THE SHARED RIVER INITIATIVE PHASE I

Towards the sustainability of freshwater systems in South Africa:

An exploration of factors that enable or constrain meeting the Ecological Reserve within the context of Integrated Water Resources Management in the catchments of the lowveld

Sharon Pollard & Derick du Toit

WATER RESEARCH COMMISSION

TT 477/10

The Shared River Initiative Phase I

Towards the sustainability of freshwater systems in South Africa:

An exploration of factors that enable or constrain meeting the Ecological Reserve within the context of Integrated Water Resources Management in the catchments of the lowveld

Report to the
WATER RESEARCH COMMISSION

by

SHARON POLLARD AND DERICK DU TOIT

Compiled by Stacey Gouws
Association for Water and Rural Development (AWARD)

WRC Report No. TT 477/10

FEBRUARY 2011

Obtainable from:

Water Research Commission
Private Bag X03
Gezina
Pretoria, 0031

The publication of this report emanates from a project entitled *The Shared Rivers Initiative Phase 1: Contextual profiles of the shared rivers of the Kruger National Park* (WRC Project no. K5/1711).

ISBN 978-1-4312-0058-0
Printed in the Republic of South Africa

EXECUTIVE SUMMARY

Background and rationale

The Olifants River ceased flowing in 2005 prompting widespread concern and calls for an integrated focus on all of the easterly-flowing rivers of the lowveld of South Africa (the Luvuvhu, Letaba, Olifants, Sabie-Sand, Crocodile and Komati Rivers). Assertions were that despite the enabling legislative frameworks for water reform and environmental flows in 1998, the integrity of most of these rivers has not improved, or continues to degrade both in terms of quality and quantity. Given that all the rivers form part of transboundary, international systems, the implications were of wider significance than South Africa alone. In response, the Shared Rivers Initiative (SRI), an action-research programme funded through the Water Research Commission was initiated in 2007.

The work reported herein is one component of the SRI and concerns itself with exploring the progress towards meeting the commitment to sustainability of these lowveld rivers as set out in the National Water Act (RSA, 1998). It asks how well we are doing and why. Although the central focus is on healthy, flowing rivers, it is not just about that alone since without equity and stakeholder involvement the former can never be achieved.

South Africa is acclaimed for statutory water reforms and conceptual and methodological sophistication – particularly in the determination of environmental water requirements (EWRs), known in South Africa as the Ecological Reserve (or the Reserve). The Reserve offers a critical benchmark against which to track the progress in meeting the commitment to sustainability. Whilst the methods related to Reserve determination are now well-developed and many Reserves have been undertaken, attention has turned to implementation which is still in its early stages. Consequently, this component set out to:

a) examine the status of the Reserve (flows) in terms of progressive realisation (i.e. compliance) and,
b) explore – together with all major stakeholders – why this might be so.

By understanding the underlying factors that constrain or enable meeting the commitment to the Reserve, a meaningful and tenable supportive programme can be designed (both research and practice focused) for real change.

As noted in the findings below, operationalising the Reserve moves the discourse and practice into a much wider arena than solely that of water conservation and protection. **Achieving EWRs – and indeed the Reserve – does not reside within the environmental domain alone**. It is predicated on water reform and the introduction of Integrated Water Resources Management (or IWRM) as a new and transformative way of managing the nation's water resources. Hence it is the collective contribution and synergies of a number of strategies, plans and practices (as envisaged in the National Water Act and the National Water Resources Strategy) that make up IWRM. It is these factors that are explored in this research.

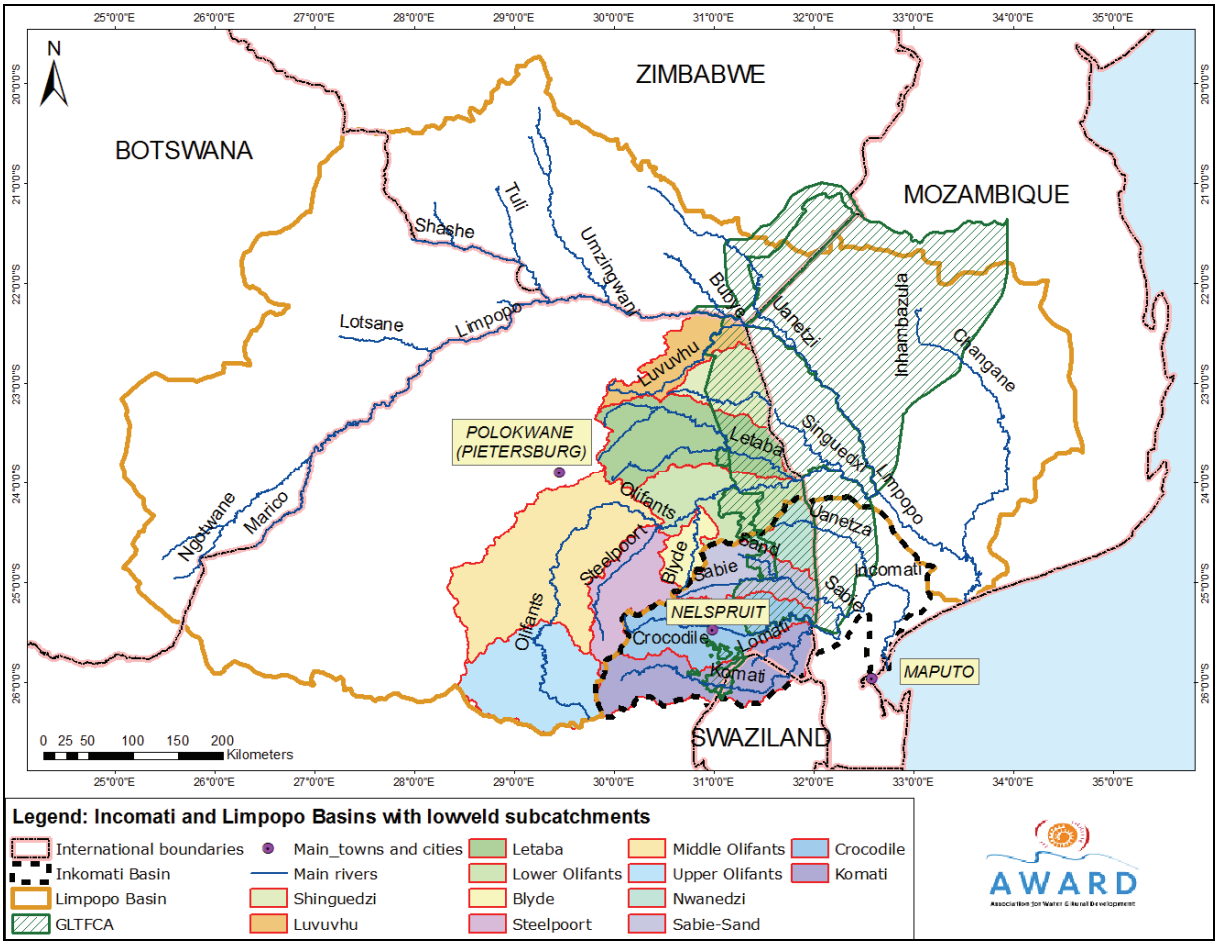

Figure 1: The study area comprises six major rivers of the South African lowveld: the Luvuvhu, Letaba, Olifants, Sabie-Sand, Crocodile and Komati Rivers (Figure 3.1). In South Africa these rivers and their catchments comprise three Water Management Areas (WMA): the Luvuvhu/ Letaba WMA in the north, the Olifants WMAs in the central region, and the Inkomati WMA, which comprises the Sabie-Sand, Crocodile and Komati Rivers in the south. All six rivers contribute to international watercourses, the Limpopo and Incomati basins

Aims and objectives

The central research question was: '*What factors enable or constrain achieving environmental flows in the lowveld rivers?*

Aim

The aim was to *provide a preliminary assessment of the status of sustainability of the water resources of the six lowveld river systems, and the factors that constrain or contribute to this, in order to provide a grounding from which the project is able to design and implement real change*.

Given this, the **objectives** were as follows:

1. To understand the current status of sustainability of the water resources
2. To provide a broad contextual profile and assessment of the factors that constrain and contribute to sustainability (i.e. compliance with policy)
3. To provide an entry-point for initiating collaboration and co-learning
4. To provide the basis for developing future phases.

The team was requested to take on two additional objectives, namely:

5. A literature review of key conceptual frameworks for the management of natural resources in complex systems.
6. An overview of the international obligations and institutional and organizational arrangements for the lowveld rivers.

Overall approach and methodology

The two aspects of the work had different methodological approaches (see Chapter 4). The first, technical in nature, involved understanding the status of the Reserve in terms of flows (i.e. compliance with the quantity component of the Ecological Reserve; see Pollard and Du Toit, in prep). The second, which aimed to understand *why* the status of compliance was as it was, involved a dialogical approach based on semi-structured interviews with a range of stakeholders. First key conceptual frameworks were examined (Chapter 2) to provide the methodological orientation and background to each study area was compiled (Chapter 3). Then an organisational analysis was undertaken per catchment (Chapter 5) which identified role-players involved – directly or indirectly – in water resources management or use. Interviewees fell into five broad categories: (i) regulators, (ii) water users; (iii) operations and maintenance; (iv) researchers and (v) interested and affected parties. The interview process was guided by the overarching framework for IWRM (the development of the Catchment Management Strategies) in South Africa (DWAF, 2007). Thus questions focused on water resources protection, authorisation, monitoring, enforcement, financing, stakeholder participation and co-operative governance.

The data were analysed according to themes identified from the first round of catchment interviews (Chapters 6, 7 and 8):

a. Understanding and embeddedness of concepts of sustainability and the Reserve in water management practices
b. Change and lags
c. Integration of WRM and water supply
d. Unlawful use
e. Skills, capacity and ability to monitor and enforce
f. Adaptive capacity and change
    i. Feedback loops and self organisation
    ii. Learning within changing contexts.

This was followed by an analysis of case studies which sought to elucidate what lay behind the successes or constraints (Chapter 9). Finally a number of thematic options for future work were scoped out by an advisory and synthesised as the basis for future work (Chapter 10).

Key findings

1. *Compliance with the Ecological Reserve*

None of the eight rivers examined met the Reserve requirements for flow i.e. non-compliance was evident throughout. With the exception of the Sabie River this situation has deteriorated since the National Water Act (NWA) was promulgated in 1998 (see Figure 10.1). In many cases including the Sabie, water quality appears to have also deteriorated but this requires verification. A number of factors underlie this and catchment-specific reasons are provided in Chapters 6-8. However whilst this might present a dismal picture of progressive realisation, this is likely to change in the Inkomati WMA, certainly in the Crocodile River, as new integrated WRM approaches come on line.

2. *Operationalising the Reserve based on an integrated, catchment-based approach (supporting IWRM)*

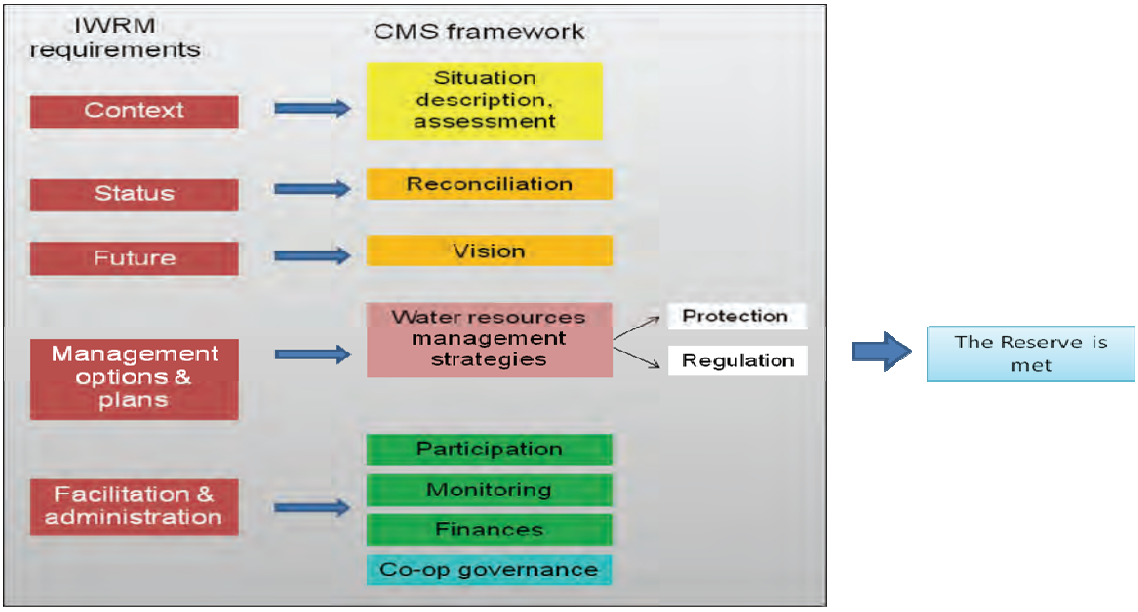

Figure 2: Schematic illustrating the relationship between IWRM requirements, the response in South Africa through the catchment management strategy and the outcome- in this case the Ecological Reserve. This indicates that it is combined and synergistic actions and plans that will collectively bring about change

Operationalising the Reserve moves the discourse and practice beyond water protection alone (i.e. Resource Directed Measures). It is dependent on water reform and the growth IWRM and hence it is the collective contribution and synergies of a number of strategies, plans and practices (as shown in Figure 2).

Central to this is the adoption of an integrated, catchment-based vision and approach, based on the principles of sustainability, equity and stakeholder participation (Pollard and Du Toit, 2008):

- Such integrated approaches are not evident in any of the catchments, with the exception of the Inkomati WMA where it is emerging through the development of the Inkomati Catchment Management Strategy. The focus is largely on the Crocodile catchment however.
- Aspects of IWRM are underway at more localized scales and these are discussed.
- With some exceptions, the almost total lack of integration between water supply and water resources management is widely evident, comprising a serious challenge to achieving sustainable IWRM.
- This is equally true of the mining sector in the Inkomati and Olifants WMA.
- Other issues such as inter-basin transfer out of highly stressed catchments (see plans for Olifants to Letaba) require examination (see Chapter 10).
- There are no consequences to not planning within the context of water resource constraints.

This situation is unlikely to change unless there are appropriate platforms and mechanisms for integrated planning together with buy-in, and hence directives, from leadership.

Case studies: Integrated approaches

The Sand River Catchment (see Box 8.1 and 9.2) illustrates the outcomes of a failure to adopt a systems view as the basis of governance and management. Despite policy commitments to change these intentions have failed to materialise in practice. Interpretations of the problem in isolation have led to poor mitigatory investments. This reflects the lack of leadership and governance (see below).

In contrast, a number of systems approaches are evident. Notable examples include the Groot Letaba below Tzaneen Dam (see Figure 6.5) and the Crocodile River where a near-real time *system for integrated planning and operations of river systems* is currently being tested (see Box 9.1). Here leadership, innovation and a developing interface between management, research and practice are key.

3. Current understanding and embeddedness of the Reserve in practice

Knowledge and familiarity with the concept of the ER varied considerably but was generally better in the Inkomati WMA than in the Olifants and Luvuvhu/ Letaba WMAs where it is weak (even in the regional office). The results for the Inkomati partly reflect the explicit acknowledgement by the Inkomati CMA (ICMA) of the obligations to meet the Reserve (both the basic human needs and ecological components). Also,

Where the Reserve was known, the pervasive view was that it was water 'for the Kruger National Park', and that only the Park would accrue benefits whilst other stakeholders would carry the risks.

Managers expressed frustration in interpreting and operationalising outputs from a Reserve determination study.

The concept of sustainability so as to ensure water for people and inter-generational rights was rarely understood as a guiding principle.

Evidence of practices where sustainability is at the forefront of planning was rare. If this does not change the implications are that sustainability will continue to be compromised.

Establishing a discourse of sustainability and entrenching this in practice warrant serious consideration, especially given the need to develop Catchment Management Strategies (Pollard and Du Toit, 2008). Without multiple stakeholder platforms at which the *status quo* of the catchment is discussed, together with a sustained programme – not once-off awareness raising campaigns – this is unlikely.

4. The importance of leadership and governance for transformation and sustained action

Leadership is key in transformation and yet this ranges from extremely weak to weak, although local exceptions are evident (e.g. Groot Letaba and Crocodile). More specifically:

The potential scope of leadership in the Inkomati CMA is severely constrained by the lack of assigned functions.

It is suggested that problems being experienced in the Olifants can be traced to the almost total lack of leadership. Despite local efforts, meaningful change is not possible under the current governance arrangements since there is no single individual tasked with the responsibility for transformation in the catchment.

This is equally true in the Middle/ Klein Letaba, Sand Rivers.

Also, ensuring integration (see above) requires support from leadership in other sectors in various institutions outside of water resources is essential. This is currently very weak.

Case studies: Governance and leadership

Critical factors for transformation and sustainability is that of leadership and governance. *This is true in the Olifants, the Middle/ Klein Letaba, the Sand and Luvuvhu* rivers where no single individual *with authority* (i.e. within DWA or a proto-CMA) has taken up *leadership and appropriate and effective governance.* Here not only is leadership weak, but so too are feedbacks (see below and Figure 9.2a as an example).

Stronger leadership is emerging in the Inkomati but is constrained by various factors which are discussed.

5. *Participatory and representative platforms for collective action and learning*

Transformation towards a collective, catchment-based vision can only be achieved through a collective understanding and approach. Whilst localized platforms do exist, these often reflect single-sector interests or focus on specific sections of the river. In general collective action towards IWRM is weak and requires attention. Furthermore, our research suggests

That different sectors within the same WMA see very different priorities for managing the shared water resource.

The existing platforms are bedevilled by a sense of inaction**.** Thus stakeholder platforms are not the answer on their own; participants need a focus around which they act (see also comments on feedbacks and leadership)

Case studies: Multiple stakeholder platforms for collective action

The evolution of the Olifants River Forum provides for an interesting case study of differences in the perceived value of the forum to stakeholders which varies widely (see Box 9.8). On the one hand, some feel that the forum is important for addressing common concerns and for getting feedback, whilst on the other some feel that the forum has failed to tackle the degrading water quality issue through a lack of focused action.

Other forums examined included the Crocodile River Forum (see Section 9.7) and the Olifants, Letaba, Luvuvhu and Inkomati Forum (OLLI).

A key ingredient of transformation is 'learning', especially social learning that confronts the diverse understandings and meanings of the different sectors. This needs to be supported.

Case study: Learning as a collective

The focus of the case study is how people learn to moderate their actions within the framework provided for by compliance monitoring and enforcement (CME). This illustrates that certain Water User Association (WUA)/ IB and certain industries have responded to the policy environment and built understanding and competence for regulating users (see Box 9.8).

6. *Self-organisation and multi-scale feedbacks*

We suggest that functional, responsive multi-scale feedbacks are essential for management in complex systems like catchments since they provide the basis for learning, reflection and response to an evolving context. However, the existence of these is variable from non-existent to emergent.

Encouraging cases are emerging in the Groot Letaba, Crocodile and Komati Rivers (see Section 6.8 and 8.8) although these need to be strengthened and linked into

wider systems (see Figure 9.1). In both cases leadership (see above) and the ability to self-organise appear to be central.

In other cases such as the Olifants, Middle/Klein Letaba and the Sand Rivers leadership and the ability to self-organise is weak or almost non-existent.

Yet again in other cases such as the Sabie River, despite good efforts to self-organise (around water quality), the feedbacks are limited to a scale which cannot bring about change and leadership at a wider scale (see Box 9.2 and Figure 9.1).

Case studies: Self-organisation and feedbacks

In the Groot Letaba the feedbacks, although fragile, are functional at a certain scale (below Tzaneen Dam see Figure 6.5). The system displays inherent self organisation between the regulator, the watch-dog and the users, and the operation of the dam releases to mitigate low-flows. Leadership is undertaken by a manager that is trusted. Moreover, the capacity for self-regulation amongst long-standing WUA members (users) is high – although bringing new, emerging farmers on board has proved more difficult.

In contrast the same manager is involved in operational systems in the Klein Letaba system but here feedbacks are virtually non-existent and the system is in an almost permanent state of crisis and water deficit. This is because feedbacks at a wider scale are needed to secure lawful use through an integrated approach. Despite repetitive attempts to secure action through the regulator little meaningful action has transpired.

Interest has grown in what makes feedbacks work and we trace their success to a number of factors (Box 9.3).

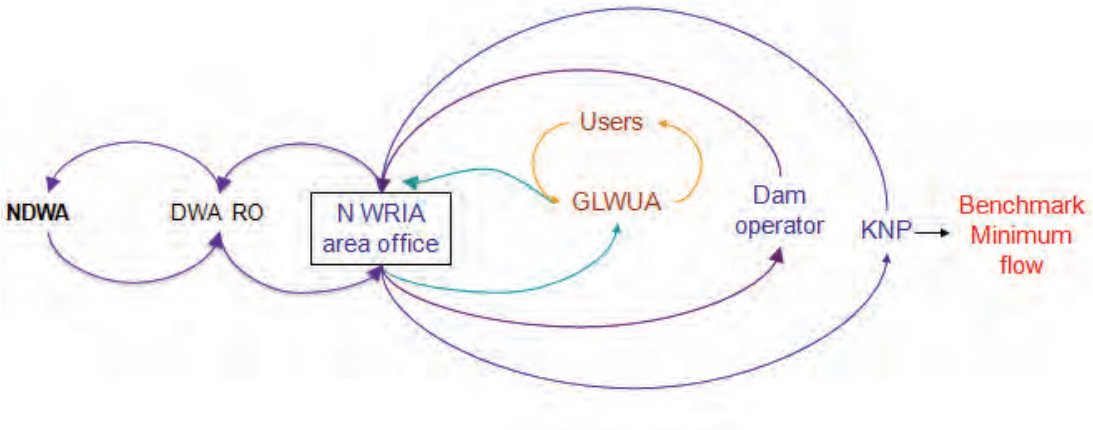

Figure 3: Schematic of an envisaged future state functional multi-scale, feedback loops in IWRM, using the Letaba Catchment as an example.

NWRIA = National Water Resources Infrastructure Agency, KNP = Kruger National Park, GLWUA = Groot Letaba Water User Association

7. Unlawfulness and the regulation of unlawful use

The Reserve cannot be achieved without a compliant or lawful catchment-based system such that water use is authorized, regulated and monitored against the Reserve requirements. This requires (a) adequate skills and resources for CME and (b) involvement of stakeholders in monitoring, reporting and rectification of transgressions. Self regulation is essential.

A number of cases of unlawful use were raised in each catchment. All of the sub-catchments are bedevilled by major issues with regard to municipal expansion and effluent control. The expansion of mining in the Komati, Crocodile and the Olifants is problematic.

Overall, monitoring and regulation is inadequate and lacks coherency. Very concerning is the dearth of legal and regulatory skills and support. The view that the "regulator cannot regulate" was pervasive – even by the regulator themselves (see Chapter 9). The fragmented or inadequate legal back-up to regions by the national legal division at DWA is a growing problem. In all the catchments with weak feedbacks, regulation competency requires urgent attention. Other pertinent issues included:

- delays in WARMS (Water Authorisation and Registration Management System),
- the lack of monitoring systems (including technical hardware such as meters),
- the lack of legal support,
- unclear responsibilities regarding CME between DWA national and regional offices, and the CMAs.
- the lack of incentives to comply with legislative requirements (especially local government)
- restrictions on recourse when working with another government structure,
- tardy procedures related to the licencing approval process,

The role of self-regulation is central in the management within complex systems because, due to their openness and unpredictable nature, complex systems cannot be managed only from the outside. Throughout all the catchments some degree of self-regulation is apparent. It is evident in long-established users who share a limited resource. These offer ideal opportunities for mentorship programmes.

Case studies: Regulatory competence

Two cases are highlighted:

1. the development of a WCDM plan by the Giyani Local Municipality as a way to bring water use under control (Box 9.5); and
2. the regulation of agricultural users by the Groot Letaba Water Users Association (Box 9.6).

