, C.M. and North, M.J., 2009. Agent-based modeling and simulation. Proceedings of the 2009 Winter Simulation Conference I.E.E.E. M. D. Rossetti, R. R. Hill, B. Johansson, A. Dunkin and R. G. Ingalls, eds. p 86-98. ISBN 978-1-4244-5771-7/09

Mander, M., Van Niekerk, M. & Hughes, C., 2014. *Investigating Climate Change Effects under Altered Land Uses on Water Yield and Downstream Ecosystem Services,* Pretoria: WRC Report No K5/2156, Water Research Commission.

Mangcu, X. (2003) Johannesburg in flight from itself. Political culture shapes urban discourse. In R. Tomlinson; R Beauregard; L, Bremner and X Mangcu (eds). Emerging Johannesburg. Perspectives on the Postapartheid City. Routledge (Oxford), 305 pages.

Mann, R., 2015. *Housing Consultant* [Interview] (17 April 2015).

Mashatile, P. (2015) Fears about government pension money plans need to be dispelled, Business Day, 23 August 2015.

Matthews, R., Gilbert, N., Roach, A., Polhill, G., and Gotts, N., 2007. Agent-based land-use models: a review of applications. *Landscape Ecology*, 22 (10), 1447–1459.

Max-Neef, M (2014) The good is the bad that we don't do. Economic crimes against humanity. A proposal. Ecological Economics, 104, pp. 1152-154.

Mc Cool, S., 2013. Personal Communication. University of Montana, USA

McCosh, J., 2015, 'Investing in ecological infrastructure to enhance water security in the uMngeni River catchment: Final Report, Green Economy Research Report No. 1, Green Fund, Development Bank of Southern Africa, Midrand.

McKenzie M & Cartwright A (2015). Enhancing ecological infrastructure in the Greater uMngeni River catchment through collective private sector action. [Online] Available at: http://www.sagreenfund.org.za/wordpress/wp-content/uploads/2015/07/uMngeni-Private-Sector-Finance-Draft-Report-V1.9.pdf

Mitchell RK, Agle BR, Wood DJ (1997) Toward a theory of stakeholder identification and salience:

Mitchell S., Hay D. and Breen C. (2014). An adaptable, multi-disciplinary water resource management framework for the uMngeni River Basin. Water Research Commission. WRC Report KV 324/13. [Online] Available at: http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/KV%20324-13.pdf.

Morgan, A & Orr, S 2015 Value of Water :- a framework for understanding water valuation, risk and stewardship. WWF Report with IFC

Msunduzi Municipality (2015). Annual Budget and Medium Term Revenue and Expenditure Framework (2012-2013 / 2014-2015). http://www.msunduzi.gov.za/site/search/downloadencode/nramaqWMqp2zp4Sx

Mulder I, Clements-Hunt P (2010) Demystifying materiality: Hardwiring biodiversity and ecosystem services into finance. UNEP Finance Initiative

Mutual & Federal, 2015. *http://www.mf.co.za/.* [Online] Available at: http://www.mf.co.za/products/farmers-insurance/agricrop/Pages/servicesbenefits.aspx [Accessed 27 April 2015].

Nel DC, Colvin C, Nel J, De Lange W, Mwenge Kahinda J-M, Engelbrecht F, Muhami B, Faccer K (2011b) SAB Ltd Hop Farms Water Risk Assessment. CSIR Report: CSIR/NRE/ECOS/2011/66/B

Nel DC, Shearing C, Reyers B (2011a) Insurers could help address climate change. *Nature*, 476: 33

Nevin, T. (2015) Our Dirty Dwindling Water Supply. Business Day 2 November, 2015. Business Day (2015)

Nonaka, I. (2004) A dynamic theory of organizational knowledge creation. Chapt 9 in Starkey, K., Tempest, S. and McKinlay, A. (2004). How Organizations Learn. Thomson learning. Pg 179

Nordhaus, W, (2013) *The Climate Casino: Risk, Uncertainty and Economics for a Warming World.* Yale University Press, London, pp. 378.

Nowotny, H., Scott, P. and Gibbons, M. (2001) Re-thinking Science Knowledge and the Public in an age of uncertainty. Polity Press.

Ostrom E (2000) Collective action and the evolution of social norms. *The Journal of Economic Perspectives,* 14(3): 137-158.

Ostrom, E. (1998) A Behavioral Approach to the Rational Choice Theory of Collective Action, Presidential Address, American Political Science Association, 1997. *American Political Science Review*, 92(1): 1–22.

Pahl-Wostl, C., 2007. The implications of complexity for integrated resources management. Environmental Modeling and Software. 22 : 561-569.