8. Lags in the implementation of the Reserve and emergence of sustainability discourse

Lags (the time between policy intent and realisation through strategic and operational actions) are a natural consequence of changes in policy, law and the administrative procedure. Policies are meaningless, however, if the lag is excessive. Meeting the Reserve is subject to progressive implementation and in some cases, such as the Crocodile catchment, steps are being put in place.

Determining 'reasonableness' is the subject of a current DWA project but even in the absence of criteria, some situations such as in the case of the Sand River Catchment, the Olifants and the Middle/ Klein Letaba can be categorised as an unacceptable lag because of the almost total lack of progress in operation despite a history of policy and paper commitments.

Case study: Unacceptable lags (see Box 8.1 and 9.2)

The Sand Catchment has a long history of commitments to meeting the Reserve (Injaka White paper on the interbasin transfer (IBT; DWAF, 1994); determining the Instream Flow Requirements (DWAF, 1996); and planning projects for operation and decision support (Sellick and Bonthuys, 2003; Sellick et al., 2002) which set out the operating rules.

None of these have come to fruition to date and reasons for this are discussed by Pollard et al. (2010) and Pollard and Agterkamp (in prep-b). In summary, these reflect a complex failure in integrated strategic planning and management, lack of authority and action, un-coordinated planning and implementation between various government departments, the lack of institutional realignment and the failure to undertake technical rehabilitation and maintenance.

Key focus areas for future action

1. Compliance with the Ecological Reserve

An overarching recommendation is for government to lead operationalisation of the Reserve through a cohesive strategic plan. This means embedding the process in plans for IWRM (such as the Catchment Management Strategies).

Some major areas of research foci are:

- Testing water quality compliance.
- Future Reserve and classification determination processes that consider the practicalities of operationalising these.
- Research that seeks to elucidate collective benefits of the Reserve at a catchment scale in a way that holds meaning for participants will be an important step.

2. Operationalising the Reserve: Developing an integrated, systems view as the basis for planning and action (supporting IWRM)

The imperative is to develop support for a systemic, integrated approach to IWRM in each catchment (as outlined in the guidelines for the catchment management strategies).

There is an urgent need for leadership and action on the co-ordinated planning for water resource management and water supply (especially water services and mining).

In terms of research this requires

- action-research to support integrated approaches and the development of a systems understanding with stakeholders;
- action-research to support integrating water resources issues into various planning documents such as the WSDPs of local government.

3. Current understanding and embeddedness of the Reserve in practice

There is a pressing need for the development of a collective understanding of water resources protection measures at the catchment level. However, future efforts need to move beyond simplistic awareness-raising campaigns' which are a naïve response to the needs emerging around the implementation of the Reserve. Social learning approaches (see Ison et al., 2004; Wals, 2007; Muro and Jeffery, 2008) are important for developing a collective understanding and reducing resource-related conflicts.

In terms of research this requires

- exploring innovative ways to understand the Reserve with stakeholders;
- addressing the transboundary (international) nature of Environmental Water Requirements;
- understanding the role of collective action and multiple stakeholder platforms in building knowledge and transforming practice.

4. *The importance of leadership and governance for transformation and sustained action*

There is a critical need to *support the development and strengthening of leadership as the basis for change*

There is an urgency to institute strong leadership *and appropriate and effective governance in the Olifants, the Middle/ Klein Letaba and the Luvuvhu rivers*. In the case of the Olifants, this may require fast-tracking the establishment of the Olifants CMA. The WRC has a central role to play in this through the facilitation of high-level discussions in this regard.

In the case of the Inkomati CMA, the assignment of functions is a priority.

Given the need for co-operative governance, securing support from key leadership positions in various institutions is essential, namely SALGA (South African Local Government Association), DPLG (Department of Provincial and Local Government), provincial governments, DAFF (Department of Agriculture Fisheries and Forestry), as well as DWA itself.

In terms of research this requires understanding the skills, critical paths and impacts of new leadership.

5. *Participatory and representative platforms for collective action and learning*

The overall recommendation is that *support be given to strengthen collective action for adaptive capacity for IWRM using existing multiple stakeholder platforms and focusing on action.*

Research needs:

- deeper understanding of learning as a key ingredient of transformation (learning that confronts the diverse understandings and meanings of the different sectors);
- documenting through action-research the progress towards a shared vision and collective action.

6. *Support for self-organisation and robust, multi-scale feedbacks in integrated, adaptive action and management*

Support needs to be given to developing and strengthening leadership and coherent, robust and multi-scale feedbacks that provide the basis for action and learning. Attention must be paid to strengthening linkages at higher scales (e.g. to DWA), monitoring and enforcement and delegation of duties if needed.

Research will greatly enhance this process as follows:

- A scholarly body of work based on the findings of this report can be undertaken to examine and support the development of functional feedbacks and leadership.
- Research and development of tenable, practical monitoring tools and indicators. Again this should be based on learning from what is currently working.
- Tracking how learning is taking place through various stakeholder platforms (see above) will offer useful lessons.

7. Unlawfulness and the regulation of unlawful use

The overarching recommendation is that *monitoring and enforcement must be strengthened as a matter of urgency and legal support given to the development of legal literacy amongst key role-players and in the water sector*.

To improve regulation, legal literacy must be built through (a) research-based approaches, (b) attracting and retaining people into the field and (c) support for the uptake of a diverse and complex legal discourse and practices into the water sector. Further specifics are listed in Chapter 10.

There is wide scope for research to support the development of legal competency:

- A review of legal support within the department is necessary.
- Research into case studies where laws designed to protect water resources have failed (especially the water Tribunal).
- Legal research to identify and analyse problems around compliance so as to build regulatory competence.
- Development of a series of legal case studies to identify and address unlawful uses that are causing significant impacts to the sustainability of the water resource.

8. Lags in the implementation of the Reserve and emergence of sustainability discourse

The recommended strategic action is contingent on the outcomes of a research consultancy currently underway, but it is likely to entail a focus on clear benchmarks and indicators for lags.

Concluding remarks

Meeting our commitment to the Reserve requires the transformation of policies and practices beyond water conservation and protection. Indeed, achieving the Reserve is predicated on water reform and IWRM and the collective contribution and synergies of a number of strategies, plans and practices (Figure 2). Progress towards this complex goal varies widely between catchments and at different scales examined. Cases where system resilience is strengthening – especially through collective action, good governance, strong leadership, feedbacks, learning and regulation – can offer lessons and frameworks for weaker situations. If a people-centred approach that is guided by sustainability is to be sought, then we also need to find new ways of understanding, collaboratively, the benefits associated with water resources protection measures (such as the Reserve and classification). Such thinking needs to extend across boundaries – be they upstream-downstream, sectoral or international. This is because we need to find ways of sharing responsibilities for our scarce freshwater resources collectively.

ACKNOWLEDGEMENTS

The authors would like to thank the Steering Committee (Dr S. Mitchell, Mr B. Madikizela, Dr H. Biggs, Dr D. Versfeld, Prof K. Rogers, Mr C. McLoughlin, Prof C. Breen, Ms T. Cousins, Mr A. Venter, Mr J. Dini, Mr D Kleyn, Mr B. Jackson, Ms J. Jay, Mr N. van Wyk, Dr S. Liphadzi and Dr T. Sawunyama, Dr P, Ashton, Ms J, Love) of the WRC Project K5/1711 for the assistance and the constructive discussions during the duration of the project. We would like to thank the Water Research Commission for the financial support of this project.

The work was made possible by the time and effort provided by key stakeholders who were interviewed. Our research assistant developed the maps and compiled the final report. Dr Harry Biggs provided input to the conceptualisation of the project. Mary van der Riet; from the School of Psychology; University of KwaZulu-Natal provided invaluable initial support for the analysis of the interviews. Mr Stephen Mallory provided information on updated water availability assessments for which he is thanked.

A number of interns assisted in the work. In particular Stacey Gouws offered invaluable assistance in interviews and analysis over the final year and compiled the final report.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF BOXES

LIST OF ABBREVIATIONS

BBBEE	Broad Based Black Economic Empowerment
BBR	Bushbuckridge
BHNR	Basic Human Needs Reserve
CCAWs	Co-ordinating Committees on Agricultural Water
CIB	Crocodile Irrigation Board
CMA	Catchment Management Agency
CMC	Catchment Management Committee
CME	Compliance Monitoring and Enforcement
CMF	Catchment Management Forum
CMIB	Crocodile Major Irrigation Board
CMS	Catchment Management Strategy
Cofomosa	Committee for Facilitation of Agriculture between Mozambique and South Africa
CPA	Common Property Association
CRS	Controlled Release Scheme
DAFF	Department of Agriculture, Forestry and Fisheries
DARDLA	Agriculture, Rural Development and Land Affairs, Mpumalanga
DEA	Department of Environmental Affairs (previously DEAT and included tourism)
DEDET	Department Economic Development, Environment, and Tourism
DFA	Development Facilitation Act (65 of 1995)
DM	District Municipality
DMR	Department of Mineral Resources (previously DME)
DNA	National Directorate for Water Affairs (Mozambique)
DoA	Department of Agriculture (now DAFF)
DPLG	Department of Provincial and Local Government
DSS	Decision Support System
DWA	Department of Water Affairs (previously DWAF and included forestry)
EF	Environmental Flows
EIA	Environmental Impact Assessment
EIP/EMP	Environmental Implementation Plan/Environmental Management Plan
EMPR	Environmental Management Programme Report
EMPs	Environmental Management Plans
EWRs	Environmental water requirements
ER	Ecological Reserve (referred to as the Reserve)
FBW	Free Basic Water
FSC	Forest Stewardship Commission
FSE	Federation for Sustainable Environment
GA	General Authorisation
GEAR	Growth, Employment and Redistribution (A Macroeconomic Strategy for South Africa)
GGP	Gross Geographic Product
GIS	Geographic Information System
GLTFCA	Great Limpopo Transfrontier Conservation Area
GLWP	Greater Letaba Water Project
GLWUA	Groot Letaba Water User Association

HDI	Historically Disadvantaged Individual
IAPs	Interested and Affected Parties
IBT	Inter-Basin Transfer
ICMA	Inkomati Catchment Management Agency
IDP	Integrated Development Plan
IEM	Integrated Environmental Management
IFR	In-stream flow requirement
IIMA	The Interim Inco-Maputo Agreement
IMC	Irrigation Management Committees
IRDS	The Integrated Rural Development Strategy
ISO	International standards
ISOTG	Incomati System Task Group
ISP	Internal Strategic Perspective
IWMP	Integrated Waste Management Plan
IWRM	Integrated Water Resources Management
IWRMP	Integrated Water Resource Management Plan
JPTC	Joint Permanent Technical Committee which became the JWC
JWC	Joint Water Commission
K2C	Kruger to Canyons Biosphere Reserve
KIB	Komati Irrigation Board
KJOF	Komati Joint Operations Forum
kl/hh/m	kiloliters per household per month
KNP	Kruger National Park
KOBWA	The Komati Basin Water Authority
LBPTC	Limpopo Basin Permanent Technical Committee
LG / LoGov	Local Government
LIB	Loskop Irrigation Board
LM	Local municipality
LRAD	Redistribution for Agricultural Development policy
LRO	Limpopo Regional Office
LUMS	Land Use Management Systems
M&E	monitoring and enforcement
MIB	Major Irrigation Board
MIG	municipal infrastructure grant
MNRE	Swaziland Ministry of Natural Resources and Energy
MOU	Memorandum of Understanding
MSA	Municipal Systems Act (No 32 of 2000)
MSPs	multiple stakeholder platforms
MTPA	Mpumalanga Tourism and Parks Agency
NEMA	National Environmental Management Act (No. 107 of 1998)
NEPAD	New Partnership for Africa's Development
NGO	Non-Governmental Organisation
NLP	National Land Care Programme
NPS	National Pricing Strategy
NWA	National Water Act (No. 36 of 1998)
NWRCS	National Water Resource Classification System
NWRIA	National Water Resources Infrastructure Agency
NWRMC	National Water Resource Monitoring Committee

NWRS	National Water Resource Strategy
OLLI	Olifants Letaba Luvuvhu Incomati (low flows committee)
ORF	Olifants River Forum
ORWRDP	Olifants River Water Resource Development Project
PES	Present Ecological Status
PGDS	Provincial Growth and Development Strategy
PRIMA	Progressive Realisation of the IncoMaputo Agreement
RA	Resilience Alliance
RBA	River Basin Authorities
RDM	Resource Directed Measures
RO	Regional Office
RQO	Resource Quality Objectives
SADC	Southern African Development Community
SALGA	South African Local Government Association
SAM	Strategic Adaptive Management
SANParks	South African National Parks
SDC	Source Directed Controls
SDFs	Spatial Development Frameworks
SFRA	Stream Flow Reduction Activities
SHEQ	Safety, Health, Environment and Quality Management
SRI	Shared Rivers Initiative
STEEP	Social, Technological, Environmental, Economic and Political
TA	Traditional Authority
TPTC	Tripartite Permanent Technical Committee with Mozambique and Swaziland
WAP	Water Allocation Plan
WARMS	Water Authorisation and Registration Management System
WAS	Water Allocation Schedule
WC/WDM	Water Conservation and Water Demand Management
WDCS	Waste Discharge Charge System
WDM	Water Demand Management
WfW	Working for Water
WMA	Water Management Area
WMI	Water Management Institution
WRC	Water Research Commission
WRSAS	Water Resource Situation Assessment Study
WSA	Water Services Act (No. 108 of 1997)
WSA / WSP	Water Services Authorities or Providers
WSAU	Water Services Authority
WSDP	Water Services Development Plan
WSI	Water Services Institute
WSP	Water Service Providers
WUA	Water User Association

CHAPTER 1. INTRODUCTION AND OBJECTIVES

1.1 Introduction and background

In essence this work concerns itself with exploring the commitment to sustainability in freshwater river systems in South Africa as envisaged in the Constitution and the National Water Act (RSA, 1998). Although the central focus is on healthy, flowing rivers it is not just about that alone since without also meeting our commitment to equity and stakeholder involvement – for ultimately it is they that use and at times manage the resource – the former can never be achieved. These ideas are not unique to South Africa; indeed as the depth of the world's water crisis grows there is a global shift to considerations of sustainability, equity and integrated approaches. South Africa is however regarded as a forerunner of change and is widely acclaimed for statutory reforms and conceptual and methodological sophistication particularly with respect to the determination of environmental water requirements (EWRs). Global efforts have also turned to the incorporation of EWRs in water resources management as a way to protect water resources and to ensure long-term sustainability. There is no universal definition of EWRs or environmental flows. Generally environmental flows refer to the flow regimes needed to keep freshwater ecosystems healthy and productive and to maintain the services they provide (Smakhtin et al., 2004). South Africa is fortunate in having a benchmark for the commitment to freshwater sustainability captured in the concept of the Ecological Reserve, for which it is widely acclaimed. The Ecological Reserve (henceforth paraphrased as the Reserve or ER) and detailed in the following section, essentially defines a dynamic quantity and quality of flow for a water resource

Whilst the methods related to Reserve determination are now well developed and many Reserves have been undertaken, implementation (giving effect to the Reserve), is still in its early stages. As attention turns increasingly to implementation, we are required to now think not only of the Reserve in conceptual terms but also it places an onus on all of us – academics, practitioners and managers alike – to draw the Reserve into the operational world (Pollard and du Toit, 2009b). Such is the focus of this work which concerns itself with the progress of implementation of the Reserve in the rivers of the lowveld specifically in terms of meeting the commitment to sustainability as set out in the Act (detailed in Section 1.3). However meeting the Reserve requirements (i.e. 'compliance') tells us little about why this is so and hence there is an emphasis on understanding what factors constrain or enable progressive realisation.

In this regard we stress one of the key findings of this work. As highlighted in Chapter 10, **achieving EWRs – and indeed the Reserve – does not reside within the environmental domain alone**. It is entirely predicated on water reform and the introduction of Integrated Water Resources Management (IWRM) as a new and transformative way of managing the nation's water resources. Hence it is the collective contribution and synergies of a number of strategies, plans and practices (as envisaged in the National Water Act and the National Water Resources Strategy (DWAF, 2004e)) that make up IWRM. This is best exemplified by the Catchment Management Strategy, as discussed in section 1.2 (see also Figure 10.1). ***It is these factors that are explored in this research***, not for example which of the methodologies for determining the Ecological Reserve are favoured or what their particular strengths or weaknesses may be. We make this point because of misunderstandings or simplistic interpretations that have been apparent throughout the research, and because operationalising the Reserve moves the discourse and practice into a much wider arena than that of water conservation and protection alone. In other words simply determining the Reserve (or any of

the additional water resource protection measures outlined in the National Water Act (NWA)) does not ensure achieving the Ecological Reserve or any other aspect of water resources management in South Africa. Rather it relies on ensuring there is an reasonable database, stakeholder participation, a collective vision for the catchment, an effective and transparent authorisation process coupled with monitoring and regulation, and of course sufficient skills and funds to support this (DWAF, 2004e; Pollard and du Toit, 2009b). Critically it is also predicated on ensuring there is high-level buy-in from other agencies and role-players – government, and importantly departments other that Water Affairs, non-governmental agencies and in some cases, neighbouring sovereign states. Understanding how we are going to meet our commitment to sustainability requires an understanding of this wider milieu and readers are encourage to familiarise themselves with the policies and practices that *collectively* contribute to IWRM.

With this background in mind, we provide an overview of some of the key policy and institutional frameworks that underpin IWRM as background to elaborating the research and its objectives.

1.2 Water reform and Integrated Water Resources Management in South Africa

South Africa's highly-acclaimed National Water Act provides the foundation for a fundamentally different way of managing the nation's water resources. Together with the White Paper (DWAF, 1997), it challenges the values of the past by framing water resources management within the context of two fundamental principles[1]: equity and sustainability (RSA, 1998). Captured in the slogan "*some, for all, for ever, together,*" these principles are strongly transformatory in nature, seeking to move towards integration, redistribution and equity in allocation, sustainable use, resource protection and participation (see preamble). Moreover, the importance of international needs is also recognised. Equally ground-breaking is the Water Services Act (RSA, 1997). It provides for the rights to basic water supply and sanitation which, although distinct from the overall management of water resources, "must be undertaken in a manner consistent with the broader goals of water resource management".

Central to the re-orientation embodied in the National Water Act (1998) is the concept of integrated water resource management (IWRM). In this regard, the Act explicitly recognises 'the need for the integrated management of all aspects of water resources'. The Department of Water Affairs defines IWRM as "*a philosophy, a process and a management strategy to achieve sustainable use of resources by all stakeholders at catchment, regional, national and international levels, while maintaining the characteristics and integrity of water resources at the catchment scale within agreed limits*" (DWAF, 2003c). It therefore aims to strike a balance between the use of resources for livelihoods and its protection for future generations, whilst promoting social equity, environmental sustainability and economic efficiency (DWAF, 2004a).

1 The White Paper and NWRS also make reference to efficiency which is an important aspect in achieving the founding principles. They state that "Given that our water resources are limited and limiting, it is essential that we use them efficiently and in the best interests of all our people. Thus, the allocation of water to users should be guided by the need to encourage and support efficient, optimal and beneficial use of water".

Another fundamental change is the management of water resources on a catchment basis. Currently 19 Water Management Areas (WMA) have been delineated, each to be managed by a Catchment Management Agency (CMA), to which there will be a progressive devolution (assignment) of responsibility and authority over water resources. The CMAs are in various stages of establishment and are to be supported by local-level bodies such as Catchment Management Forums and Water User Associations.

Most notably, the NWA affords only one right to water – that of the Reserve (Box 1.1). This concept includes the Ecological Reserve which, in essence, offers statutory commitment to environmental flows. The Act highlighted the need to use water for beneficial purposes while ensuring sufficient water to maintain the integrity of the aquatic ecosystem, in effect an environmental water requirements.

Box 1.1: The Reserve (NWA: RSA, 1998)

The Reserve refers to the quantity and quality of water required -
(a) to satisfy basic human needs (Basic Human Needs Reserve)
(b) to protect aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resource (Ecological Reserve)
The Reserve refers to the modified EWR where operational limitations and stakeholder considerations are taken into account.

How will environmental water requirements be achieved?

These principles of equity and sustainability are to be given practical meaning through the strategic planning process of developing the Catchment Management Strategies (CMS). This is important to our story since the framework for Catchment Management Strategies (Figure 1.1) demonstrates that a 'bundle of strategies' is collectively required to achieve sustainability. Thus one does not 'implement the Reserve' but rather the plans for IWRM that are collectively designed (through the CMS) to achieve the desired outcomes, including the Reserve. Indeed, the fact that meeting the EWRs is a process that is linked to a wider socio-political environment is evident in the Department's definition of IWRM, given above. Although the formal process of developing strategies is still in its infancy, this does not imply that strategic planning has not been part of the past decades orientation. Much of what is to be undertaken through the CMS process (a legislative requirement) is already underway. The key difference is that the strategy is a formal and integrated commitment to change as developed by catchment stakeholders and guided by a vision.

The CMS offers the opportunity to plan for complex and changing environments and to manage this through a strategic, adaptive process that embraces learning informed by practice (DWAF, 2004a; Pollard and du Toit, 2008). These are thus key concepts and ones which we will return to later, but first an overview of the framework that guides the development of CMS is presented (see DWAF (2007b) and Pollard and du Toit (2008) for further detail). From the overall framework (Figure 1.1), IWRM is conceptualised as four clusters of information and strategies, which collectively comprise the strategy[2]. A number of these deal specifically with the 'business' of IWRM whilst others facilitate the IWRM. Two key, complementary strategic areas, known as Resource Directed Measures[3] (RDM) and

[2] Development of certain key policy instruments was still underway: Water Allocation Reform process, National Water Resources Information Management Service (DWAF 2004c).

[3] Collectively this comprises Classification, the Reserve and Resource Quality Objectives. These measures focus on the quality of the water resource itself. Resource quality means the overall condition of the water resource (including quantity and quality) of in-stream and riparian habitats and aquatic biota.

Source Directed Controls[4] (SDC), are regarded as key to achieving the vision. The RDM are directed at protecting the water resources base by setting objectives for the desired condition of resources, whilst SDC are measures to control water use to limit impacts to acceptable levels, as defined through RDM. The integration strategy recognises that multiple institutions are involved with various aspects of water-related activities and their plans either have to be aligned (e.g. Integrated Development Plans and Water Services Development Plans of municipalities). This includes international agreements. As stated, even though the strategies are not yet in place, the underlying principles and objectives should currently guide practice as set out by the NWA.

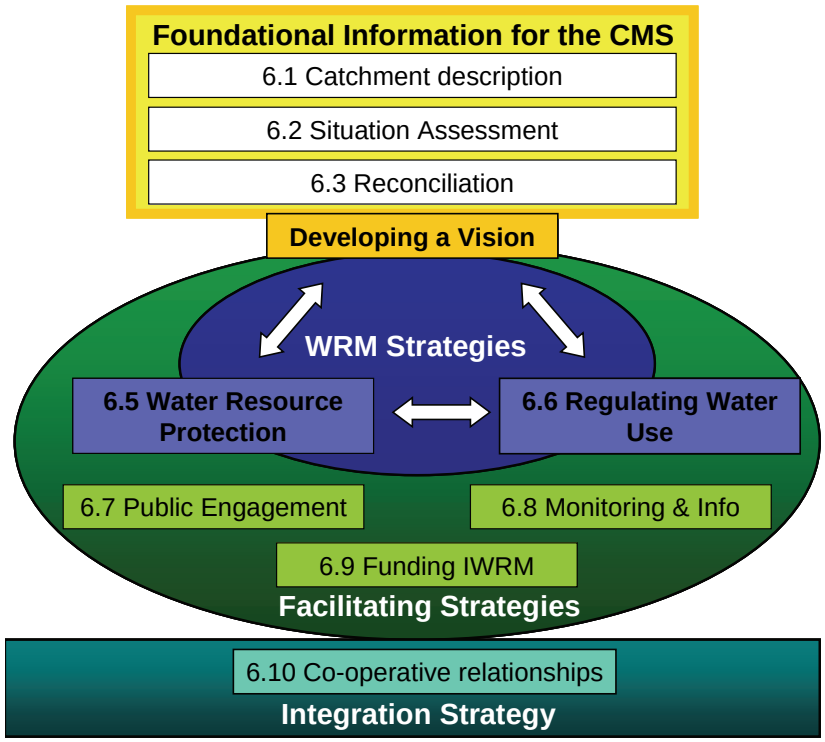

Figure 1.1: Framework for IWRM and hence the Catchment Management Strategies in South Africa (from DWAF 2007; Pollard and du Toit 2008). This framework provided a basis for the semi-structured interviews

It is important to understand that in South Africa different legislative frameworks govern water resources management (the National Water Act (RSA, 1998)) and water supply (the Water services Act (RSA, 1997) and the Municipal Systems Act (RSA, 2000)). Moreover, the spatial boundaries for the management of water resources (catchments) and domestic water supply (municipalities) are not coincident (Pollard and du Toit, 2005). This provides an even greater imperative for co-ordination and integrated planning.

That the NWA views water resources as a resource of diverse goods and services (rather than simply a source of water) is evident in the classification system comprising three permissible classes[5]. Each

[4] These measures contribute to defining the limits and constraints that must be imposed on the use of water resources to achieve the desired level of protection. 'Water use' refers to all 11 uses defined in the Act

[5] 'natural', 'moderately used or impacted', or 'heavily used or impacted'.

of these – in effect a negotiated desired state – delivers a different complement of ecosystem services and each has attached risks and tradeoffs. Associated with each class is a recommended ecological category[6] and a Reserve which is a composite description of a dynamic hydrological, geomorphological, physico-chemical, and biological state. The Reserve refers to both the quantity and quality of the water. Once a management class has been selected by stakeholders – an expression of a negotiated desired state – it forms the basis of planning. All Reserve determinations done ahead of resource classification are considered 'preliminary Reserve determinations'. There are four levels of RDM determination (desktop, rapid, intermediate and comprehensive[7]) that are required for different circumstances that reflect the degree of use, the sensitivity and importance of the catchment, and the potential impact of the proposed water use. It is important to separate the above process (planning) from implementation.

Thus in summary whilst sustainability is colloquially – and sometimes crudely – interpreted as 'water resource protection', and technically may be centrally 'held' within the RDM sub-strategy, it is a principle that underscores our approach to IWRM. It would be easy but naïve to assume that sustainability will be achieved simply through the development of a Reserve determination; it must be addressed through the synergies of various sub-strategies including water allocation reform in some instances.

1.3 Study background, objectives and key questions

This work forms part of the Shared Rivers Initiative, an action-research transboundary programme currently funded through the Water Research Commission (WRC), which started in 2007. The overall aim of this programme, now nearing the end of Phase I, *is to understand and effect change in the implementation of policies and legislations relevant to the wise use of the Lowveld river systems*.

The programme arose out of concerns that despite the aforementioned enabling legislative and institutional frameworks for water reform and environmental flows, the integrity of almost all of the rivers that flow eastwards and that are shared with other countries have not improved, or are continuing to degrade both in terms of quality and quantity. Given the direct benefits to peoples' livelihoods and the fact that these rivers are shared with other states, and hence are bound by international agreements, the implications are far-reaching. Indeed as the work started there was evidence suggestive of deteriorating conditions. For example, the lower Olifants River ceased flowing on a number of occasions in 2005 despite a Reserve determination having been undertaken for the catchment. Likewise the Sand River flows stopped on a number of occasions, most notably during 2005 and 2006 (see Pollard et al., 2010). In the Crocodile a reversal of seasonality together with very low-flows was a major concern. At another scale Mozambique and South Africa have experienced conflict over the recent raising of the Massingir Dam wall on the Olifants River. The South African concerns related to the flooding of the gorge which will destroy one of the world's largest breeding grounds for the Nile crocodile whilst the Mozambicans contend that South Africa is delivering insufficient flows thereby compromising the desperately needed development opportunities. On the other hand it appeared that flows in the Letaba had been improving but whether or not this was in

[6] Based on PES as well as Ecological importance and Sensitivity and Socio-Cultural Importance

[7] Comprehensive Reserve determination is required in the case of (a) compulsory licencing; (b) water use allocation planning; (c) large impacts; (d) sensitive/ stressed catchments (DWAF 2003a).

line with the Reserve requirements was uncertain. Indeed many of the assertions that suggested an overall deterioration in the integrity of these rivers remained largely anecdotal and required a structured examination.

Consequently, one component of the Shared Rivers Initiative, and that reported herein, set out to explore such perceptions. The aim of this component or sub-project is to *provide a preliminary assessment of the status of sustainability of the water resources of the six[8] lowveld river systems, and the factors that constrain or contribute to this, in order to provide a grounding from which the project is able to design and implement real change*. The idea was to provide a collaborative, contextual profile of such issues for each of the six rivers so as to provide the basis for future supportive initiatives.

The focus of this work is on freshwater sustainability and an examination of whether we are moving towards our commitment to sustainability as set out in the Act (see following discussion on progressive realisation). Indeed as stated earlier, one of the objectives of IWRM in South Africa is to ensure sustainability of water resources through strategic planning, management and implementation of plans (Pollard and du Toit, 2008) The benchmark, or indicator, for this is primarily the Ecological Reserve, but meeting the Reserve requirements (i.e. 'compliance') tells us little about ***why*** this is so and hence there is also a focus on understanding what factors constrain or enable this. Thus an important aspect of this work was to scope out together with the stakeholders, either general or specific constraining or enabling factors, primarily so that a **collaborative and supportive** set of interventions could be developed in Phase II. This orientation underpins the research approach.

Given this context, the objectives were as follows:

1. To understand the current status of sustainability of the water resources
2. To provide a broad contextual profile and assessment of the factors that constrain and contribute to sustainability (i.e. compliance with policy)
3. To provide an entry-point for initiating collaboration and co-learning
4. To provide the basis for developing future phases.

The team was requested to take on two additional objectives as the work progressed, namely:

5. A literature review of key conceptual frameworks for the management of natural resources in complex systems.
6. An overview of the international obligations and institutional and organizational arrangements for the lowveld rivers

Compliance[9] and the concept of progressive realisation

The central focus of the work was on understanding compliance or non-compliance with the requirements of the Ecological Reserve. Fundamental to this is the concept of ***progressive realisation*** – a term which has its roots in international law and the discourse on human rights (Pejan et al., 2007). The Constitution of South Africa (1996) recognises the need for the progressive realisation of the rights set out in the Bill of Rights including those of access to water, sanitation, education, health care and the environment. The NWA also makes frequent reference to progressive implementation. With respect to water resources protection it states: '*These measures are to be developed progressively within the contexts of the national water resource strategy and the*

[8] Komati; Crocodile; Sabie-Sand; Olifants; Letaba; Luvuvhu

[9] It transpired that, as the research progressed, the concept of compliance and what constitutes non-compliance was more complicated than originally thought and is an issue we return to in Chapter 9.

catchment management strategies (NWA: RSA, 1998); Chapter 3, preamble). This makes it clear that the implementation of the Reserve and other aspects of IWRM are to be progressively realised. Thus *lags are an inherent part of the process of reform and change* in a complex environment and are to be anticipated (see discussion on complexity in Chapter 2). Setting the Reserve today will not mean that it is met tomorrow. However, given that the NWA was enacted nearly a decade ago, it is an important time for reflection and assessment: how well are we doing and what has supported or constrained this?' become important questions in this regard.

Research questions

Given this, the central research question is: '*What factors enable or constrain achieving environmental flows in the lowveld rivers?* A sub-set of questions underlie this question, namely:

1. What is the status of the Reserve?
2. Do people give importance to sustainability (in a practice-based way)?
3. Is there unlawful use of water? (raises issues regarding monitoring)
4. How effective/ adequate is regulation and enforcement? (the Reserve and licencing)
5. Is there shared practice around the Reserve? (innovations around meeting the Reserve)
6. What feedbacks exist? (see Chapter 2)
7. Do emerging narratives consider consequences for (a) sustainability and (b) or other users, or do they only talk of their own interests?
8. Do participants assign blame elsewhere for non-compliance (is there reflexivity regarding practice?)

It is important to note that this work is not aimed at understanding *perceptions* of compliance alone but rather on underlying causes. As Schlager (1987) suggests, compliance with the law can be broadly categorised as both 'administrative' and/ or 'cultural' (attitudes, practices, behaviours) illustrating the complex nature of compliance.

1.4 Structure of the report

As background to the research, Chapter 2 provides an overview of the key conceptual frameworks of the work including complexity and resilience, socio-ecological systems, social learning, strategic adaptive management, action research, activity theory and a rights framework.

Chapter 3 provides an overview of the catchments of the study site. As noted, the research was undertaken in six rivers of the lowveld (see earlier). The area comprises three Water Management Areas in South Africa (Luvuvhu/Letaba WMA; Olifants WMA and Inkomati WMA) and two transboundary basins: the Limpopo and Incomati. The focus is largely at a catchment scale and key issues are also examined at a national and WMA and basin perspective where appropriate.

Chapter 4 provides an overview of the approach used both for assessing the status of compliance with the Reserve and for the interviews.

Chapter 5 sets the scene by describing the organizational arrangements for IWRM for each of the catchments. Chapters 6, 7 and 8 provide an overview of the results according to analytical themes for each WMA, Luvuvhu/Letaba WMA; Olifants WMA and Inkomati WMA respectively. Chapter 9 provides an examination of specific case studies, seeking to elucidate the factors behind successes and constraints.

Chapter 10 closes the report with a discussion of the key issues emerging, the implications of the constraints and enabling factors, and recommendations for the way forward.

CHAPTER 2. THEORETICAL FRAMEWORKS GUIDING THE RESEARCH AND INTERPRETATION

In this section we present a series of overarching theoretical frameworks that were referred to and/or applied in the structuring of the research method and, specifically, the analytical process. Since there is a strong social component to the drafting of the contextual profiles, a number of these research frameworks are informed by or taken from the social sciences. We note however that ALL the frameworks referred to, have to some extent, associations with what is currently known as **complexity theory**.

In this section we start with an overview of complexity theory and then present associated theoretical frameworks that have guided the profile drafting process. Readers are referred to the additional outputs of the project that cover the theoretical aspects in more detail. Also noted is that some of these frameworks will be influential in further research of the SRI.

Complexity theory

The contextual profile drafting process of the Shared Rivers Initiative is largely framed by this theoretical framework. We provide a brief overview of this methodological orientation in order to ground the chapters that follow.

Complexity theory arose as a critique of linear causality and reductionist science. At the heart of this critique was the concern that this thinking has – and continues to – influence management and governance (see for example Levin 1999 Levin, 1999, Gunderson, 2001, Holling, 2001, Folke et al., 2002, Folke, 2003, Allison and Hobbs, 2004, Walker et al., 2004, Anderies et al., 2006). In challenging this, scholars have pointed out that sustainability remains an elusive vision. Not only has linear conventional thinking failed to chart a sustainable path but in many cases it has actually contributed to the problem (Walters and Salt, 2006).

It is widely recognised that natural and social[10] systems are complex in their own right and that additional complexity is added by their interactions. Berkes et al. (2003) note that this poses particular challenges for disciplinary approaches (the 'silo' approach). Indeed, some assert that they cannot be understood – let alone managed – through conventional disciplinary approaches (Jasanoff et al. 1997 cited in Berkes et al., 2003). This is because the phenomena that we experience or see are reflections of multiple, diverse and distributed (scalar) causes. These attributes essentially describe complex systems, hence leading us to the assertion that complex systems thinking is thus required. This acknowledgement lies at the heart of new integrative approaches such as sustainability science (see Lubchenco, 1998; Burns et al., 2006), and 'bridging' approaches such as ecological economics (Constanza et al., 1997) and integrated conservation and development. Indeed the call for integrated approaches in water resources management, such as those embodied in Integrated Water Resources Management reflects such concerns (see for example Munro, 1995, McKay, 1996, Gorgens et al., 1998, GWP, 2003, Penning de Vries et al., 2002, King and Brown, 2006, Pollard and Toit in press).

[10] The primary focus of *social systems* in the sense applied by the Resilience Network is on governance (especially property rights); knowledge, ethics and values; whilst *ecological systems* are self-regulating communities of interacting organisms (including people) (Berkes et al. 2003)

Complexity thinking builds on *general systems approaches* pioneered in the 1930s, which examined 'wholeness' and how parts operate together, not from examining the parts themselves (Von Bertalanffy, 1972). General systems theory was enhanced by subsequent developments in the field of complexity studies such as those of Forrester (1992) and Holland (1992). These approaches foster a broader view of overall context and focus on dynamics of cause-and-effect and feedbacks. Two useful references are work by Cilliers (Cilliers, 1998) who deals with complexity in detail, and Levin (1999) who examines complexity and the commons. Levin suggests that any system which shows the following three attributes will show complex behaviour: diversity of components; interactions between these components (especially local ones); and any selection process such as that posed through natural selection or a stock market.

Jessop (2003) explains that embracing complexity in research has a number of implications. These are:

1. recognition of diversity and variability as inherent to the system,
2. that complex phenomena cannot be explained by simple algorithms but explanations of the world require some attention to complexity reduction,
3. a research orientation that does not seek definitive truths about the system,
4. methodologically, analysis requires an approach that respects the notion of complexity by being based on the dual movement from abstract to concrete and from simple to complex,
5. ecosystems (and in our context, catchments) are open learning systems that include the traits of resilience, flexibility, adaptability, and network connectivity (Capra, 1996, 2007). The essence of sustainability lies in the way ecosystems are organised and are able to respond to disturbances and/or crises,
6. there is attention to the historical, genealogical and dialogical as these are sources of constructed meanings.

Complexity theory proposes that socio-ecological systems derive their essential properties, and in fact their existence, from their relationships (Capra, 2007). The character of these relationships is influenced by interactions around events, communication and **learning**. The resilience, and hence sustainability of a system, is not an individual property, but a property of an entire network. One would assume that a vulnerable (unsustainable) system would have weak networks where feedback plays little or no role in organizing or regulating the system. This means that learning (from mistakes for example) cannot, or does not, occur. On the other hand, a system that is able to experience events, reflect on them and so learn is assumed to be responsive and capable of adapting to changes that are inherently part of complex systems.

Doll (1993) maintains that accepting uncertainty forces us to dialogue with each other in order to respond and cope with elements of change. The kind of learning required within open systems is not prediction and control but rather what Habermas (1981) terms "dialogic action" where transformation of the participants and the situation is pertinent. The importance of social elements in processes of learning is recognised by educational theorists such as Bruner (1983) and Vygotsky (1987). Any attempts to establish environmental literacy need to recognise the importance of social processes as a way of creating knowledge and responding to contextual change.

Adopting complexity principles has particular applicability to the contextual profiles. There are three key points:

1. Seeing the catchment as a complex system with interlinkages where all things are potentially connected is an important point of departure for making sense of water resources

management processes. The complex nature of Integrated Water Resource Management (IWRM) cannot avoid the integratedness of water, linking a multitude of issues in catchments.

2. Whatever happens in the real world is not as a result of a single causal mechanism. Events are a result of the interaction of diverse causal and counter-causal tendencies. Events are best studied 'genealogically' (Foucault, 1975) – i.e. with attention to embeddedness and time factors.
3. The world is subject to an infinite number of (often mutually exclusive) future possibilities and governance mechanisms are one way of reducing the number of future possibilities (Jessop, 2003).

These points, taken together, represent a point of departure for making meaning of the issues emerging from the six contextual profiles. More importantly, the main reason for grounding the SRI in complexity theory relates to the intentions of the national water legislation. South Africa has progressive water legislation consistent with sustainability principles which recognise complexity (Burns et al., 2006, Pollard and Toit, in press) although the expression of its principles in only in the very early stages (see Bammer, 2005). This work is therefore innovative and exploratory in this regard and aims to shed some light on the implications of recognizing complexity in legislation and at the same time putting in place practices aimed at sustainable water management.

Resilience theory

Particularly in the last two decades, many initiatives have grappled with and embraced complexity. One such initiative, the Resilience Alliance (http://resalliance.org) has popularised the handling of complexity through the concept of *resilience.* The Resilience Alliance argues that systems typically show non-linear behaviour and produce surprises consistent with complex behaviour. They thus propose that a goal of management (rather than seeking to achieve maximum or optimum stable production), is to embrace variation. This, they suggest, accepts that all systems show cyclical behaviour through a 'front loop' (consistent with *some* of the assumptions of e.g. continuing growth in economic theory) but followed by a 'back loop' which is seldom taken into consideration. They propose that being honest and explicit about the universality of the 'back loop' opens real opportunities to manage sustainably and to stop seeing surprises (like droughts and floods) as unfortunate accidents interfering with continued growth along the 'front loop'. The aim becomes **resilience**, the ability to keep a system within prescribed 'healthy' but varying bounds (or in the case of undesirable system configurations, to overcome this 'undesirable' resilience and transform the system along a trajectory to a more desirable configuration). The Resilience Alliance (or RA) has defined resilience as:

> "The capacity of a system to absorb disturbance and re-organise so as to retain essentially the same function, structure and feedbacks – to have the same identity (that is, to remain in the same system regime)".

The relevance of resilience theory to the SRI is that it provides a conceptual framework for seeking more sustainable configurations for management to explore without adopting linear cause/effect models. These are particularly important with respect to providing for environmental water requirements in highly variable climates. Also the aims of seeking resilience as a goal rather than ridged maximization goals could provide a valuable way forward in dealing with highly water stressed catchments such as those of the lowveld. Lastly the focus on learning and flexibility are important aspects of a transforming water sector where opportunities and change are marked characteristics.

Although the contextual profiles do not include the typical methodological tools of 'systems diagrams' and 'resilience analyses', such understanding emerges in the analysis presented in Chapter 9. We suggest that of the numerous 'holistic' methods, resilience theory most clearly and explicitly raise the profile of cross-scale linkages. It offers a fresh vantage on complex topics (such implementing the Reserve). As a theoretical framework it offers a way of elaborating multiple drivers operative in complex systems whilst internalizing that outcomes cannot be predicted. Moreover, the varying effects at different scales introduce surprise and unintended consequences which may be counterintuitive. However this, together with the process of making linkages explicit, also means that various options ('solutions') are available in complex systems.

Strategic Adaptive Management (SAM)

SAM is built on the assumption that natural systems are complex, our knowledge is imperfect but we can learn from purposeful, documented objectives and actions. It is a framework for the stewardship of conservation areas based on learning-by-doing. In many cases this represents a fundamental shift from a management approach for previous management styles which were strongly interventionist and which viewed an ecosystem as a stable, linear system and which attempted to reduce variability (Biggs and Rogers, 2003, Pollard and Du Toit, 2006).

The aim of SAM in the environmental management field is to move management away from reactive, conflict driven, management of human impacts, to consensus driven, and learning orientated management for clear ecosystem targets. Folke et al. (1998) maintain that SAMS requires 'ecological literacy' which refers to a situation where stakeholders learn how to respond to environmental feedback. One particular view of SAM is to involve stakeholders in the research and management processes as key to helping them cope with the unpredictability of change, to adapt resource management practices iteratively so that it was with natural variability and disturbance patterns.

The contextual profiling process of SRI adopts the principle where stakeholders and researchers need to interact with each other in a processes of discovery and learning about how each other's behaviours affects an ecosystem, how this alters the status of the natural resources in which they have a shared interest. The SRI contextual profiling therefore explicitly recognises SAM as a guiding set of principles for addressing future management options that might emerge in subsequent phases of the project.

Action research

Action research is a flexible process which allows action (change, improvement) and research (understanding, knowledge) to be achieved at the same time. Understanding allows informed change and at the same time is informed by that change. People affected by the change are usually involved in the action research process (Dick, 2000).

The process of action research achieves its action outcomes mostly by involving people in the planning and action, as well as by being flexible, adaptive and responsive to people and their contexts. In more conventional management situations, managers or 'senior' personnel decide on what has to be done whilst others are expected to carry these instructions. Here the 'deciders' and the 'doers' are different people/groups of people. Action research seeks to remove the gap between the two (Dick, 2000). The assumption is that this generates commitment to achieving overarching goals.

Action research also allows wider views, information and experiences to enter the process through collaboration. Because action research is a cyclical process of act—review—plan—act, it is able to be flexible and responsive – this is its value for working in a way that recognises the uncertainty and unpredictability of complex systems.

Participants of action research contribute to the research aspect by means of dialogue: they ask questions, interact, engage, review and critically reflect. This means that the action research process is highly inclusive and respects the principles of participatory processes. An action research study can begin with imprecise research questions, the research design is refined as the inquiry proceeds.

Action research is the main methodological framework applied to activities conducted during the 'fieldwork' component of profile development. During this stage the interaction with stakeholders was planned according to the principles of action research so that participants were encouraged, through the dialogues, to confront issues, frame questions and raise issues of concern that have direct bearing on their specific practices. The intention is to revisit these issues after a first phase of synthesis and analysis (this report). Out of this synthesis it is planned to construct action that will explore options for seeking more sustainable configurations for managing the six rivers of the lowveld over the coming decade.

Grounded theory

Grounded theory (Glaser and Strauss, 1967) is an approach that is often used in close conjunction with action research, where action research supports the action component and grounded theory provides the research rigour. Grounded theory can be described as a qualitative research method that uses a systematic set of procedures to derive, inductively, theory about a particular issue. According to Dick (2000) the emerging data is gradually compared to the theory emerging from the interpretation of the previous data in a process of theory building. In some cases the action research and theory building are combined in what is known as grounded action research (Glaser, 1978).

Theory is said to be grounded when it emerges from and generates explanations of relationships and events that reflect the life experience of those participants in the research. Data under this orientation serves four functions in contributing to theory development viz. initiate new theory, reformulate, refocus or clarify existing theory. An important point that Haig (1995) makes is that theories are constructed to explain phenomena NOT data and that grounded theories should be taken as grounded in phenomena not data.

Strauss and Corbin (1990) maintain that formulating theoretical interpretations of data grounded in reality provides a powerful method for understanding the world and for developing action strategies. This approach argues that multiple perspectives must be systematically sought during the research enquiry.

Since the SRI will make use of action research approaches in supporting activity and action around the understanding and implementation of the Reserve, it is suggested that the use of grounded theory to add rigour to the research process will be valuable. Here the consultation with broad spectrum of role players (see earlier) will form the basis for the generation of data and subsequently for the building of theory that will then be tested again through a series of field actions.

The SRI contextual profiling process relates directly to a grounded theory approach in that it is from the phenomena that emerge from the profiling process that theoretical positions for water

management will be explored. Feedback loops and self-organization are two examples of what the research has explored and are documented in detail in this report.

Activity theory

Activity theory is not a specific theory of a particular domain, with specific techniques and procedures. It is a cross disciplinary approach offering conceptual tools and methodological principles which need to be concretized according to a particular area of study (in this case the Ecological Reserve). The theory has its roots in a Soviet cultural-historical research tradition that is still in an evolving state (Engelstrom, 1999).

The application of activity theory to the analysis and interpretation of the contextual profiles is appealing in that it is a theory that addresses the "whole" – in this case water management areas. The three principles of activity theory provide a sound point of departure for assessing activities associated with implementing the Ecological Reserve.

Activity theory is mainly concerned with the analysis and interpretation of data that record and describe human behaviour and discourse. One of the key principles is that the **entire activity system is the unit for analysis**. Engelstrom (1996) maintains that conventional cognitivist views are inadequate for dealing with problem solving, thinking and learning as the individual experience is described and analysed as if consisting of relatively discrete and situational actions. The system on the other hand is described as something beyond individual influence – if described at all. Engelstrom explains: ..."if we take a prolonged look at any institution, we get a picture of a continuously constructed collective activity system that is not reducible to series or sums of individual discrete actions". He maintains that the challenge is to understand the indirect or even hidden influence of individual actions on the creation and reproduction of activity systems. Under this theory contexts *are* activity systems where the context integrates the subject, the object and the instruments into a unifying whole. Between the various components of an activity system continuous construction is going on. Individuals not only use instruments, they also renew and develop them, whether consciously or not. They not only obey rules, they also mould and reformulate them.