Parnell, S., 2015. Fostering transformative climate adaptation and mitigation in the African city: opportunities and constraints of urban planning. In: S. e. a. Paulet, ed. *Urban Vulnerability and Climate Change in Africa - A Multidisciplinary Approach.* s.l.:s.n.

participatory water management: recent advances in theory, practice, and evaluation. *Ecology and Society.*17(1): 30. http://dx.doi.org/10.5751/ES-04733-170130

Pegram G, Orr S, Williams C (2009) Investigating shared risk in water. WWF-UK

Petersen SP, Shearing C, Nel DC (2014) A practitioners guide to setting up collaborative initiatives. WWF South Africa

Porter ME, Kramer MR (2011) Creating shared value: How to reinvent capitalism and unleash a wave of innovation and growth. *Harvard Business Review*, Jan-Feb 2011, 63-77

Ramanath, A. M. and Gilbert, N., 2004. The Design of Participatory Agent-Based Social Simulations. *Journal of Artificial Societies and Social Simulation*, 7 (4) 1. http://jasss.soc.surrey.ac.uk/7/4/1.html (accessed 10 February 2014)

RCL Foods Limited, 2014. *RCL Foods Limited Integrated Annual Report for the year ended 30th June 2014,* s.l.: s.n.

Reddy, J. (2013) Proposed Budget and WRM Charges for 2014-2015. Department of Water Affairs. Powerpoint Presentation.

Reed, D. & De Wit, M., 2003. *Towards a Just South Africa: the Political Economy of natural Resource Wealth,* s.l.: WWF MPO.

Reed, M. S., Hubacek, K., Bonn, A., Burt, T. P., Holden, J., Stringer, L. C., Beharry-Borg, N., Buckmaster, S., Chapman, D., Chapman, P. J., Clay, G. D., Cornell, S. J., Dougill, A. J. Evely, A. C. Fraser, E. D. G. Jin, N.Irvine, B. J., Kirkby, M. J. Kunin, W. E. Prell, C., Quinn, C. H., Slee, B., Stagl, S., Termansen, M., Thorp, S. and Worrall. F., 2013. Anticipating and managing future trade-offs and complementarities between ecosystem services. *Ecology and Society* 18(1): 5. http://dx.doi.org/10.5751/ES-04924-180105

Review of Water Pricing Strategies (2012). Project to Revise the Pricing Strategy for Water Use Charges and Develop a Funding Model for Water Infrastructure Development and Use and a Model for the Establishment of an Economic Regulator.

Ritchey, T., 2013. Wicked Problems, Modelling Social Messes with Morphological Analysis. *Acta Morphologica Generalis AMG Vol.2 No.1 (2013)*

Rittel, H.W.J and Webber , M.W., 1973. Dilemmas in a general theory of planning. Policy Sciences 4, 155-169 . Elsevier, Amsterdam

River Health Programme (2002). State of the Rivers Report: Umgeni River and its neighbouring rivers and streams. [Online] Available at: http://www.csir.co.za/rhp/state_of_rivers/umngeni_02.pdf

Rock, M; Murphy, J; Rasiah, R, Van Seters, P; Managi, S. (2009) A hard slog, not a leap-frog: Globalization and sustainability transitions in South-East Asia. Technological Forecasting and Social Change, 76(2), p.241-254.

Safire, n.d. *http://www.safireinsurance.com/.* [Online] Available at: http://www.safireinsurance.com/about-safire/ [Accessed 6 April 2015].

Sagoff, M. (2012) The rise and fall of ecological economics, *Breakthrough Journal*, (January). Available at http://thebreakthrough.org/index, pp. 14.

SANBI (2014). A Framework for investing in ecological infrastructure in South Africa.

SAPPI, 2014. *Debt Update.* [Online] Available at: www.sappi.com/Investors/.../Debt%20Update%20December%202014.pdf [Accessed 13 March 2015].

SAPPI, 2014. *SAPPI Integrated Report 2014,* s.l.: SAPPI.

Scharmer C.O. (2009) Leadership development is not about filling a gap but about igniting a field of inspired connection and action; Ten propositions on transforming the current leadership development paradigm. Paper prepared for: *Round Table Meeting On Leadership For Development Impact.* The World Bank, The World Bank Institute, Washington, DC. September 27- 28, 2009, draft 1.1, (revised Oct. 5, 2009)

Scharmer C.O. (2009a). *Theory U:- Leading from the Future as it Emerges*. Berrett – Koehler, San Francisco. 462 pp.

Scharmer, C.O. and Kaufer, K. (2013) Leading from the Emerging Future:- From Ego-System to Eco-System Economies . Berrett – Koehler, San Francisco.

Schreiner, B, and Hassan, R. (2011) Transforming Water Management in South Africa. Springer.

Schreiner, B., Pegram, G. & von der Heyden, C. 2009. Reality check on water resources management: Are we doing the right things in the best possible way? Development Planning Division. Working Paper Series No.11, DBSA: Midrand.

Senge , P., Scharmer C.O., Jaworski, J. and Flowers, B. S. (2005) Presence :- exploring profound change in people, organizations and society. Nicholas Brealey, London.

South African Biodiversity Institute. (2015). Save the Midmar Dam Project. [Online] Available at: http://www.sanbi.org/sites/default/files/documents/documents/umgungundlovu-project.pdf

South African Government (2015). National Infrastructure Plan. [Online]. Available at: http://www.gov.za/issues/national-infrastructure-plan

South African Sugar Association, n.d. *Cane Growing in South Africa.* [Online] Available at: http://www.sasa.org.za/sugar_industry/CaneGrowinginSA.aspx [Accessed 12 March 2015].