Activity theory raises some important questions for the analysis of the contextual profiles, specifically in relation to the emergence and evolution of practices associated with achieving (or not achieving) sustainability in water management. Although the initial analysis in this report does not provide a comprehensive application of activity theory and its principles, it has been formative in interpreting the 'implementation' of the Reserve as an activity system. The importance of discourse and the evolution of practices within institutions (DWA, Water User Associations (WUAs) etc) are important issues highlighted in an interpretation guided by activity theory.

A rights framework

Since the provision of water for environmental requirements is afforded the status of a Constitutional right in South African law it was essential to bear this framework in mind in conducting the first phase of the research. In many cases respondents referred to legal standing in the dialogues. The clarity, or confusion, that is created by water reform is a fundamental issue that came up in all the contextual profiles. The analysis of the profiles would be incomplete without attention to legal issues. To this end we provide a brief overview of a rights framework that has guided the application of water for environmental requirements in South Africa over the past decade.

A rights framework provides a way of setting priorities based on principles drawn from a socio-legal perspective that has its roots in the rights movement that started after the Second World War. There often exists confusion between a *human rights approach* and a *rights-based approach*. This stems in part from the frequent reference to a human rights approach as a rights approach, although they are two very different. This issue is often raised in the context of the Reserve as a right, or, incorrectly in terms of the National Water Act (NWA), a right to use water in terms of an institutional or legislative authorization.

South Africa has placed the right to sufficient water as a Constitutional Right in its Bill of Rights.[11] Consequently, the Constitution (RSA, 1996) has placed a *legal obligation* on the government to realize the right to sufficient water. This requires different action to a moral, economic, or political obligation. In order to comply with this constitutional mandate, the government has enacted policies, framework legislation, strategies, and institutions to manage water resources and deliver water services. In particular, the NWA (RSA, 1998) and the Water Services Act (WSA) (RSA, 1997) are the two main pieces of framework legislation enacted to realize the right to water.

One of the key legal instruments to realize the right to water in South Africa is the Reserve, both Ecological and Basic Human Needs. The Reserve is defined in law in terms of the quantity and quality of water, which are required to protect basic human needs and to protect aquatic ecosystems so as to secure ecologically sustainable development and utilization.[12] Despite the importance of the Reserve in securing the right to water, there has been little discussion with regard to the legal interpretation of this valuable instrument (i.e. justiciability).

Generally, rights approaches impose three *specific obligations* on States: obligations to *respect*, obligations to *protect*, and obligations to *fulfil*. These obligations are perhaps the most important with regard to the right to water, as they provide a degree of narrowness in order to easier evaluate government action. Furthermore, the South African Constitution (RSA, 1996) also clarifies the existence of these obligations in relation to all the rights contained in the Bill of Rights. The obligation to *respect* is a negative obligation, requiring that the State refrain from interfering directly or indirectly with the enjoyment of the right to water. The obligations to *protect* and *fulfil* are considered positive obligations, in that they require an active role and are generally subject to *progressive realization*.

Progressive realization is a complex term in human rights law that specifies concrete actions, including that measures should be non-retrogressive (moving backwards from the status quo), that are deliberate and targeted towards the full realization of the right. This includes, among other things, to ensure that adequate monitoring mechanisms are in place to evaluate the realization of the right to water, including the establishment of realistic and legitimate indicators and benchmarks, and to ensure that the basic minimum content of water, discussed above, is met as a priority.

States violate the right to water through non-compliance with their obligations to ensure the content of the right to water. As mentioned **above, South Africa has specific obligations to respect, protect, fulfil and promote its Constitutional rights**.

[11] Article 27(1).
[12] National Water Act, section 1(1)(xviii).

Since environmental flows are given particular status in the NWA as a right, the use of a rights framework is valuable for trying to quantify government action as well as understand legal aspects of trying to implement such an approach. The nature of obligations and to whom they fall in relation to implementing the Reserve is an important area for clarity to emerge as is the nature of progressive realisation associated with environmental flows. These issues are raised in the contextual profiles.

Social learning

Social learning does not simply refer to learning within a social environment. It has very specific epistemological and ontological underpinnings that distinguish it from conventional (traditional) learning practices and processes. In many senses it can be taken to be closely aligned with the sustainability movement. It has its roots in education for sustainability and environmental education processes and practices (Wals and Jickling, 2002) and draws heavily on social constructivist views of learning and knowledge.

The concept of social learning is built on the likelihood of confronting diverging norms, values, interests and constructions of reality in moving towards sustainable living. A key premise is that such differences need to explicitly recognised rather than concealed. The main processes of social learning entail deconstructing the differences in order to understand and analyse the roots and persistence of the divergence so that a collaborative change process can be embarked upon (Wals, 2007). Alternatively put: social learning includes a critical analysis of own values, interest and constructions of reality (deconstruction), exposure to alternative ones (confrontation) and the construction of new ones (reconstruction). The aim is to encourage, promote and develop social relationships and mutual respect (social capital) so that a group can become more open to alternative ideas and with that more resilient and responsive to challenges both from within and from outside.

Social learning is seen as emerging from, and being a condition for, a process of change (Proost and Leeuwis, 2007). Social learning needs to be regarded not as an instrument, but as process strategy to support the emergence of innovation. The value of difference and diversity in generating creativity is an important consideration for scholars of social learning processes (Wals, 2007). They speak of the importance of ‘social cohesion’ and ‘social capital’ in creating change and building resilience in complex situations characterised by varying degrees of uncertainty. The importance of collaborative action that preserves the unique qualities of each individual is emphasised (Apple, 2007).

The social aspect in social learning refers to the social relationships between stakeholders and the methods of creating dialogue and brings people together in platforms. According to Proost and Leeuwis (2007) there is a list of preconditions for social learning, thus:

- Sense of urgency
- Feelings of interdependence amongst stakeholders (what is a commonly held interest or goal)
- Stakeholders organise themselves for negotiation: meetings and other opportunities for interaction
- A degree of confidence that a negotiated outcome satisfying to all parties will be reached
- A degree of institutional space to implement outcomes
- Accepted leadership of the process
- Process facilitation
- Reflection built in from the start

The strong focus on decentralised democratized processes in water management places a high degree of responsibility on local stakeholders in terms of decision making and management. This situation calls for learning, adaptation and response to an ever evolving context.

The processes of social learning will have growing applicability as action projects are initiated in Phase II. Also as the development of CMSs occurs so will the engagement of a number of stakeholders in strategic planning be a valuable opportunity for social learning to take place.

Multiple stakeholder platforms for learning and collective action

The role of bringing stakeholders together to negotiate the management of limited resources is recognised as a global trend and reflected in the NWA through its emphasis on the public participation in matters regarding water resources management. IWRM is a management approach which requires the active participation of multiple parties, across multiple levels, in many different ways. Given the history of water management in South Africa, IWRM requires a change from single-sector, centralised, delivery-oriented management to sector-integrated, locally focused management which includes the interests of diverse stakeholders. IWRM and Participatory Water Resources Management are inseparable.

The expectation in employing such an approach is that water users, with different stakes and views of how the resource should be managed, arrive at a strategic plan for a specific hydrological region. Essentially this entails decentralisation and democratization of water management functions where various stakeholder groups are engaged in platforms for participation and decision making. These are commonly called multiple stakeholder platforms (MSPs) (Steins and Edwards, 1998, Warner and Verhallen, 2005 and Warner, 2007). MSPs therefore give meeting to the decentralization process by providing spaces where stakeholders can be involved in processes of improving specific situations/conditions that adversely affect them. An MSP has been formally defined as a "*decision-making body (voluntary or statutory) comprising different stakeholders who perceive the same resource management problem, realise their interdependence for solving it, and come together to agree on action strategies for solving the problem*" (Steins and Edwards, 1998:1).

The processes that are associated with MSPs are more important than the actual entity. Processes enable different individuals and groups to enter into dialogue, negotiation, learning, decision-making and collective action. In practical terms, platforms are intended to be more than places where stakeholders defend vested interests in water resources. They are platforms where collaborative planning occurs and actions initiated. Ideally the platform should emerge from the interactions and should not be established in a vacuum or prior to the process of interaction. A typical MSP process consists of three stages: planning strategically (planning), implementing and managing (acting) and learning and adapting (reflecting/reviewing) (Proost and Leeuwis, 2007).

CHAPTER 3. STUDY SITES: AN OVERVIEW OF THE SIX CATCHMENTS

3.1 Introduction

The study area comprises six major rivers of the South African lowveld, a vast plain that lies in the north-east of southern Africa extending from the Drakensberg Escarpment and western Soutpansberg Mountains to the Indian Ocean. These are the Luvuvhu, Letaba, Olifants, Sabie-Sand, Crocodile and Komati Rivers (Figure 3.1). In South Africa these rivers and their catchments are part of three Water Management Areas (WMA): the Luvuvhu/ Letaba WMA in the north of the study site, the Olifants WMAs in the central region, and the Inkomati WMA, which comprises the Sabie-Sand, Crocodile and Komati Rivers in the south. All six rivers contribute to international watercourses, the Limpopo and Incomati basins. The Luvuvhu/ Letaba and Olifants WMAs collectively contribute to Limpopo Basin which is shared between Botswana, Zimbabwe, South Africa and Mozambique. In South Africa this basin also includes the Limpopo WMA which was not examined as part of this study. The Inkomati WMA is part of Incomati Basin which is shared between Mozambique, Swaziland and South Africa. The transboundary nature of the Inkomati WMA places certain international obligations on South Africa for cross-border flow. All six rivers either flow through or border the Kruger National Park (KNP) which now forms part of the Great Limpopo Transfrontier Conservation Area (GLTFCA). This flagship conservation area, ratified in 2002, spans across South Africa, Mozambique and Zimbabwe.

In the west, the Drakensberg Escarpment and a small portion the Soutpansberg in the north forms the divide between South African highveld (between 1500 and 15 00 m.a.s.l.) and the dominant plains of the lowveld with an average altitude of between 400 and 150 m.a.s.l. All the rivers have their source in the high-lying regions and then descend into the lowveld where they join either the Limpopo of Incomati systems. The Incomati flows into the Indian Ocean at Marracuene some 30 km north of Maputo and the Limpopo some 200 km further north at Xai-Xai. With the exception of the high-lying regions in South Africa, the majority of the both basins receive 600 mm of rainfall or less and mean annual evaporation exceeds is in excess of rainfall (FAO, 2004; ICMA, 2010). This implies that most agricultural activities require irrigation. These factors highlight the vulnerability of the area in terms of water security and the importance of the study rivers to the area which in the South African portion alone is home to some 4,311,350 people. It also illustrates the importance of strategic national and transboundary plans and processes to ensure the long-term sustainability of these water resources (see Chapter 3 and 5).

The following sections will provide an overview of the biophysical and socio-economic attributes as well as the situation with respect to water resources for each of the WMAs of the study area. This provides the context for the findings of the research given in Chapters 5 to 9.

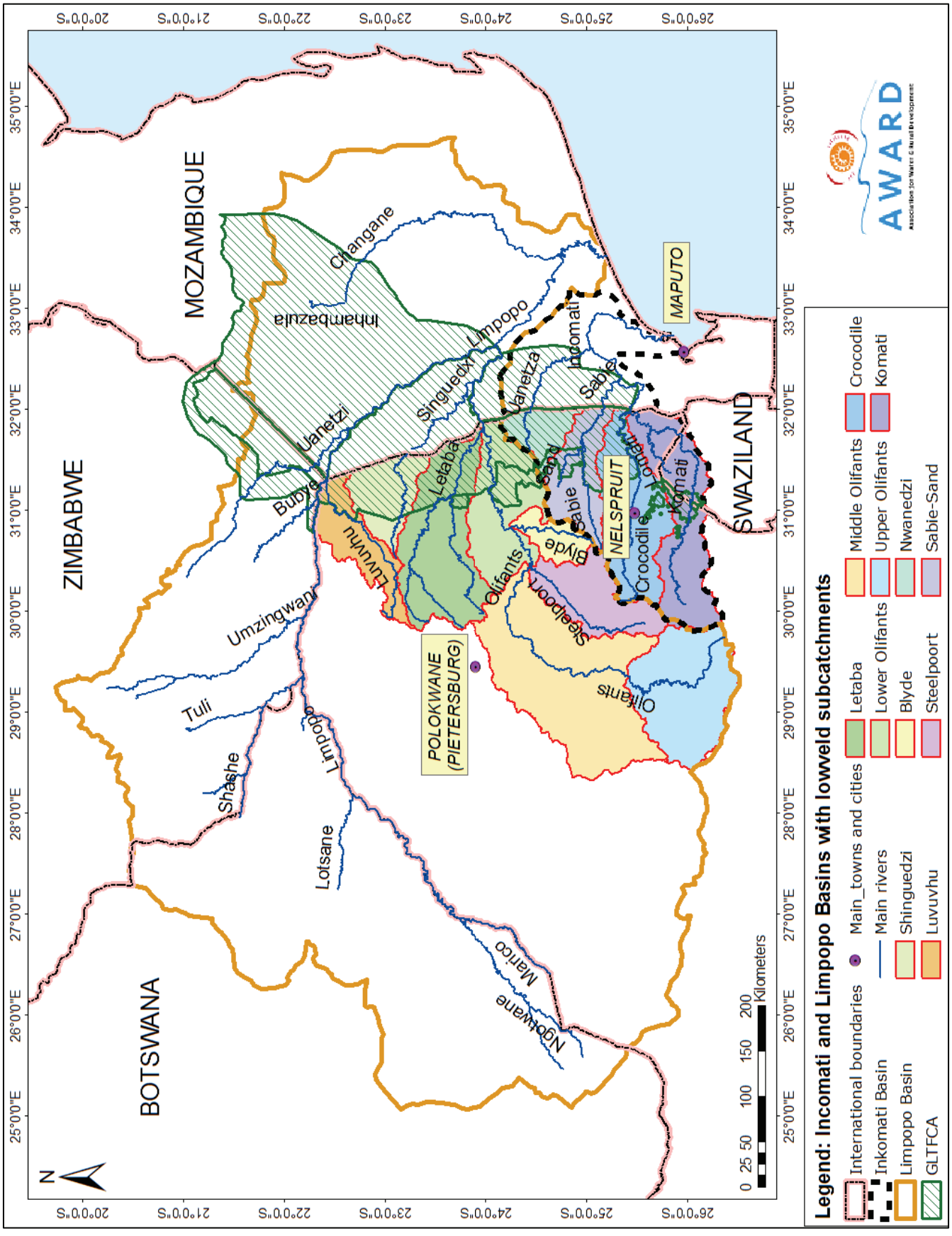

Figure 3.1: Map showing the six lowveld rivers, the three Water management areas in which they occur and the two respective basins.

3.2 The Luvuvhu/ Letaba Water Management Area

The Luvuvhu River Catchment covers a total area of 3,800km² and the Mutale River catchment, 2,150km². The Luvuvhu Catchment is drained by the Luvuvhu River and its major tributaries the Latonyanda, Mutshindudi and Mbwedi rivers (Figure 3.2). The Mutale catchment is drained by the Mutale River and its main tributary, the Mbodi River. The Luvuvhu River supports important ecosystems including the Luvuvhu Gorge on the western boundary of the Kruger Park and the Pafuri Floodplain which is subject to increasing threat from upstream abstractions. The Mutale River drains the northern slopes of the Soutpansberg, which is more arid and less developed than the catchment of the Luvuvhu River. Lake Fundudzi, a holy place for local people, is the source of the Mutale. A number of wetlands such as Sambandou are of ecological importance and threatened by agricultural development.

Photo 1: Lake Fundudzi along the Mutale River is a lake of important cultural significance.

Photo 2: Due to poor landuse practices on the surrounding slopes, massive sediment loads are being dumped into Lake Fundudzi causing serious sedimentation problems which threatens the existence of the lake.

The Letaba River Catchment with an area of 13,500 km^2, comprises the Groot Letaba sub-catchment in the south and the Klein Letaba in the north (Figure 3.2). The Middle Letaba River which flows in a north-easterly direction drains into the Klein Letaba just downstream of the Middle Letaba Dam. The confluence of the Groot and Middle Letaba Rivers is at the KNP border and that with the Olifants River is 7 km upstream of the Mozambique border.

The main urban area of the Luvuvhu Catchment is Thohoyandou. The main urban areas are Tzaneen and Nkowakowa in the Groot Letaba River Catchment and Giyani in the Klein Letaba River Catchment.

3.2.1 Overview of biophysical attributes

The topography of this WMA varies from a zone of high mountains in the west through low mountains and foothills in the central part of the WMA to the low lying plains in the east. The mountainous zone or Great Escarpment includes the northern portion of the Drakensberg Mountain range and the eastern Soutpansberg. The Soutpansberg Mountains which form the northern boundary of the Luvuvhu Catchment have a major effect on the hydrology as a result of the higher rainfall associated with this topographic influence.

The mean annual temperature ranges from about 18°C in the mountainous areas to more than 28°C in the eastern parts of the WMA with an average of 25.5°C for the WMA as a whole. Maximum temperatures are experienced in January and minimum in July. Rainfall is strongly seasonal and occurs mainly during the summer months (i.e. October to March) and is strongly influenced by the topography. The peak rainfall months are January and February. The mean annual precipitation varies from less than 450mm on the low lying plains (northern and eastern part of the WMA) to more than 1500 mm in the mountainous west.

The geology varies over the WMA. In the Luvuvhu, the geology consists mainly of sedimentary rocks in the north and metamorphic and igneous rocks in the south. High quality coal deposits are found near Tshikondeni and in the northern part of the KNP. The Bushveld Igneous Complex touches on the southern parts of the WMA. In the Letaba, the geology is predominantly made up of granites that allow shallow weathering and the development of sand soils and numerous diabase dykes.

Photo 3: The catchments of the lowveld are home to some of the world's most important species from a tourism perspective, however the role that rivers play in sustaining their ecosystems is under appreciated.

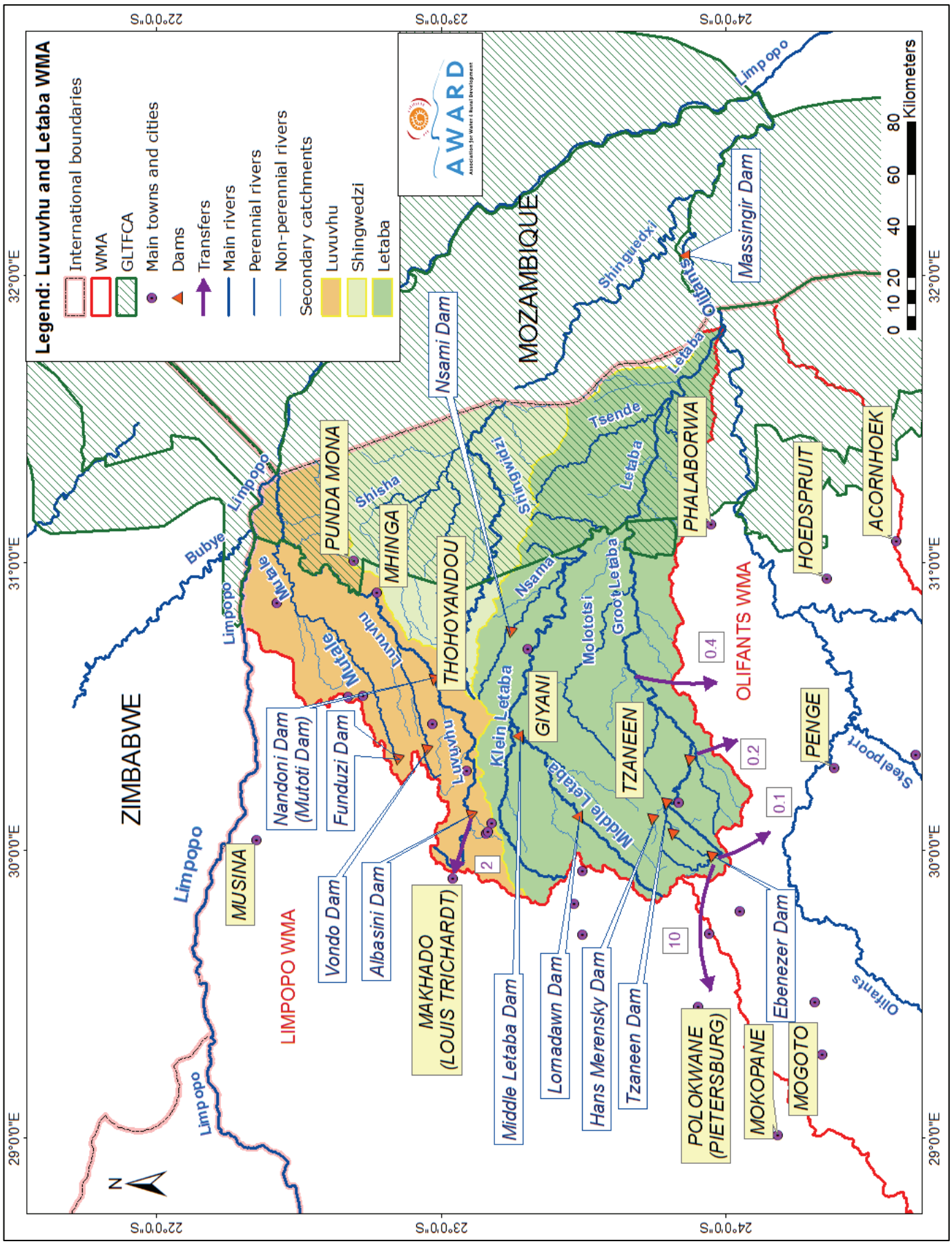

Figure 3.2: Map showing the Luvuvhu and Letaba WMA with main rivers, dams and transfers.

Land use

The major land uses include irrigated, commercial agriculture, afforestation and small-scale, rain-fed agriculture (Figure 3.3). Coal mining takes place in the lower Mutale catchment. The western portion of the catchment is under conservation. The legacy of former bantustans of the apartheid regime is evidenced in the densely-populated rural areas of the Middle Letaba, the lower Groot Letaba and some parts of the Luvuvhu Catchment.

The western third of the Luvuvhu Catchment is principally under agriculture, whilst forestry dominates the higher lying areas in the Soutpansberg Range. There is extensive development of smallholdings for fruit farming in the upper reaches. The Levubu Irrigation scheme is situated directly below the Albasini Dam, although allegations are that the scheme is empty due to increased use for Makhado. There are a number of tea and coffee estates supplied by Vondo Dam, Makumbane Dam, and Mambedi Dam and from run of river. The middle region is densely populated with urban, semi-urban and rural settlements practicing subsistence agriculture. There are plans to revive smallholder irrigation schemes, some of which have started. The lower, eastern reaches comprise conservation areas of the Makuya and Kruger National Park.

The Mutale catchment is less developed and is predominantly rural in nature with dryland and small-scale, irrigated farming. Schemes here are also in the process of being revitalized. There are two main mines within the catchment; the Tshikondeni Coal Mine and the Geocapro Magnesite Mine. These reportedly have no significant impact on the hydrology or water quality in the catchment. Water use by the mines is also very limited.

Intensive commercial, irrigated agriculture is practiced in the upper parts of the Klein Letaba Catchment, upstream and downstream of the Middle Letaba Dam, and along the Groot Letaba and Letsitele Rivers. Citrus, tropical fruit and vegetables (including the largest tomato production area in the country) are grown. Large areas of the high rainfall Drakensberg Escarpment and Soutpansberg are under commercial forestry. Land and water resources available for agriculture are already highly utilised, particularly with respect to irrigation and afforestation.

3.2.2 Overview of socio-economic characteristics

The population of the Luvuvhu/Letaba WMA was estimated at some 1.535,000 people (1995 population) of which over 90% reside in the rural areas DWAF, 2003b (Figure 3.3). A large proportion of these people are regarded as poor and live in the densely-populated areas that constituted the former apartheid bantustans of Lebowa and Gazankulu. These areas are also characterized by major socio-economic problems (poor education standards, high unemployment (formal – estimated at 49% of the workforce), and high level of HIV-Aids). According to the ISP, based on figures from nearly 10 years ago, the largest economic sectors in the WMA are government, trade and agriculture. Most of the economic activity is centred in the Tzaneen area with the surrounding activities in irrigation and afforestation (agriculture, trade). Tourism, associated with the KNP, is also an important sector.

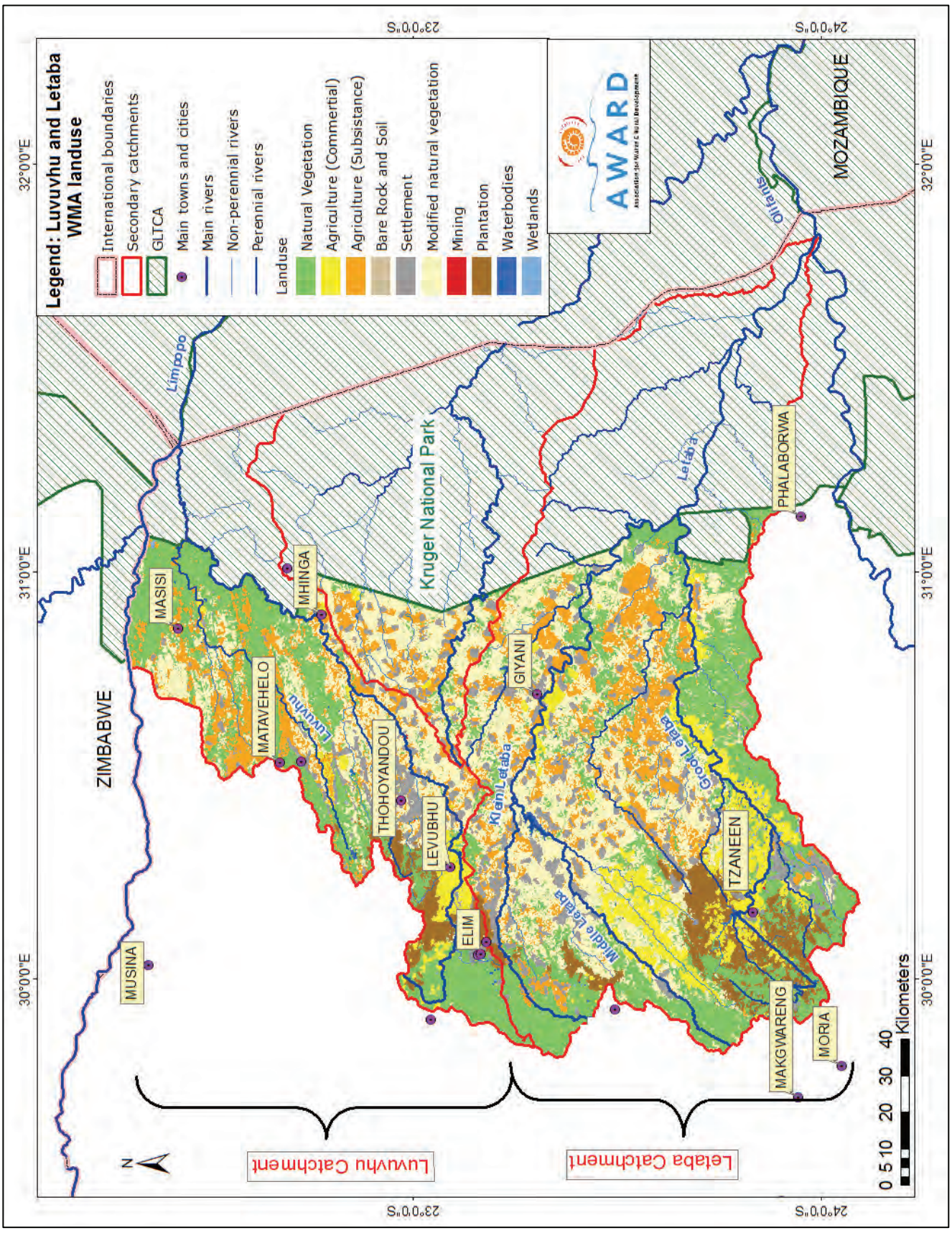

Figure 3.3: Map showing landuse and settlements in the Luvuvhu and Letaba WMA

3.2.3 Water resources and water balance

A number of regional water supply schemes have been developed to supply water for domestic, irrigation and industrial purposes. These are detailed in the relevant catchment profiles (see Deliverables 2, 3 and 4).

The water resources availability, demand and reconciliation are shown in Table 3.1. These figures indicate that the Letaba catchment is in deficit of 42 M m^3/a (based on 2000 estimates (DWAF, 2004c)). A recent study on systems operation for the Letaba River suggests that the domestic demand is higher than the figures presented below (34 Mm^3/a; S. Mallory, IWR Africa, pers. comm.). In the Luvuvhu Catchment water resources were fully utilized until the completion of the Nondoni Dam (so much so that groundwater is the main source of water for smallholder farms below Albasini Dam). Alien invasive vegetation is a particular problem in the upper reaches of the Luvuvhu Catchment (estimated to be 168 km^2) and removal will increase resource availability.

Table 3.1: Summary of the water resources, demand and balance from the ISP (DWAF, 2004c)

Availability/ use	Luvuvhu	Mutale	Groot Letaba	Klein Letaba	Lower Letaba
MAR	520	see Luvuvhu	382	151	42
Total local yield	**143**	**27**	**159**	**32**	
Use					
Urban	5	0	3	3	
Rural	9	2	10	8	
Industry/Mining	0	1	0	0	
Irrigation	83	24	133	25	
Afforestation	6	1	35	1	
Total demand	**103**	**28**	**181**	**37**	
Transfer in	4	5	0	0	0
Transfer out	7	4	15	0	0
Balance (incl. Desktop Reserve)	**37**	**0**	**-37**	**-5**	**0**

Letaba Catchment

The surface water resources are extensively developed with a large number of small to major dams constructed to meet domestic (urban and rural), irrigation and industrial water needs (DWAF, 2004c; Appendix 3.1). The water supply schemes generally consist of dams for storage, bulk water pipelines and extensive conveyance canals. The largest water user is irrigation followed by forestry.

The water quality is generally regarded as good in the upper reaches but deteriorates somewhat in the lower reaches due to salination from natural sources, as well as nutrient enrichment due to human activities such as the discharge of treated domestic wastewater and run-off from agricultural areas.

There are no transfers into the Groot Letaba River. However, there is a significant transfer out to Polokwane and an annual allocation of 18,5 Mm^3/a is exported from the Dap Naude Dam and Ebenezer Dam (Baker, 2007). The bulk is from the Ebenezer Dam (allocation of 12 Mm^3/a which is exceeded – see Chapter 6).

The ISP noted the following:

- The Groot Letaba is in deficit although users upstream of the Tzaneen Dam enjoy a relatively high level of assurance while those downstream experience shortages. Irrigation of mostly perennial high-value crops has expanded to fully utilise the water resources prior to any allowance for the Ecological Reserve. Financial losses during droughts have resulted in high efficient water use by irrigators.
- Large-scale afforestation in the upper catchments has a large impact on the water resources.
- The Reserve implementation will have socio-economic consequences. The broad longer-term strategy is to implement compulsory licencing. Also, the construction of Nwamwitwa Dam and the raising of Tzaneen Dam wall are expected to mitigate negative impacts and secure the Reserve.

Klein Letaba

The situation in the Klein Letaba is regarded by various people as "chaotic" (see Chapter 6). The original estimates of the yield of the Middle Letaba Dam are believed to be highly over inflated. This, together with rapidly increasing supply from this dam to meet domestic requirements for Giyani and other towns has resulted in downstream irrigators experiencing serious deficits and the scheme has fallen into disuse. The ISP also noted the following issues.

- Water conservation and demand management measures are soon to be implemented in the Giyani area to curtail inefficient and wasteful water use.
- Compulsory licencing will not solve the problem of deficits downstream of the Middle Letaba Dam and this is therefore not recommended.

Given the reconciliation concerns, DWA has initiated the Greater Letaba Water Project (GLWP) (Box 3.1) which will provide up-to-date water use figures.

Box 3.1: DWA and the Greater Letaba Water Project (GLWP)

(http://www.dwaf.gov.za/projects/GrootLetaba/)

Demands on the water resources of the Groot Letaba River can no longer be met within reasonable risks of shortages from the existing infrastructure. Due to this situation DWA is re-assessing how best to manage the supply of water from the Groot Letaba River system. The system includes Dap Naude, Ebenezer and Tzaneen Dams and other smaller dams. Practical implementation of water releases for the Reserve in the Groot Letaba River system as a whole is being investigated. Investigations include an assessment of the yield characteristics of all available resources in the river system serving the wide variety of user sectors and abstraction points.

Luvuvhu/ Mutale Catchment

Agricultural development in the headwaters of the Luvuvhu River has had a significant impact on the water supplies available from Albasini Dam. Added to this is the impact of forestry development in the Soutpansberg which has also impacted on the water resources. Major dams include the recently-completed Nandoni dam, and the Vondo, Albasini, and Damani dams and smaller Tshakhuma and

Mambedi Dams (see Deliverable 2). Some 2.4 Mm^3 of water is allocated for transfer from Albasini Dam to Makhado Municipality in the Limpopo WMA. However, only about 1,6 million m^3/a has been available in the past due to the low yields from Albasini Dam. No major storage dam exists in the Mutale catchment. Extensive areas of irrigable land occur in the lower reaches of the Mutale River but development is limited, partly by the availability of water at reasonable cost.

In summary the ISP makes the following points:

- Water requirements have exceeded availability in the Luvuvhu Catchment (mainly for irrigation) but the completion of the Nandoni Dam has resulted in a surplus of 37 Mm^3/a becoming available in the Luvuvhu catchment.
- There is a high but unmonitored groundwater use in the Luvuvhu catchment and impacts on the surface water resource are uncertain but need to be investigated.

3.3 The Olifants Water Management Area

The Olifants Water Management Area (WMA 4) has a surface area of approximately 54 550 km^2. It comprises seven secondary catchments (B4) which show significant variations in climate, water availability, level and nature of economic development, and population density. As such DWA (DWAF, 2004d) divided the WMA into sub-areas to facilitate improved management of water resources. We have further separated the Blyde sub-area from the Lower Olifants as this has unique characteristics. Thus this report will discuss the five sub-catchments, namely the Upper Olifants, Middle Olifants, Steelpoort, Blyde and Lower Olifants (Figure 3.5 and 3.6).

The **Upper Olifants** which constitutes the catchment of the Olifants River from the source down to Loskop Dam.

The **Middle Olifants** comprises the area downstream of Loskop Dam to the confluence of the Steelpoort River, a (river) distance of approximately 302 km.

The **Steelpoort** Catchment

The **Blyde** Catchment bounded by the Steelpoort and Lower Olifants boundaries.

The **Lower Olifants** represents the catchment of the Olifants River between the foothills of the Drakensberg Escarpment and the Mozambique border.

Figure 3.4: Map showing the Olifants WMA with main rivers and dams.

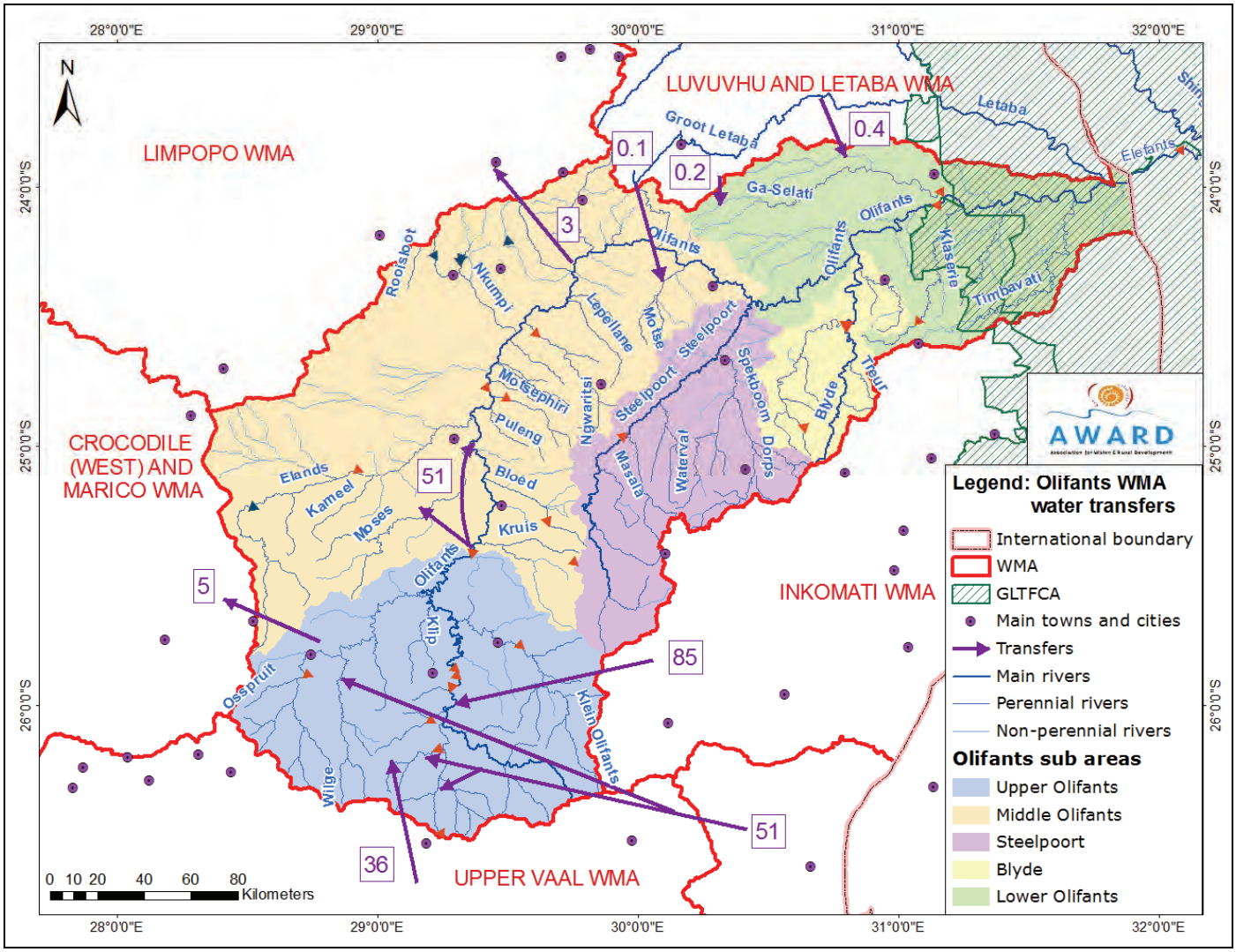

Figure 3.5: Map of the water transfers in the Olifants WMA.
See Figure 3.6 for more details on dams and major towns in the WMA.

3.3.1 Overview of biophysical characteristics

At its source the river flows through gently rolling hills in the highveld with an average altitude of 1473 m.a.s.l. Below Loskop Dam the river descends to the middleveld with an average altitude of 869 m.a.s.l. until the Drakensburg escarpment. Thereafter the river descends rapidly through the Olifants gorge to enter the flat wide expanse of the Lowveld region (400-150 m.a.s.l) in the north east before flowing into Mozambique and joining the Limpopo River. Rainfall and temperature are strongly influenced by the topography; in general rainfall declines as the landscape changes from highveld to lowveld (with the exception of the area around Wilge) whilst temperatures increase with decreasing altitude.

The mean annual temperature ranges from 14°C in the southwest to more than 22°C in the northeast parts with an average of 16°C for the WMA as a whole. Maximum temperatures (34.1ºC) are experienced in January and minimum in July (5.5ºC). Rainfall is strongly seasonal and occurs mainly during the summer months (i.e. October to March). The peak rainfall months are January and

February. The mean annual precipitation varies from 500 mm in the highveld, to 1000 mm in the mountainous areas of the middleveld, to less than 500 mm at the border with Mozambique. The mean annual gross evaporation ranges from 1300 mm to 2000 mm over the WMA, reaching a maximum of 2000 mm over the Springbok flats in the eastern part of Middle Olifants sub-area.

The geology consists of hard rock igneous formations in the central part of the Olifants WMA, predominantly made up of Bushveld Igneous Complex. Rich coal deposits occur in the Upper Olifants Catchment, specifically in the Witbank-Middleburg-Trichardt region. There is a large dolomite intrusion extending along the Blyde River and further northwest along the WMA boundary.

Land cover/ land use

The major land uses in the catchment include irrigated commercial agriculture, afforestation, livestock and game farming, mining and small-scale, rain-fed agriculture (Figure 3.7). The eastern portion of the catchment is under conservation. The densely-populated former bantustans occur in the Middle Olifants. Large areas of rain-fed agriculture occur in the southern and north-western parts of the WMA (grain and cotton). Over-grazing is prevalent in many areas. Intensive commercial (irrigated) agriculture is practiced around Loskop Dam, and in the Lower Olifants River near the confluence of the Blyde and Olifants Rivers as well as along the upper Selati River. Some high rainfall areas of the Drakensberg – specifically the Blyde River Valley – are under commercial forestry. Game farming contributes to a successful tourism industry (DWAF, 2004f).

3.3.2 Overview of socio-economic characteristics

The estimated population was 2.8 million in 2000 (DWAF, 2004d). The Middle Olifants is distinctive; although it is home to over 67% it has limited services and commerce. Again, the former apartheid bantustans of Lebowa, KwaNdebele, Boputhatswana and Gazankulu that comprised this area are characterized by major socio-economic problems. The main urban areas are found in the Upper-Olifants sub-area. Main towns in the WMA are as follows: Witbank, Bronkhorstspruit and Middleburg in the Upper Olifants, Marble Hall, Jane Furse, Mogoto, Lebowakgomo, Moria and Penge in the Middle Olifants, Lydenburg and Burgersfort in the Steelpoort Catchment and Phalaborwa and Hoedspruit in the Lower Olifants area.

According to the ISP, based on figures from a decade ago, the largest economic sectors in terms of GGP in the WMA are mining (22%), manufacturing (18%), electricity generation (16%), government (16%) and agriculture (7%). Economic activity in this WMA is centred around the Highveld region, Middleburg-Belfast area and Phalaborwa which are important mining areas. Middleburg and Witbank are economic hubs with their steel mills. The energy sector is located in the Highveld region. There are six active coal fired power stations in the WMA (Arnot, Duvha, Hendrina, Kendal, and Komati). Their impacts on pollution of surface and groundwater resources are managed, theoretically, through licencing procedures. The atmospheric deposition of emissions from the power stations have been cited as a source of salinity both in the Olifants and the Upper Vaal WMAs (Herold and Gorgens, 1991)

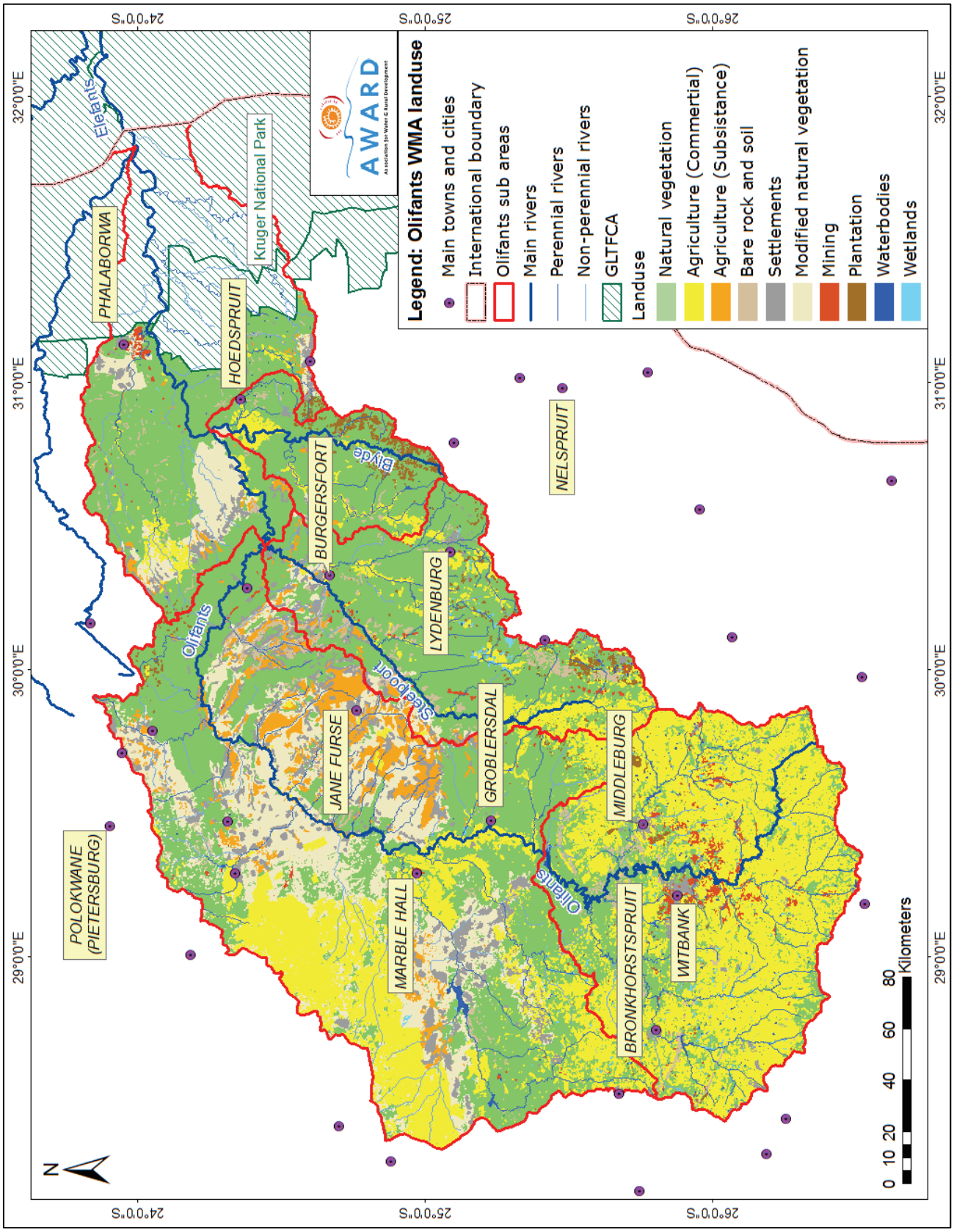

Figure 3.6: Map showing landuse and settlements in the Olifants WMA.

3.3.3 Water resources and water balance

The following figures on water resources availability and demand are those given in the Internal Strategic Perspective or ISP (DWAF, 2004d). However, there are a number of later reports being finalised for the upper and middle Olifants[13] or currently underway. The current DWA study entitled *The Development of a Reconciliation Strategy for the Olifants River Water Supply System* will re-examine the water resources and water balance given the changes that have occurred in the last decade.

According to the ISP, the surface water resources are extensively developed with a large number of small to major dams (see Appendix 3.2 and Figure 3.5) constructed to meet domestic (urban and rural), irrigation, mining (especially coal) and industrial water needs (DWAF, 2004f). The Department notes that: *"The current deficit situation in the WMA, even without allowance for the EWR, shows that the WMA is already under stress. This implies that no further abstractions can be allowed from the resource at the current level of water supply infrastructure development."* (DWAF, 2004d). By far the largest water user is irrigated agriculture especially in the Middle Olifants (Figure 3.7 and 3.8).