Statistics South Africa (2012). Census 2011. [Online] Available at: http://beta2.statssa.gov.za/ .

Statistics South Africa, 2012. *Income and Expenditure of Households 2010/2011,* Pretoria: Statistics South Africa.

Statistics South Africa, n.d. *Census 2011.* [Online] Available at: http://beta2.statssa.gov.za/ [Accessed 13 02 2015].

Still, D, 2015. Chairman. Chairman. Duzi-uMngeni Conservation Trust. Person Comm. 3rd September 2015.

Stockholm Resilience Alliance (2015) Principles for Building Resilience :- Sustaining Ecosystem Services in Social-Ecological Systems . eds Biggs, R , Schlüter, M ,. Schoon , ML , Cambridge University Press , ISBN:9781107082656

Sustainable Cities (2015) Cities can save money by investing in natural infrastructure for water. Available at: http://www.sustainablecitiescollective.com/node?ref=navbar

Tabara, J. D., Wallman, P., Elmqvist, B., Ilhan, A., Madrid, C., Olson, L., 2007. Participatory modelling for the integrated sustainability assessment of water: the world cellular model framework. The Matisse project. Working paper 9. http://www.matisse-project.net (accessed 4 July 2009)

Thornton, J.A., Harding, W.R., Dent, M.C. Hart, R.C., Lin, H., Rast, C.L., Rast, W. , Ryding, S. and Slawski, T.M., 2013. Eutrophication as a 'wicked' problem. Lakes and Reservoirs: Research and Management. 18: 298-316. Wiley Publication

Trans-Caledon Tunnel Authority (2015). Trans-Caledon Tunnel Authority – About us. [Online] Available at: http://www.tcta.co.za/#!blank/b7gh5

Trans-Caledon Tunnel Authority , 2015. *Spring Grove Dam.* [Online] Available at: www.springgrovedam.co.za [Accessed 2 May 2015].

Turton, A,. 2013. Personal Communication., Environmental Advisor, South African Environmentalist of the Year 2010

Umgeni Water (2013). Annual Report 2012/2013. [Online] Available at: http://www.umgeni.co.za/pdf/ar_2013/UMGENI_AR_2012_2013.pdf

Umgeni Water (2014a). Infrastructure Master Plan 2014/2015. [Online] Available at: http://www.umgeni.co.za/projects/infra-structuremasterplans/docs/2014/imp2014vol1_17apr14_signed.pdf

Umgeni Water (2014b). Umgeni Water Reviewed Interim Financial Results as 31 December 2014 [Online] Available at: www.umgeni.co.za/pdf/2015/april/UMGENI_INTERIM_2014.pdf

Valkering, P., 2009. Toddling along the River Meuse:-Integrated Assessment and participatory Agent-Based Modelling to support River Management. PhD Thesis. International Centre for Integrated Assessment and Sustainable Development (ICIS), Maastricht University. ISBN: 978-90-5278-897-5

Van de Kerkhof, M., and Wieczorek, A., 2005. Learning and stakeholder participation in transition processes towards sustainability: Methodological considerations. *Technological Forecasting and Social Change*, 72 (6), 733-747.

Vatn, A. and Bromley, D. (1994) "Choices without prices without apologies" *Journal of Environmental Economics and Management*, 26(2): 129 – 148.

Von Korff, Y., K. A. Daniell, S. Moellenkamp, P. Bots, and R. M. Bijlsma. 2012. Implementing

Water Research Commission (2014). National Water Summit 2014. Principle 2 . Extract from The Water Wheel Sept-Oct 2014, WRC, Pretoria

Water Research Commission, 2014. *Preliminary Guideline for the Determination of Buffer Zones for Rivers, Wetlands and Estuaries. Available.* [Online] Available at: http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20610-1-14.pdf [Accessed 22 April 2015].

Watkins, K., 2015. *Climate change and energy: managing the risks and seizing the opportunity in Africa. Forthcoming NCE Paper..* s.l.:s.n.

Wildlands Conservation Trust (2013). Annual Financial Statements for the year ended 30 June 2013. [Online] Available at: http://www.wildlands.co.za/wp-content/uploads/2013/12/WCT-Financials-2013.pdf.

Wildlands Conservation Trust website (2015). Our Work, Where we do it. [Online]. Available at: http://www.wildlands.co.za/our-work/where-we-do-it/.

Woodhill, J. (2010) Sustainability, Social Learning and the Democratic Imperative: Lessons from the Australian Landcare Movement. Chapter 4. In Blackmore, C ed. (2010) Social Learning Systems and Communities of Practice. 1st Ed . Springer. ISBN 978-1-84996-132-5

World Bank (2015) Green Bond Fact Sheet. Available at: http://www.treasury.worldbank.org

World Commission on Environment and Development (WCED) (1987). Our Common Future. Rome.

World Economic Forum (2015) Global Risks Report 2015 .. URL www.weforum.org/reports/global-risks-report-2015 . Accessed 23 August