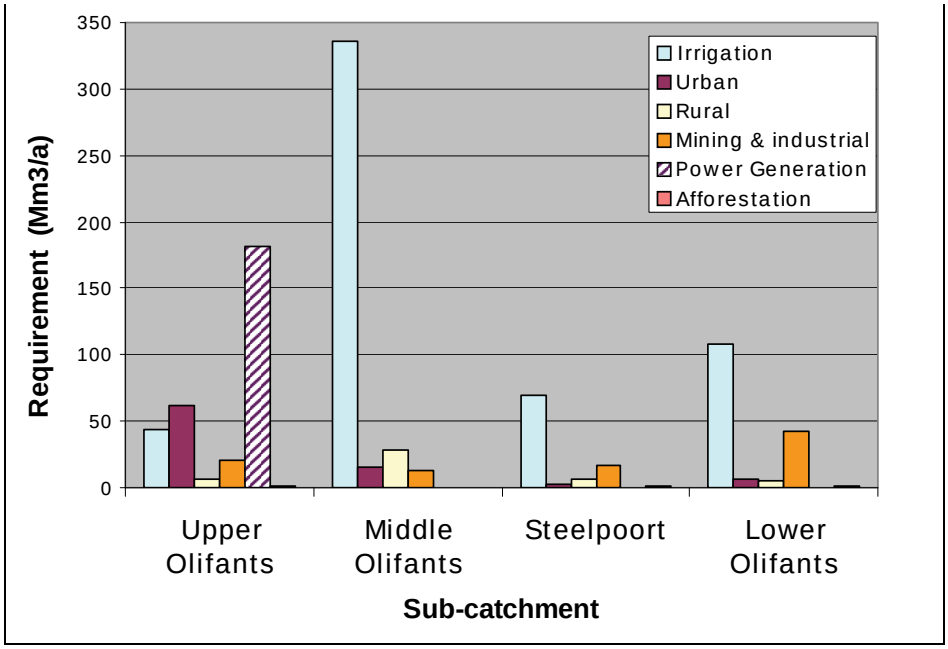

Figure 3.7: Water requirements in the Olifants WMA (2000)

The overall water resources situation is indicated in Table 3.2 which shows that the catchment is in deficit of 192 M m^3/a (based on 2000 estimates) whilst current work suggests this may be significantly greater (Mallory, IWR Africa, pers. comm.).

[13] Water Availability Assessment Study and Integrated Water Resource Management Plan for the Upper and Middle Olifants Catchment

Table 3.2: Summary of the water resources, demand and balance for the Olifants WMA (DWAF, 2004d)

Availability/ Use	Upper Olifants	Middle Olifants	Steelpoort	Lower Olifants	Total
Total local yield	238	210	61	100	**609**
Transfers in	171	92	0	1	264
Grand Total Water Availability	**409**	**302**	**61**	**101**	**873**
Use					
Irrigation	44	336	69	108	**557**
Urban	62	15	3	7	**87**
Rural	6	28	6	5	**45**
Mining and industrial	20	13	17	43	**93**
Power Generation	181	0	0	0	**181**
Afforestation	1	0	1	1	**3**
Total requirements	**314**	**392**	**96**	**164**	**966**
Transfers out	96	3	0	0	**8**
Grand Total	**410**	**395**	**96**	**164**	**974**
Balance	**-1**	**-93**	**-35**	**-63**	**-192**

Water quality

The declining and precarious state of the water quality in the Olifants WMA has received increasing attention and public concern over the last two years principally as a result of the threats related to acid-mine drainage, the increased mining activity in the upper catchment, poor waste-water and sewerage treatment plants and the death of crocodiles in the lower Olifants after the raising of the Massingir dam wall (Mozambique). Given this we summarise some of the major quality concerns below from the ISP (DWAF, 2004d – see summary in Table B.22) whilst more general issues are summarised in Table 3.3. A recent study is also underway to examine the water quality issues (P.J. Oberholster, Assessment of eutrophication and chemical pollution in surface waters of the Upper Olifants River system: Implications for aquatic ecosystem health and the health of human users of water):

The water quality is reduced in the **Upper Olifants** due to mining activity, specifically from the coal mines. Some 62 Mm^3/a is predicted to decant from workings post closure[14]. More recent exposure in the press regarding the impacts of mines has raised public attention regarding the urgency of addressing this issue (50/50 7th June 2010). Municipalities have also been implicated in terms of contributing to water quality problems (DWAF, 2010).

The water quality in the **Loskop Dam** has deteriorated over time although is still maintained via the Wilge River. This is of serious concern to commercial farmers downstream of Loskop Dam (see aforementioned study).

[14] The quality of the mine water varies depending on the local geology. Mine water is acid in Klipspruit, Spookspruit and parts of Middelburg Dam catchment. Heavy metals such as iron, aluminium, and manganese are associated with low pH waters. Mine water is generally high in dissolved solids with sulphate the dominant- or indicator – anion and calcium and magnesium the cations. Some of waters contain high sodium particularly in Middelburg Dam catchment.

A study to quantify the **groundwater resources in the Steelpoort** reports that the water quality of these resources is under threat from the mining and agricultural activity.
The ISP reports that the water quality problems in the **Middle and Steelpoort** areas are *salinity, eutrophication, toxicity and sediment. The salinity and eutrophication problems are due to the irrigation return flows, mining impacts and sewage treatment plant discharges. Pesticides and herbicides have been cited as the cause of the toxicity problems but this needs to be confirmed by monitoring*.
Also, water in the Middle and **Steelpoort** Catchments and isolated areas of the Lower Olifants Catchment is impacted by high nitrate concentrations due to agriculture fertilizer applications and poor agricultural practice. Poor rural sanitation systems also increase the nitrate concentrations in the rivers.
In the **Lower Olifants**, the water quality is influenced by the water quality of the return flows from the mining complex around Phalaborwa in the Ga-Selati River
The water quality of the **Blyde and Mohlapitse Rivers** is good and maintains the water quality in the Olifants River in the KNP at an acceptable quality.
In terms of management, water quality cannot be managed separately to quantity (DWAF, 2004d). DWAF (now DWA) notes that the direct discharges to rivers are licenced and managed on the basis of assimilative capacities of those rivers, and on the receiving water quality. However, these limits are often exceeded through the **cumulative impact of diffuse discharges**, impacting negatively on users downstream.

The quality of groundwater is naturally of a high standard in this WMA according to the former DWAF (DWAF, 2004d), although high iron and fluoride concentrations are found in some areas. However the coal mining threatens the ground water quality due to acid mine leachate.

Table 3.3: Summary of water-related land uses per area and major issues as identified by DWA (DWAF, 2004d; f). These guided much of the research focus of this project

Land use per area	Major issues identified by DWA (DWAF, 2004c; e)
Upper Olifants The main land use practices are the WMA's two main towns (Witbank and Middleburg); extensive dryland agriculture; commercial agriculture; mining (mainly coal); thermal power stations (coal powered); some wetlands and some plantations.	*There is very little scope to further develop the surface water resources. Future requirements will have to be met by transferred water at full cost. This will only be considered after the implementation of WC&DM and the development of local resources have been considered* (DWAF, 2004f). The Olifants WMA as a whole is in deficit although the Upper Olifants sub-area is essentially in balance (DWAF, 2004d). However the assurance of supply is predicted to drop as urban demands increase. Water quality will be under threat when coal mines close. There is concern over the pollution of ground water with acid mine leachate in the coal mining areas Reserve implementation likely to impact on socio-economic development

Middle Olifants The main land cover/land use practices are irrigated agriculture below Loskop Dam; dryland irrigation; rural settlements; degradation; some plantations; wetlands; alien vegetation.	The Middle Olifants sub-area has the highest deficit of water Large irrigation developments exist downstream of Loskop Dam. Some of the irrigation schemes in this sub area have fallen into disuse; however they are being revised as part of a poverty eradication initiative. Substantial potential for increased groundwater utilisation has been identified on the Nebo Plateau (in the vicinity of Jane Furse). Severe land degradation due to overgrazing and poor agriculture practices.
Steelpoort The main landuse practices are agriculture (dryland and large-scale irrigated); mining (mainly ferro-chrome, chrome and platinum); there are also mineral processing plants associated with mines; rural settlements; wetlands; some plantations; and the town of Lydenburg.	The Steelpoort sub-area is in deficit for the current level of water infrastructure development. Water quality is good however salinity, eutrophication, toxicity and sedimentation are a problem (see earlier). Agriculture is the main land use in this largely rural sub area. There is extensive irrigation in some areas DWAF, 2004d. There are irrigation schemes but many have fallen into disuse (like in the Middle Olifants), but also plans to revise these exist. Ground water is important for rural livelihoods, but the quality and quantity of this is under threat from mining. Compulsory licencing must be implemented to free up water for Ecological Reserve and address the water deficit.
Blyde The main landuse practices in the Blyde sub-area are irrigated agriculture (mainly citrus and mangos); extensive; Blyde River Canyon (tourism) – Blyde National/Provincial Park.	*Extensive irrigation takes place along the Olifants River, in the Blyde River catchment* DWAF, 2004d. The Blyde River is essential in meeting the water quality and minimum flow requirements set for KNP at the Phalaborwa Barrage. Further development of the groundwater resources is not advised as this will directly impact on surface water flows due to the inter-connectivity of the dolomite aquifer and surface waters Large-scale afforestation in the Blyde sub-area has a large impact on the water resources.
Lower Olifants The main land use practices are irrigated and dryland agriculture; degradation, mining before KNP (mainly phosphate, copper and associated deposits); the town of Phalaborwa.	Water quality problems are also experienced due to the discharge of mine effluent in the Phalaborwa area

Given the reconciliation concerns, DWA has initiated the Olifants River Water Resource Development Project (ORWRDP) (Box 3.2).

Box 3.2: DWA and the Olifants River Water Resource Development Project (ORWRDP)
(http://www.dwa.gov.za/ORWRDP/)

Water requirements in parts of the Limpopo and Mpumalanga Provinces are expected to increase significantly due to the expansion of current activities as well as new and proposed developments in the region, in particular the mining sector. In order to meet these social and economic development needs of the region, the DWA is currently assessing the feasibility of various water resource development options in the Olifants and Mogalakwena/Sand Catchments of the two provinces. The purpose and need for the ORWRDP are, therefore, to provide physical infrastructure (storage dams and associated bulk distribution system and pump stations) that will enable new allocations and the reallocation of water to meet current and future water needs of all sectors within the Olifants and Mogalakwena/Sand Catchments.

3.4 The Inkomati Water Management Area

The Inkomati WMA (WMA 5) covers an area of approximately 28,757 km2 (Figure 3.9). It is divided into three sub-catchments[15], as follows.

The **Sabie-Sand River Catchment** which lies in the north of the WMA. The Sand River is the main tributary of the Sabie.

The **Crocodile Catchment** (includes the regional capital of Nelspruit).

The **Komati Catchment**. The Komati River, which rises in South Africa, flows through Swaziland and then re-enters South Africa before flowing on into Mozambique;

The confluence of the Crocodile and Komati rivers lies just upstream of the Mozambique border at Ressano Garcia where after the river is known as the Incomati River. The Sabie flows into the Incomati below Corumana Dam near the town of Moamba.

As noted, these rivers are all part of the Incomati **international watercourse** which is shared between the Republic of Mozambique, the Kingdom of Swaziland and the Republic of South Africa.

[15] The undeveloped Nwanedzi River that is wholly within the Kruger National Park and is not considered in this report.

Figure 3.8: Map showing the Inkomati WMA with main rivers, dams, water transfers and the Inkomati Basin.

3.4.1 Overview of biophysical attributes

The topography of this WMA varies from a zone of high mountains of the Drakensberg Escarpment in the west with altitudes over 2000 m.a.s.l. through foothills in the central part to the low lying plains in the east. The Escarpment effectively divides the WMA into a western plateau or Highveld and sub-tropical Lowveld in the east. The Lebombo mountain range forms the eastern border of the catchment.

As with the other WMAs the topography strongly influences the rainfall. The mean annual rainfall varies from as high as 1445 mm/a in the escarpment and mountainous areas of the catchment (near Swaziland), to as low as 470mm/a in the lowveld region. The other climatic characteristics are similar to those given for the other WMAs.

Land use

The Inkomati WMA is dominated by extensive afforestation and irrigated, commercial agriculture (Figure 3.10; and see Table 3.4). It also has the largest number of previously disadvantaged and emerging farmers in the country. There are also significant urban, rural and industrial users in the catchment (ICMA, 2010). According to the Catchment Management Strategy (ICMA,2010), conservation areas cover some 35 % of the area including the Kruger National Park, the Sabie-Sand Wildtuin and other smaller reserves. Mining occurs mainly in the upper reaches of the Komati Catchment and to a lesser extent in the Crocodile and Sabie Catchments. Prospecting applications have increased significantly in the last two years (FSE pers. comm.). Approximately 9% of the WMA comprises 'communal lands'. Essentially these are the former bantustans of the apartheid system: Gazankulu, Lebowa and Kangwane.

Photo 4: The importance of natural ecosystems and tourism in the lower parts of all of the lowveld catchments is emphasised by the contribution they make to the regional GDP and job creation.

The most important sectors in terms of contribution to gross geographic product (GGP)[16] are as follows (ICMA, 2010): manufacturing – 24,6 %; agriculture – 18,6 %; government – 16,4 %; trade – 13,4 % and other – 27,0 %. Irrigated commercial agriculture is by far the biggest water user but also the largest provider of jobs.

3.4.2 Overview of socio-economic attributes

The population of the IWMA is estimated at 1,511,348 (ICMA, 2010). With a population of about 616,000, the Sabie Sand has the highest population of the three catchments, and by far the largest number occurs in the smallest Sand Catchment. The population of the Komati is 415 000 whilst that of the Crocodile is 478, 000 people. The area is predominantly rural and as described in the other two WMAs poverty is still rife in the former bantustans underscoring the pressing need for development including the increasing demands for water.

Land reform and water

An important characteristic of the WMA is the high number of land claims and beneficiaries. These are mainly on farm land and hence water plays a central role in ensuring their long terms sustainability. The CMS (ICMA, 2010) points out that in the Nkomazi region alone there are at least 125,124 beneficiaries of land as of June 2007. The total gazetted area under claim totals some 83,783 ha.

[16] GGP – total income or payment received by the production factors – (land, labour, capital, and entrepreneurship) – for their participation in the production within that area.

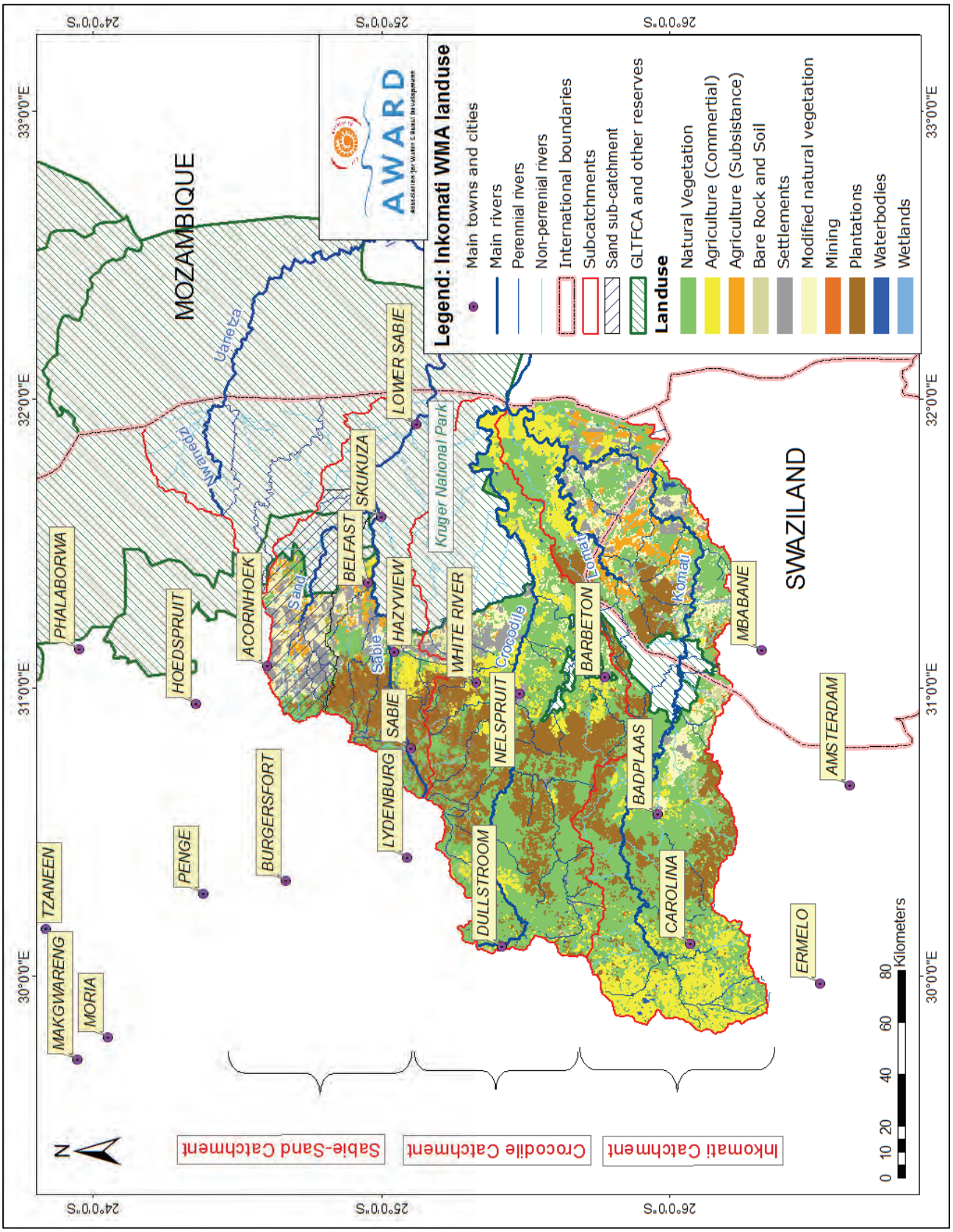

Figure 3.9: Land use and settlements in the Inkomati WMA

3.4.3 Water resources and water balance

In terms of infrastructure, the WMA has a number of dams including the recently completed Injaka Dam in the Marite River (completed in 2002), and the Driekoppies and Maguga Dams on the Komati River, as well as a number of smaller dams (Appendix 3.3). There are also a number of water schemes throughout the WMA.

A recent study commissioned by DWA, the Inkomati Water Availability Assessment Study (IWAAS, 2009) has revised the ISP DWA 2004 figures for water resource availability and demand. The purpose of this study was to understand the impacts of increased demand and to set up a water resources model with the latest water use[17] and system configuration so as to facilitate water reallocation. The following section summarises these findings. The results differ from those of the ISP in a number of ways. The MAR is about 15% less than that of the ISP estimates in the Sand Catchment, 10% lower in the Sabie and 5% lower in the Crocodile and Komati. The water use in Crocodile is higher than originally estimated by the ISP as is that of the Komati in both Swaziland and South Africa following the completion of Maguga Dam.

Table 3.4 indicates that the total demand which takes into account the requirements of the Reserve far exceed the available resources. Also currently, the Reserve is not built into the operating rules of most of the systems such as that of the Kwena Dam on the Crocodile River.

Table 3.4: Water availability and demand and water balance of the Inkomati WMA including the Reserve estimates (based on the preliminary estimate 2008[18] (DWAF, 2009; IWAAS, 2009). SFRA = Stream flow reduction activity

Availability/ Use	X1: Komati	X2: Crocodile	X3: Sabie	Inkomati WMA
Availability	775	555	116	1446
Current use (excl Reserve)	**858**	**632.3**	**179.5**	**1670**
Allocated use with Reserve				
Cross Border	62	51	0	112
Reserve	228	205	209	
Domestic	47	73	82	202
Industry/Mining	2	27	0	29
Irrigation	642	482	98	1222
Strategic	105	0	0	105
Total demand with Reserve	**1086**	**837**	**389**	**2311**
Afforestation	117	158	90	365
Alien Vegetation	32	32	16	80
Balance currently	**-83**	**-77.3**	**-63.5**	**-223.8**
Balance with Reserve	**-311**	**-282**	**-273**	**-865**

[17] The water requirements were calculated primarily from the Validation and Verification study (DWAF, 2006), while additional information on urban water use was obtained from the Water Service Development Plans and interviews.

[18] This has been updated in 2009

International agreements

As noted, South Africa's international obligations according to the Piggs Peak Agreement and the more recent Interim IncoMaputo Water Use Agreement (TPTC, 2002) are to ensure a minimum cross-border flow of 2.6 m^3/s at Ressano Garcia for environmental purposes. Over and above this are requirements for 29 Mm^3/a for irrigation and 1 Mm^3/a for domestic purposes.

The Sabie-Sand Catchment

Table 3.5 indicates that the Sabie-Sand Catchment is in water deficit. This is due to shortages in the Sand River Catchment. Not only have the specifications of the White Paper for Injaka Dam to augment flows in the Sand River (Table 3.5) not been operationalised (see Chapter 6) but there is less water available than previously thought (see earlier) coupled with increased water use. Transfers into the Sand River Catchment are still required and will need to increase to improve the standard of water services to villages in the Sand River (S. Mallory, Water for Africa Water Resources, pers comm.).

Table 3.5: Water to be supplied to the Sand sub-catchment from Injaka Dam as set out in the White Paper (DWAF, 1994)

Injaka dam: High assurance supplies	
Water for primary use in the Sand catchment	18.1 million m3/a
Water for primary use in the Sabie catchment	14.0 million m3/a
Water for augmenting low flow of the Sand River in the Sabie Sand Game Reserve	4.1 million m3/a
Water for augmenting low flow of the Sabie River in the Kruger National Park	5.0 million m3/a
Injaka dam: Low assurance supplies	
Irrigation of 280ha in Sand catchment	2.9 million m3/a
Irrigation of 1480ha in Sabie catchment	13.7 million m3/a
Total	**57.8 million m3/a**
Total (IBT: Sand)	**25.1 million m3/a**

The Crocodile Catchment

The greatest demand for water is from irrigated agriculture and forestry. In terms of water infrastructure the catchment has one major dam, the Kwena Dam, in the upper catchment (which augments low flows) and a number of smaller dams in the central portion (Witklip, Primkop, Klipkoppie/ Longmere; see Appendix 3.3).

The water requirements exceed the available resource, and the catchment is considered to be **highly stressed**. The IWAAS conclusion is that the irrigation demands have been increasing since the 1990's up to their current levels. DWA's current policy for many years has been not to issue any more water use licences to irrigation but there is probably still some unlawful development.

Currently there is a real time study underway to address key problems east of the Kwena Dam. The objectives of this study – known as the *Real Time Operating Decision Support System for the Crocodile East River System* – are to assist with water distribution (run of river) and water releases

(dams), to ensure compliance with the Reserve and with international obligations (Crocodile East RTOS meeting Nov 2007). The DSS must be capable of determining operational plans and should include a water allocation and utilisation management and monitoring system (DSS Team pers. comm.).

The Komati Catchment

The greatest water user in the Komati Catchment is irrigated agriculture (see Table 3.4). Pollard et al. 2010 provide figures that indicate the increase in irrigated agriculture in the Komati River particularly over the last two decades. This is accompanied by an increased demand for water. This is followed by stream flow reduction (forestry at 12%) and unique to the Komati, water for strategic use i.e. Eskom (10%). The two major dams Vygeboom and Nooitgedacht dams were built to provide water to the Eskom power Stations on the highveld. Most of the water from the upper Komati is for the use of Eskom. Alien vegetation has a significant impact on the water resources (3% if demand).

The ISP notes that the key issue in this sub-area is the transfer of water out of the WMA to the Olifants WMA. The NWRS reserves this transfer (i.e. requires national authorisation) up to **132 M m^3/a**, even though the current transfer is only about 97 M m^3/a. The implication is that transfers out of this sub-area could increase in future.

An important factor in the management of this sub-area is the position of **Swaziland downstream** of the sub-area. There is a treaty between South Africa and Swaziland, as well as the more recent Interim IncoMaputo Water Use Agreement, both of which influence the management of the water resources of this sub-area (see Chapter 5).

The lower Komati is considered to be highly stressed. However, the completion of the Maguga Dam brings the situation back into approximate balance. Implementation of the Reserve in the Komati catchment can be achieved now that the Driekoppies and Maguga dams are complete without resulting in large deficits in the lower catchment, but this is based on the assumption that the Reserve will also be implemented in the upper reaches, where much of the water for the Ecological Reserve originates.

Photo 5: Maguga Dam in Swaziland along with the Driekoppies scheme provides an opportunity to manage the Komati with a higher level of assurance. The allocation of environmental flows within this system needs to be a priority that is held collectively and not seen as a competing user.

CHAPTER 4. RESEARCH ORIENTATION AND METHODOLOGY

4.1 Introduction

In order to give meaning to collaborative research process so as to contribute to, and build, a competent community of practitioners, the research orientation moved away from traditional extractive research to more participatory methods, specifically action-research (see Chapter 2). This recognises that inhabitants of a catchment have an important role to play in the enquiry process, as it is out of the enquiry that options will be tabled and future actions implemented. It is suggested that this is an appropriate methodology for dealing with natural resource management challenges such as those presented by Integrated Water Resource Management (IWRM). In support of this approach we present a quote from McDougall and Braun (2003):

> *We are at a global crossroads in terms of human and environmental development. Research in NRM needs to respond more effectively than it ever has before, if we are to successfully meet the local, regional and global challenges facing humanity. And yet, NRM research itself also appears to be at a crossroads, with some latent tensions surrounding traditional research on one side and participatory research on the other. This is further complicated by the increasing recognition of diversity as a critical, but as yet weakly implemented, factor in development and NRM.*
>
> *Are traditional research, participatory research and diversity analysis compatible? Our response is that although traditional and participatory approaches may have different philosophical roots and other differences, they are not only compatible but, in many cases, they need one another. Together they generate richer and deeper knowledge, and more effective and appropriate technology than either one alone. How should they be combined to achieve this? There is no prescription for developing research approaches, nor will there ever be. The challenge is for research teams to implement careful, early and on-going assessments of their NRM issues and multiple objectives – through the lenses of complexity, dynamism, gender and diversity – as the basis for the thoughtful and creative building of research approaches for each research initiative. Research teams can use these assessments to sieve through the plethora of research options and decide, with their partners, which aspects of each approach are of value in that context.*

The most challenging component of any participatory research approach is the organization and maintenance of the stakeholder processes (Cooperrider and Dutton, 2001). Success, therefore, hinges on positive interactions and creating a spirit of collaboration between researchers, role-players and other partners.

4.2 Overall approach

A phased approach has been adopted to allow for ongoing reflection on research design and for the steering committee to consider appropriate responses to contextual changes, should they be necessary. The preparatory phase included, as planned outputs, the following:

1. **A review of national and international policy**
   - Interviewing members of the river basin commissions and implementing agents to establish the nature of the relevant treaties and protocols; and
   - Reviewing national policies and instruments for regulating and managing equitable sharing of water.
2. **A review and assessment of existing information of each catchment**
   - Conducting an information-systems review for each of the rivers (WARMS, ISPs, etc); Assessing the relevant information systems for accuracy and reliability; and
   - Matching knowledge systems with the action research priorities – as determined for each basin.

This was followed by two key pieces of work to develop the contextual profiles, each with different methodological approaches. The first, technical in nature, involved understanding the status of the Reserve in terms of flows (i.e. compliance with the quantity component of the Ecological Reserve). The second, which aimed to understand *why* the status of compliance was as it was, involved a dialogical approach based on semi-structured interviews with a range of stakeholders. This also involved an institutional/ organisational analysis.

3. **Development of contextual profiles**
   - An assessment of the status of compliance and/or non-compliance;
   - Organisational analysis to a) understand perceived roles and responsibilities pertaining to water resources management and b) to identify relevant role-players and stakeholders for interviews;
   - the identification of factors that constrain or enable the implementation of policy regarding sustainability (i.e. environmental flows) in six rivers;
   - Critical assessment of profiles and synthesis of key themes for future action.

4.3 Contextual profiles

The aim of the contextual profile is to ground the initiative in the 'reality' of the context from a number of perspectives, sources of information and sector interests. Furthermore, the contextual profile provides the basic framework for initiating action research processes, where questions are identified, actions are designed and implemented and then reflected upon. Where there is a strong focus on action research, the contextual profile is also used to track change over time.

In the case of the SRI Phase 1, the contextual profiles focus on understanding the current status of sustainability in the six Lowveld river systems, and the factors that constrain or enable this. The focus is strongly on **compliance or non-compliance** with Environmental Water Requirements (EWRS), also known as the Reserve in South Africa.

The structure and process of conducting contextual profiles is depicted in Figure 4.1.

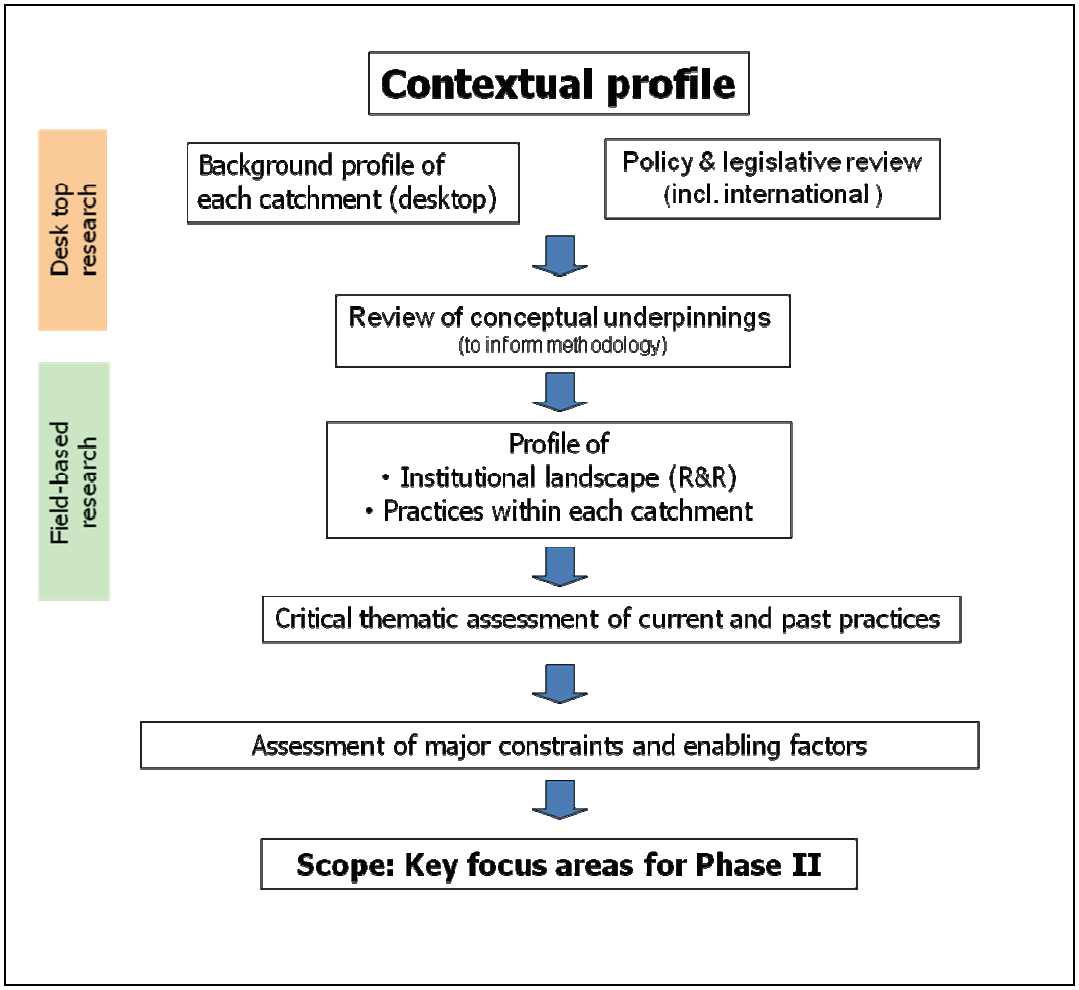

Figure 4.1: An overview of the overall steps for the development of contextual profiles

Important characteristics of the research design include the following:

1. A two-pronged approach of desk-top work and field-based interactions;
2. A grounded theoretical perspective for the ongoing work to inform research team. The familiarly with complexity theory, socio-economic systems, activity theory, communities of practice, social learning amongst others (documented in Chapter 2) was seen as an important position of understanding from which to engage with stakeholders;
3. Stakeholders engaged in dialogical processes to elucidate key practices associated with water resources management and at the same time a scoping of the institutional environment within which practitioners and practices are embedded;
4. A collaborative critical assessment of practices in the catchment and how they impact on sustainability;
5. Collaborative identification of risks and the identification of key areas of potential future action;
6. A synthesis of key areas and themes for future actions to be carried forward.

The major part of the research activities involved the engaging with a wide variety of role players and stakeholders from the six catchments. The research was primarily undertaken at a catchment scale

although key issues were also examined at a national perspective and WMA perspective where appropriate.

4.3.1 The status of compliance

Details of the methodology for the assessment of compliance with the Ecological Reserve are given in Pollard et al. 2010 and summarised below. This component was undertaken as a desktop study. In essence the input data comprises rainfall, the EWR requirements and gauged flows (observed). Thereafter, the Reserve requirements at a EWR site (normally the downstream site) are compared with the observed flows. The process is summarised in Figure 4.2. In order to define development periods, data from WR 2005 was examined to define increased land and water use. This was complimented by specialist knowledge on major infrastructural and management interventions

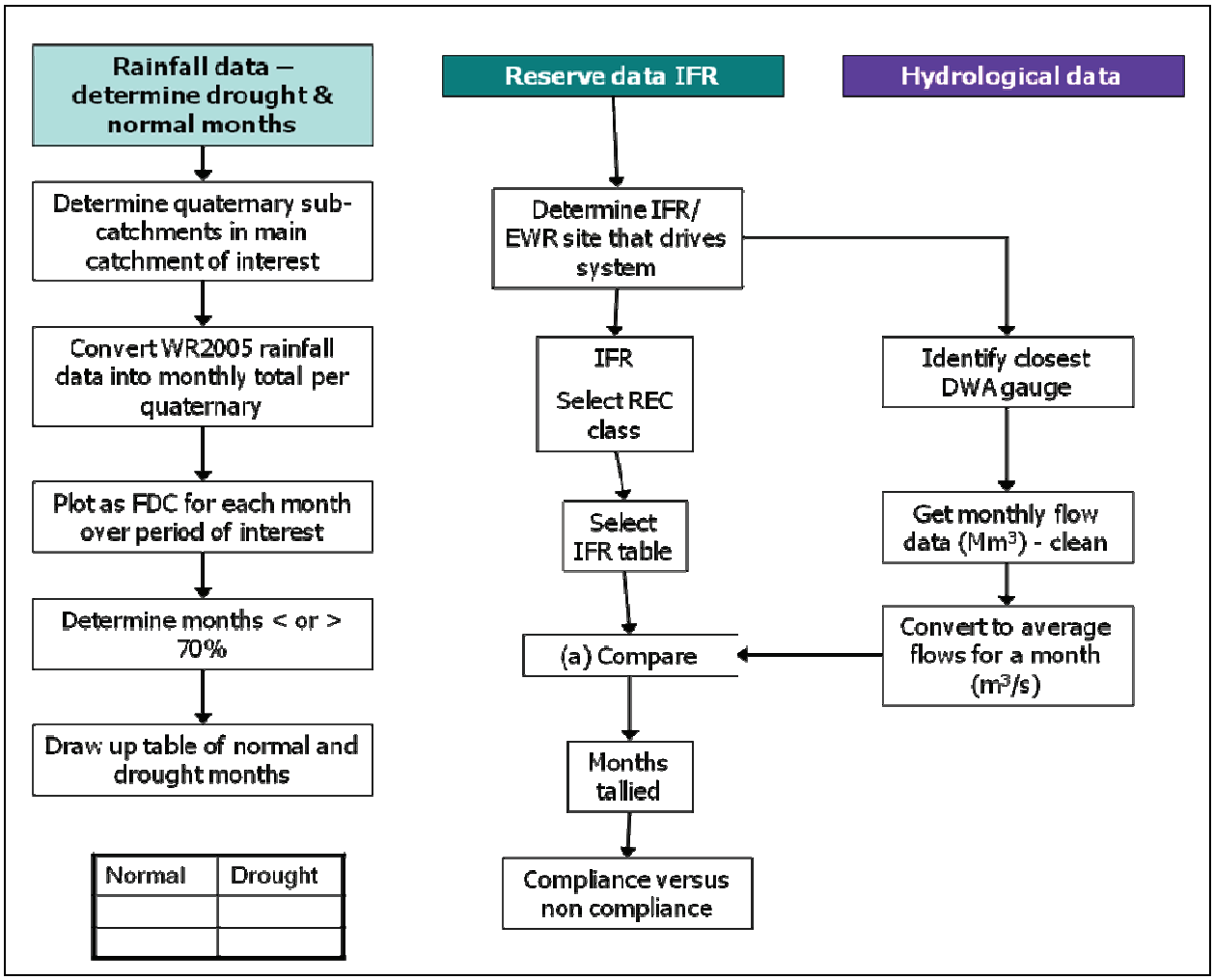

Figure 4.2: Overall process to compliance assessment (adapted from Pollard et al., 2010) Note IFR is taken to represent environmental water requirements)

4.3.2 Organisational analysis

Each contextual profile contains an overview of the institutions/ organisations that are directly or indirectly associated with the management of water resources, in particular where the principle of sustainability is an important consideration. Most importantly, the profiles focus on those that have some role in the implementation of the Reserve. It is the actors that will ultimately determine whether sustainable frameworks are 'achieved' or set in place and adhered to. The actors, within their institutional contexts, are the sources of practices for achieving sustainability and it is the actors that are or are not willing to review these practices in favour of selecting more sustainable options.

For the purposes of each profile actors are divided into five broad categories. Although these divisions are broad they provide a useful overview and way of characterizing roles, functions and intentions. Respondents were chosen to represent the following broad groupings within a catchment:

1. Regulators
    a. National DWA
    b. Regional DWA
    c. Satellite offices
    d. Departments where appropriate (e.g. DAFF or DEA)
2. Water users
    a. Water User Associations (WUA)
    b. Irrigation boards or commercial farmers associations
    c. Co-operatives
    d. Municipalities as Water Services Authorities or Providers (WSA / WSP)
    e. Other users (e.g. mines; Eskom)
    f. Government departments who act as representatives of users e.g. DAFF
3. Operations and maintenance
    a. Technical staff
    b. Dam operators
4. Researchers
    a. Consultants and academics
5. Other interested and affected parties
    a. E.g. Working for Water/ Wetlands

A number of interviews were also held with key stakeholders in Mozambique and Swaziland: Ara-Sul, a water resource consultant, Universidade Eduardo Mondlane in the former and Kobwa in the latter. These were largely to share information on the programme and to ask about any key issues and concerns.

Some actors, however, cannot be classified into any one category as they may be involved in multiple functions, for example water user associations may provide water and at the same time provide a regulatory function at the level of regulating its members.

A crucial factor in the contextual profiling was the determination of practices associated with each of these groups and evident in each catchment. Participative research methods were employed to establish the nature of these practices. The importance of this stage is emphasised in that subsequent phases will be aimed at collectively transforming problematic practices (from a sustainability point of view). The intention of the contextual profiles is not to identify problems and then prescribe solutions but rather to highlight key thematic areas that warrant attention and then look to engaging practitioners in working towards possible interventions that address context specific

issues. This approach would draw heavily on action research methodologies rather than on the traditional dissemination of research findings. The aim of the project is to ultimately build capacity to implement change. This will be achieved through the building of conceptual understanding and associated appropriate practices that will ultimately be embedded in institutional functioning.

4.3.3 Understanding factors that enable or constrain compliance with the Reserve

The interview process which involved semi-structured interviews guided by the overarching framework for IWRM in South Africa (see Chapter 1, Figure 1.1). Thus questions focused on water resources protection, authorisation, monitoring, enforcement, financing, stakeholder participation and co-operative governance. This is because all of these factors collectively contribute to achieving sustainable and equitable water resources. Stakeholders engaged in dialogical processes to elucidate key practices associated with water resources management and at the same time a scoping of the institutional environment within which practitioners and practices are embedded.

Given this, the central research question was: '*What factors enable or constrain achieving environmental flows in the lowveld rivers?* A sub-set of questions underlie this question, namely:

1. What is the status of the Reserve?
2. Do people give importance to sustainability (in a practice-based way)?
3. Is there unlawful use of water? (raises issues regarding monitoring)
4. How effective/ adequate is regulation and enforcement? (the Reserve and licencing)
5. Is there shared practice around the Reserve? (innovations around meeting the Reserve)
6. What feedbacks exist? (see Chapter 2)
7. Do emerging narratives consider consequences for (a) sustainability and (b) or other users, or do they only talk of their own interests?
8. Do participants assign blame elsewhere for non-compliance (is there reflexivity regarding practice?)

The research output aimed to respond to this question in a holistic and comprehensive manner. The aim was not to arrive at conclusive answers but to open up the dialogue with stakeholders so that the systemic nature of the issue can be addressed. To this end themes are identified and key issues emerging from the research are presented. The intention is to feed outcomes back to respondents in Phase II of SRI in order to collaboratively explore options for future action within the contexts of specific catchments.

Most discussions were held with individuals, with a few instances involving a number of representatives for the same institution. In some cases the initial dialogues were followed up with a second contact if issues were unclear or gaps were evident. The questions were presented as an open framework for discussion with the respondents playing an important role in raising specific issues.

Attempts were made to verify claims such as those related to unlawfulness. In this regard however, it is important to note that although the profiling collects *perceptions of compliance* it is not with a direct analysis of these perceptions that the project is concerned. As Schlager (1987) suggests, compliance with the law can be broadly categorised as 'administrative' or 'cultural' (attitudes, practices, behaviours). Thus reasons may for example, be due to 'poorly- skilled staff', although the perception may be that there are insufficient staff; or that the dam operator fails to follow operating

rules whilst the perception is that upstream users are taking all the water. It is the synthesis of meanings that prevail and their collective implications for practice that will form the basis of Phase II. Since Phase II aims to support change, getting beyond perceptions is therefore critical. Validation of suggested reasons for non-compliance is important and will be done through collective engagement of stakeholders.

The synthesis and analysis of data was conducted according to a number of steps. Although Phase I is a scoping of issues, the research is designed not just to provide a descriptive of these but also an interpretation. Broadly, there are three 'steps' to this analysis, as shown below.

1) Listing the issues that people raise – their experiences on a daily basis. This is a descriptive of personal and institutionally held meanings, experience of practices and conceptualisation of 'the problem' in relation to the questions posed.
2) Grouping the issues that arise on the basis of institutions and catchments into key themes.
3) Synthesis and analysis – the 'meta-level' sorting of these and an interpretation against a number of thematic areas (see below).

Profile format

Six contextual profiles are presented as the main output of this research, one profile for each of the six catchments described in Chapter 3. For the purposes of this report results have been grouped according to the three Water Management Areas that pertain to the lowveld, viz.

1. Luvuvhu/Letaba,
2. Olifants and
3. Inkomati WMAs.

4.4 Analysis and analytical themes

The data are analysed according to key themes which were identified from listing and grouping key issues following the first round of catchment interviews. The analytical themes were:

a) Current understanding and embeddedness of concepts of sustainability and the Reserve in water management practices
b) Change and lags:
c) Integration of WRM and water supply:
d) Unlawful use:
e) Skills, capacity and ability to monitor and enforce:
f) Adaptive capacity and change:
g) Feedback loops and self organisation:
h) Learning within changing contexts:

1. Understanding and embeddedness of the Reserve (sustainability) within catchment management practice

The National Water Act (NWA) is transformative in that it requires of water managers and practitioners a number of important systemic shifts based on new priorities for water management. In this sense the priorities shift and so a requirement for changed practices arises. The source of the intended change is a 'new language' for management.

The NWA introduces the principle of sustainability through the 'language' of integrated water resources management (Pollard and Du Toit, 2008). We say that IWRM has resulted in the introduction of a sustainability discourse with new concepts, practices and approaches. Accessing this discourse is an important first step in making the transformation from 'old' to 'new' management priorities.

However, this may not be a straightforward process as tensions might arise in making the change. New concepts might conflict with, and/or contradict practices that have been part of previous legislation and water management of the past. Earlier work in the lowveld catchments reports that at almost every level of the water sector and civil society there is conceptual conflation and a basic lack of clarity as to what new policies and legislation imply for actual practice (du Toit, 2005; Biggs and Toit, 2008).

The presence or absence of sustainability from the discourse of water management is of central concern to the implementation of the Reserve. Where there is no or little focus on management of water for sustainability there is likely to be poor attention to the Reserve. In an earlier report (Pollard and du Toit, 2004) we noted that different sectors have developed their own understanding, and therefore their own practice, around water resources management. The authors report that these understandings are carried over into the language and practice, reflected in the different ways that the concept of management is applied.

Under this theme we look at how the principles of sustainability are embedded in water resources management and specifically at current levels of understanding of the key instrument, the Ecological Reserve, for giving effect to it. What is attempted under this theme is a preliminary assessment of access to a sustainability discourse by managers and water users and is by no means an exhaustive study.

Photo 6: Collaborative learning environments where a number of department officials, organisations and resource users work together for purposes of equitability and sustainability are becoming important.

2. *Lags in the implementation of the Reserve and emergence of sustainability discourse*

Building of the theme above, and drawing on complexity and resilience theory, we focus on the nature of the transformation process in relation to timeframes and the practicalities of adopting a sustainability discourse in the water sector. Complexity theory recognises that lags are inherent to any system and in relation to IWRM they are a consequence of change, administrative planning and procedure, and multiple agents being part of management actions. Lags are to be anticipated.

Under this theme we focus specifically on the implementation of the Reserve and lags associated with its full operationalisation. Setting the Reserve today will not mean that it is met tomorrow. However it is important to consider which of these lags is unreasonable and what makes certain delays unreasonable. This is a hard question to answer given that there is little experience upon which to base the new approach to WRM and given the various constraints of skills and funding. Here various discourses might eventually be brought to bear including legal discourse that looks at progressive realisation and reasonability tests against which to make value judgments (du Toit et al., 2008). Moreover, the issue of lags requires further examination given that these may vary, reflecting lags in procedures, sequence, and in the development of capacity, skill and social capital (to co-manage and collaborate).

3. *Links between water resources management and water supply/ use*

The importance of having an overarching view of the IWRM relates to its integratedness. Without linking different resource use practices and protocols to each other it is impossible to achieve and integrated approach as intentioned by the NWA. This is pertinent in respect of the WRM and Water Supply as planning for delivery and provision must be done within the context of what is available from the resource immediately and what is likely to be available over the long term. Planning to meet immediate needs without consideration for the trajectories and patterns (in terms of quantity and quality) are likely to lead to precarious and insecure water situations.

It has been noted that in South Africa water resources are divided in into issues of management and supply – both supported by different acts, the NWA (RSA, 1998) and the Water Services Act (WSA) (RSA, 1997), respectively. In the case of water management the drivers are planning, protection, authorization, monitoring and regulation whilst in water supply the drivers are meeting demands, efficiency of distribution, and cost recovery (or profit). There are potential tensions between the two and if not resolved can lead to conflict with the ultimate degradation of the resource.

While there are attempts to harmonise water management with water supply imperatives there are a number of tensions that present the management of the lowveld rivers with a number of problems. It is in this theme that we pick on issues mentioned by respondent and highlight the major challenges in this regard.

4. Unlawfulness and the regulation of unlawful use

Creating a legal framework to support water resource protection is one of the many challenges faced by the South African Government in realising its Constitutional mandate to achieve sustainability. One of the consequences of introducing the legal basis for management of water is that the notions of lawfulness and unlawfulness are created. Unlawfulness is a condition that is deemed in contravention to, or in violation of, the state of lawfulness created by the principles of the law (Pejan, 2004). Arguably the most important aspects of the legal basis for management of water in South Africa are to provide a framework from which to protect the resource (also known as resource directed measures –RDM) and regulate the use of water (source directed controls –SDC). These two are different in their intentions and approach but share the overarching goal of ensuring water security at the water management area (WMA) level. Ostensibly the one cannot be achieved without the other – with the apparatus to protect water being built into the conditions prescribed in the authorisation process.

In regulating licenced users, water is made available for statutory requirements of basic domestic use, the Ecological Reserve and international agreements. Unregulated use in stressed ('closed') catchments is likely to lead to users 'encroaching' (wilfully or unwilfully) on the statutory provisions.

Under this theme we explore the various patterns and incidences of 'unlawfulness' in the six catchments with a view to understanding how they come to originate and what this status might mean for working towards compliance in the near future. The intention of this section is not to make allegations as regards actual unlawfulness but rather to scope out the key issues in order to provide a firm basis for developing compliance actions in future.

Equally important is the phenomenon of self regulation. As part of this theme we look at a variety of self regulating components and their ability to contribute to water management as a whole. Here we are referencing to the contributions that various sectors, organizations and institutions make, collectively, to setting and meeting with agreed upon standards for water use and management.

5. Skills, competence and ability to implement

Planning for and the incorporation of sustainability into IWRM is a complex process that will require a new discourse in the water sector which means that water managers and users need to access new concepts and logic associated with this orientation to management. There is also likely to be a strong need for the development and testing of new 'tools' that focus on the practicalities of achieving sustainability. The Ecological Reserve is such a tool. With such a tool comes the need to develop skills within key management and practitioner groups so that it can be put into practice. This may require the review of practices, selection of alternatives or the development of new practices. In some cases, where there is non-compliance with legal obligations, legal action might be pertinent.

Key to the whole endeavour of planning for sustainability is the building of skills and competence amongst the people involved in all levels of water resource and services management (relevant spheres of government, agriculture, mining, legal sector etc.).
Under this theme we consider the current situation regarding skills and competence to take on and implement water management with a shift in focus towards sustainability.

6. Adaptive capacity and change

A characteristic of open, dynamic systems is that they demonstrate the ability to adapt and respond to change. The tendency is to avoid negative consequences of actions within such a system, this assumes an ability to learn and incorporate learning into future action. Under this theme we explore the nature of adaptive capacity and responsivity to change in the six catchments. Here we will consider two related sub-themes:

i. Feedback loops and self organisation:

Feedback loops are considered as essential components of resilient systems and adaptive management (Holling 2001; Gunderson and Holling 2002; Biggs and Rogers 2003). The concept is not a difficult one and at a practical level it means that as something is discovered or learnt as part of a management process, this information is passed on to an (appropriate) body who takes (appropriate and effective) action and feeds this back. This is the basis for a learning and reflexive system. Where systems often fail is where any of these steps fail such as in cases where the learning is not passed on or is passed to an inappropriate body. In Tanzania for example, despite socio-political change, persistent feedback loops between monitoring and action have ensured a resilient management system (Tengo and Hammer, 2003). As recognition for this is growing so does the interest in what makes them successful.

One of the fundamental principles of systems thinking is that of self-organisation Doll, 1993. This means that elements of a system have the potential to organise themselves within a complex system so that a system need not tend towards disorder. This perspective can be translated in a learning sense to mean that the self-organising nature of a collective enables opportunities for the creation of options and solutions to contextually-based problems. The deepening of understanding comes from reflecting on actions and experiences, not from implementing a set of preformatted solutions to generic problems.

In this sub-theme we look at the issue of feedback loops and the role that they might play in enhancing planning for sustainability. Attention is also given to the associated phenomena of communication and self organisation as key factors functioning alongside feedback loops in six complex catchments.

ii. Learning within changing contexts:

If learning is a complex social process (Vygotsky, 1987) we need to recognise the importance of dialogical approaches to learning where meaning is negotiated and responses are arrived at through critical engagement and dialogue. In an attempt to deal with natural resources management within a systems approach, the focus on individual 'learning' falls away (Hales, 1990). What does matter is embeddedness and correspondence across scales and levels within that system. Here social structures, governance, self-organisation, communication and collaboration become critical.

Learning within complex systems is seen as a process of reflecting in and on action (Schon, 1983; Lave and Wenger, 1991). The reflexive orientation encourages groups of individuals to identify problems, deliberate, propose solutions and respond to contextual changes in an ongoing series of action and reflection cycles. The learning and

understanding that grow within a particular context are a direct response of collectives of practitioners ("communities of practice" – Lave and Wenger, 1991) to local realities. These may be important formative ideas for the development of sustainability discourses in the management of the rivers of the lowveld.

It is by means of these contextual profiles that we aim to a) raise key issues associated with adopting sustainability discourse in the lowveld rivers and b) propose creative interventions that may contribute to managing the catchments as open dynamic systems rather than closed, static entities.

4.5 Integrative analysis for key cases studies

Finally specific case studies (Chapter 9) were identified and examined. Here the objective was to elucidate what lay behind the apparent success or challenges. Conceptually this is based on the thesis that IWRM seeks to build sustainable and equitable futures for freshwater resources by developing the resilience of the system to cope with and adapt to change and to buffer shocks and stresses. This raises the question as to what it is that helps to build adaptable, resilient systems. The analysis was based on a synthesis of characteristics of resilience from the literature and from our work. The following characteristics of adaptive capacity were then examined:

1. Developing an integrated, systems view as the basis for planning and action
2. The adaptive cycle: feedback loops, leadership, and self organisation
3. Self regulation: different players in a system take responsibility for actions
4. Learning, understanding and competence as the basis for transformation
5. Collective action.

Finally a number of recommendations for future work were developed by an advisory group to the project steering committee.

CHAPTER 5. AN OVERVIEW OF THE INSTITUTIONAL ARRANGEMENTS FOR IWRM IN THE STUDY AREA

5.1 Introduction

Democracy in South Africa heralded an era of institutional changes. But first we need to understand what is meant by the term ***institution*** which conjures up images of formal bodies and buildings. However, this represents a very narrow interpretation of what are defined as 'humanly devised constraints that structure human interaction'. Ostrom (2000) recognises institutions as "the set of rules actually used (the working rules or rules-in-use) by a set of individuals to organise repetitive activities (e.g. marriage) that produce outcomes affecting those individuals and potentially affecting others" (emphasis added). Importantly, institutions are socially constructed; they have normative and cognitive, as well as regulative dimensions (Jentoft et al., 1998) and hence are about the relationship between people. They make possible collective action and stabilize cooperation modes between actors and organizations. Thus institutions are also defined as "rules of the game". They can include both statutory and local instruments (the law, courts) and organisations (catchment councils, chieftaincies). It is important to note that they are made up of:

- formal constraints (rules, laws, constitutions),
- informal constraints (norms of behaviour, conventions, and self-imposed codes of conduct), and
- their enforcement characteristics.

The breadth of these institutions spans international law, state and local laws to which one may add religious and project specific legal orders Meinzen-Dick and Pradhan, 2002. Thus rarely is a resource such as water subjected to only one institution; rather it is their overlapping effects – known as ***legal pluralism*** – that give rise to a nuanced and case-specific reality. Whilst the state can set the broad rules based on sound principles, their execution relies on the interaction of a variety of role-players. In countries like South Africa where, despite the phenomenal transition to policies based on equity and sustainability, the capacity to implement them is sorely lacking, local-level support and ownership become a key component of their success or failure. This **legal pluralism** is then an almost ubiquitous characteristic of natural resource governance systems such as that over water. **Water governance** can be defined as '*the range of political, social, economic and administrative systems that are in place to regulate the development and management of water resources and provision of water services at different levels of society*'.

Institutional change in South Africa has involved an almost complete overhaul of the legislative and organizational frameworks of the Apartheid era. Not only were reforms directly pertaining to water introduced, but so too were many other legal instruments that directly (for example National Environmental Management Act), or indirectly (the Municipal Structures Act) have implications for water resources management. Appreciably, the depth and breadth of such change is beyond the scope of this chapter and have been reviewed by a number of different authors over the last decade (see for example Dlamini and Cousins, 2009; DWAF, 2003d; Pejan et al., 2007). Much of the legislative reform pertaining to water was covered in Chapter 1. Rather in this chapter we present an overview of the institutional and organizational changes and developments that pertain either directly or indirectly to Integrated Water Resource Management (IWRM) nationally and more specifically, within the study area. The purpose is to describe what structures currently exist and hence who we interviewed and an analysis of their involvement in water resources management. This together with

an understanding of the legislative framework described in Chapter 1, serves as a backdrop to understanding the multiple actors, their roles and responsibilities and the various steps that are collectively required to 'deliver the Ecological Reserve'.

5.2 Overview of legislative reform pertaining to water resources management and supply

As noted above a detailed review of legislative reform for water resources management is beyond the scope of this report. Here we highlight key changes that underscore water reform and provide an overview of the multiple legislative instruments that have bearing on water resources management and supply (Appendix 5.1A).

In terms of legislative reform South Africa's highly-acclaimed National Water Act (NWA) (RSA, 1998) provides the foundation for a fundamentally different way of managing the nation's water resources. Together with the White Paper (DWAF, 1997), it challenges the values of the past by framing water resources management within the context of two fundamental principles[19]: equity and sustainability (Act 36, RSA 1998). Captured in the slogan "*some, for all, for ever, together,*" these principles are strongly transformatory in nature, seeking to move towards integration, redistribution and equity in allocation, sustainable use, resource protection and participation (see preamble). Moreover, the importance of international needs is also recognised. Equally ground-breaking is the Water Services Act (Act 108, RSA, 1997). It provides for the rights to basic water supply and sanitation which, although distinct from the overall management of water resources, "must be undertaken in a manner consistent with the broader goals of water resource management".

Another fundamental change is the management of water resources on a catchment basis. Currently 19 Water Management Areas (WMA) have been delineated, each to be managed by a Catchment Management Agency (CMA), to which there will be a progressive devolution (assignment) of responsibility and authority over water resources. The CMAs are in various stages of establishment and are to be supported by local-level bodies such as Catchment Management Forums and Water User Associations (see Table 5.1). Central to this re-orientation is the concept of Integrated Water Resources Management (IWRM) which was elaborated in Chapter 1.

In addition to the aforementioned acts, a number of policy instruments have bearing on water resources. In particular those related to environmental management and protection, agricultural and forest resources, land and land reform and governance are of direct relevance. These acts are listed in Appendix 5.1B.

It is important to understand that in South Africa different legislative frameworks govern water resources management (NWA) and water supply (Water Services Act and the Municipal Systems Act). Moreover, the spatial boundaries for the management of water resources (catchments) and domestic water supply (municipalities) are not coincident Pollard and du Toit, 2005. The imperative therefore is to ensure harmony and integration between the planning instruments that emerge from these

[19] The White Paper and NWRS also make reference to efficiency which is an important aspect in achieving the founding principles. They state that "Given that our water resources are limited and limiting, it is essential that

different legal instruments such as between the catchment management strategies of the CMAs and the water services development plans of local government (see Appendix 5.2).

5.3 Organisational arrangements for water resources management and supply

The national Department of Water Affairs (formerly included Forestry) is the overall authority responsible for water resources management and water services provision. In terms of WRM it has some four directorates that are directly focused on WRM. The Department has nine regional offices, two of which are relevant to the study area, the Limpopo and Nelspruit Regional Offices. The Luvuvhu/Letaba WMA falls under the Limpopo DWA regional office in Polokwane and the Inkomati WMA under the Mpumalanga office in Nelspruit. The Olifants WMA is divided between the two regional offices with WRM under the Nelspruit office and water services, the Polokwane office.

There are a number of water management and services institutions which together fulfil roles related to IWRM (see Table 5.1.). In terms of the NWA (S1) '*water management institutions'* include CMAs, Water User Associations, International Water Management Bodies and 'any person who fulfils the functions of a water management institution in terms of the Act'. In terms of the Water Services Act (S1) '*water services institutions'* include Water Boards, Water Services Authorities, Water Services Providers and Water Services Committees.

Water Resources Management

As noted, the national office of DWA holds the overall responsibility for the management of water resources and the development of the national water resource strategy. As CMAs are established and take up their role of IWRM, the National DWA will play an oversight role. Certain key functions will remain the overall responsibility of the national office water for strategic uses including international agreements, determination of the class and Reserve, transfers, assignment of functions to the CMA and approval of the CMS.

Catchment Management Agencies provide the second sphere of the water management structure, under the national department, as provided for in the Act (see Table 5.1). They are governed by a Board, which represents a broad stakeholder grouping together with experts. As noted above, the department is in the process of establishing a CMA in each of the 19 WMAs. At the time of writing two had been established; the Inkomati CMA, which includes three of the study catchments, and the Breede-Overberg in the Western Cape. Also involved in WRM to some degree are the Water User Associations, or WUA which are either newly-established or being established through the transformation of old irrigation boards. They are intended to ensure the representation of major water users, thus extending beyond the agricultural sector.

The National Water Resources Infrastructure Agency (NWRIA) has recently been established by DWA to develop and manage national and multi-purpose water resource infrastructure. The establishment of the agency will see a phased integration of the department's water resource infrastructure branch.

---

we use them efficiently and in the best interests of all our people. Thus, the allocation of water to users should be guided by the need to encourage and support efficient, optimal and beneficial use of water".

Water Services provision

According to the Constitution, the Municipal Structures Act and the Water Services Act, the responsibility for service provision is shared amongst municipalities (which in practice means the country's 52 district municipalities), water boards and community-based organizations in rural areas. The national government, through the Department of Water Affairs, also operates dams, bulk water supply infrastructure and some retail infrastructure. As noted, the Water Services Act also establishes Water Services Authorities (WSA) and Water Services Providers (WSP), both important institutions in terms of IWRM. In general the district municipalities act as the WSA although this function is being taken over by local municipalities in some cases. The national government can also assign responsibility for service provision to local municipalities of which there are 231.

Government-owned **water boards** play a key role in the South African water sector and are classified as water services providers (Table 5.1). Unlike municipalities, they only deal with water matters, usually bulk water. Through their role in the operation of dams and bulk infrastructure they play an important role in WRM.

Table 5.1: Water Resources and services institutions in South Africa

Body	Description
Water management institutions (NWA S1)	
Catchment Management Agencies (CMA)	CMAs are statutory bodies established under S77 of the NWA to be established for each water management area. They must seek co-operation and agreement on water-related matters from the various stakeholders and interested persons. A CMA manages water resources within a WMA. Such management is carried out in accordance with a catchment management strategy which is progressively developed by each CMA. The CMA must give effect to the catchment management strategy, which is underpinned by the principles of equity and sustainability. They may delegate certain functions of the implementation to local institutions.
Water User Associations (WUA) and irrigation boards	Water User Associations are an association of individual water users who wish to undertake water related activities for their mutual benefit. This involves managing their water allocation within their area which is a form of WRM within a section of the catchment in question. They are currently being established through the transformation of the former irrigation boards, established under the previous Water Act, who administered the bulk distribution of water to irrigators within a defined area. Under the NWA of 1998, they must be transformed to form Water User Associations so as to (a) include 'emerging' farmers, and (b) to fulfil a similar function to an irrigation board but, if appropriate, to widen its functions beyond irrigation practices. WUA – WUAs may be delegated powers by the CMA (s86)(1)(b) or the Minister (s63(1)(c)).

Body	Description
Catchment Management Committee (CMC)	Catchment Management Committees are statutory bodies, (although not specifically referred to by this name in the Act) that may be established by a CMA (s82)(5), or by the Minister acting as a CMA (s86)(1)(d). They may act as an executive committee for the entire WMA or as consultative committees for individual primary catchments (which is the model that is developing in the Inkomati WMA). They are representative committees that are more in touch with the details of a sub-catchment than say the CMA, and provide a mechanism for information to flow to the Board and *vice versa*. Powers may be delegated to a CMC by the Minister acting as CMA (s86)(1)(d). It is likely that some WUAs will be represented on catchment management committees,
Catchment Management Forums (CMF)	Non-statutory. Meet to discuss issues of mutual concern and seek ways of addressing them. May also be issues-based, such as a forum to address water quality problems. They have an important stakeholder participation role in a catchment of a WMA.
International Water Management Bodies	These bodies are in place to facilitate international cooperation and the development and operation of large international water resource infrastructure such as the Lesotho Highlands Water Project or for co-operative sharing and management of a shared water resource. Where these bodies have been established in internationally shared river basins (s102), the Minister may delegate powers to them (s103)(2) and 63(1)(c).
Water Services Institutions (RSA, 1997)	
Water Boards	Water boards operate under the *Water Services Act (Act 108 of 1997)* (s1). Water Boards are classified in the Water Services Act as Water Services Providers (primary function of bulk water supply, purification and distribution) and in this respect fulfil a similar role to Local Municipalities. However, a Water Board deals only with water matters (normally bulk purification and supply). Some also provide technical assistance to municipalities. Specific catchment management functions may be delegated to them under the Act (s63)(1)(e) and (s86)(1)(b). The Water Boards report to the Department of Water Affairs. There are 15 Water Boards in South Africa, together indirectly serving more than 24 million people in 90 municipalities in 2005, or about half the population of South Africa.
Water Services Authorities (WSA)	A Water Services Authority (WSA) is any municipality (district or local) that has authority to provide water services within its area of jurisdiction in terms of the Municipal Systems Act (RSA, 2000) and Water Services Act (RSA, 1997). District Municipalities (DMs) are defined as Water Services Authorities (WSA) in terms of the Water Services Act (Act 108 of 1997), and are required to prepare Integrated Development Plans (IDPs) which include Water Services Development Plans which must contain a water balance. Note that LMs can also act as a WSA.
Water Services Providers (WSP)	Water Services Providers (WSP) refer to any local or regional 'person' who provides water services and/or accepts waste water for treatment.

In the study area there are a number of other statutory or non-statutory bodies that operate within the different catchments and these are dealt with below. One that warrants mentions is the Co-ordinating Committees on Agricultural Water (CCAWs) between DWA and the National and Provincial

Departments of Agriculture and other relevant departments in each of the nine provinces. Also a number of institutions are in the process of being established or transformed in order to give effect to the NWA. There are three WMAs, each of which will have a CMA and, as noted, the Inkomati CMA has been gazetted. In order to ensure participation in WRM, the CMAs are to be supported through Catchment Management Forums, in various stages of establishment. Also involved in WRM to some degree are the WUA which are either newly-established or being established through the transformation of old irrigation boards. There are a number of relevant bodies dealing with international transboundary water sharing agreements on both the Limpopo and Incomati Basins. In terms of water services institutions two Water Boards are operative in the study area: Lepelle Northern Water (operating in the Luvuvhu/ Letaba and Olifants WMA) and Bushbuckridge Water Board (operative in the Inkomati WMA, where Silulumanzi also shares some WSP responsibilities (see Chapter 6). There are some a number of district municipalities most of which operate as WSAs together with a number of local municipalities.

5.4 Organisational arrangements in the Luvuvhu/ Letaba WMA (2)

There are a number of water-related institutions which play a role in the catchment. The water resources institutions (see Table 5.1) include the DWA regional office in Polokwane, and additional satellite offices such as those in Giyani and Thohoyandou. The overall WRM functions fall under the Limpopo office in Polokwane. However, certain dams[20] and former 'government controlled areas' are managed under the newly-established National Water Resources Infrastructure Agency which has an area office in Tzaneen (J. Venter, pers. comm.). The agency is responsible for the operation of the Tzaneen, Middle Letaba, Ntsami and planned Nwamitwa Dams. Currently there is no CMA although the process is underway and a proto-CMA is in place. The DWA regional office in Polokwane acts as the proto-CMA until the CMA is established.

There are also a number of WUAs, Irrigation Boards and a Farmers Union. At the time of writing, the status of transformation (see Table 5.1) is unclear. The transformation of old irrigation boards to WUA is being supported in Limpopo through a dedicated facilitator.

The spatial boundaries of water resources management and water supply are not coincident (Pollard and du Toit, 2005; Figure 5.1). The water services institutions comprise the Water Services Authorities (i.e. District) and Providers as well as the Lepelle Northern Water. In terms of water supply, this WMA falls within Limpopo province. The Luvuvhu Catchment partly includes one district municipality (Vhembe) and four local municipalities, whilst the Letaba Catchment overlaps with two district municipalities, Mopani and Vhembe and six local municipalities (Table 5.2). These spatial differences also imply that the WSIs partly extend into different catchments and hence they must consider the water resource availability of each when developing their WSDPs. For example Mopani DM relies on water resources from both the Luvuvhu/Letaba and Inkomati WMAs (see Figure 5.1).

[20] Flood control; dams that supply more than one sector, Nondweni weir with fish ways

Table 5.2: Summary of the water related institutions of the Luvuvhu/ Letaba WMA and sub-catchments.
Institutions in italics are marginally included. OLLI = Olifants Letaba Luvuvhu Inkomati (low flows committee); IAPs = Interested and Affected Parties. Based on best available information.

Luvuvhu/ Letaba WMA	
Regional	DWA Regional Office (RO) Oversight and WRM functions other than those delegated to ICMA
	DWA District and satellite offices
	NWRIA and area offices
	Proto-CMA Catchment Management Agency
Other regional offices	DARDLA (Agriculture, Rural Development and Land Affairs)
	LandCare and CCAW
	Department Economic Development, Environment, and Tourism (DEDET)
	Department of Mineral Resources (DMR)
Other Strategic	IBTs
	Eskom

Catchment	**Luvuvhu**	**Letaba**
Committees/ Forums		
Catchment Forums	Appear to follow the wall-to-wall WUA model	
Catchment Committees	OLLI	OLLI
Water Users		
WUA /IB/	Soutpansberg Farmers Association	Groot Letaba WUA
	Mutshimbwe WUA	*Thabina WUA*
	Mutare WUA	*Middle-Letaba WUA*
	Nwamitwa WUA	*Letsitele WUA*
	Luvuvhu WUA	*Lenokwe WUA*
		Mawa WUA
Schemes	Mutale	Middle Letaba RWSS[21]
		Mariveni, Mabunda and Seloane
Other users		
Forestry	Various	Various
Mining (unnamed)	Various – Small to large scale	Various
Conservation	KNP, Limpopo Tourism and Parks	KNP, Limpopo Tourism and Parks
Consultants (unnamed)	Various	Various
IAPs		
	Working for Water	Working for Water

[21] includes 3 schemes, 11 pump stations for irrigation, supplied by 60 km canal from ML Dam

Water Services		
WSA		
Municipalities	Vhembe DM	Mopani DM
WSP		
Bulk WSP	Lepelle Northern Water	Lepelle Northern Water
Municipalities	Mutale (LM 432)	Greater Giyani (LIM 331)
	Makhado (LM 344)	Greater Letaba (LIM 332)
	Thulamela (LM343)	Greater Tzaneen (LIM 333) applying for WSA status
		Ba-Phalaborwa (LIM 334) applying for WSA status

Table 5.3: District and local municipalities of catchments of the Luvuvhu/Letaba WMA.
Those Municipalities in italics are marginally included.

Luvuvhu/ Mutale	Letaba
Vhembe District (WSA)	**Mopani District**
Mutale LM	Greater Giyani LM (WSP)
Makhado LM	Greater Letaba LM (WSP)
Thulamela LM	Greater Tzaneen LM (Currently applying for WSA status)
KNP LM	Ba-Phalaborwa LM (Currently applying for WSA status)
	KNP LM
	Vhembe District
	Makhado LM
	Thulamela LM
	Capricorn District
	Molemole LM
	Polokwane LM

In terms of water supply, this WMA falls within Limpopo provinces and is administered by the Polokwane RO. The WMA overlaps with three district municipalities and ten local municipalities (Table 5.3; Figure 5.1). These WSA and WSPs need to be considered in terms of water resources management and allocations and because their boundaries extend into other catchments, they must consider the water resource availability of each when developing their water services development plans.

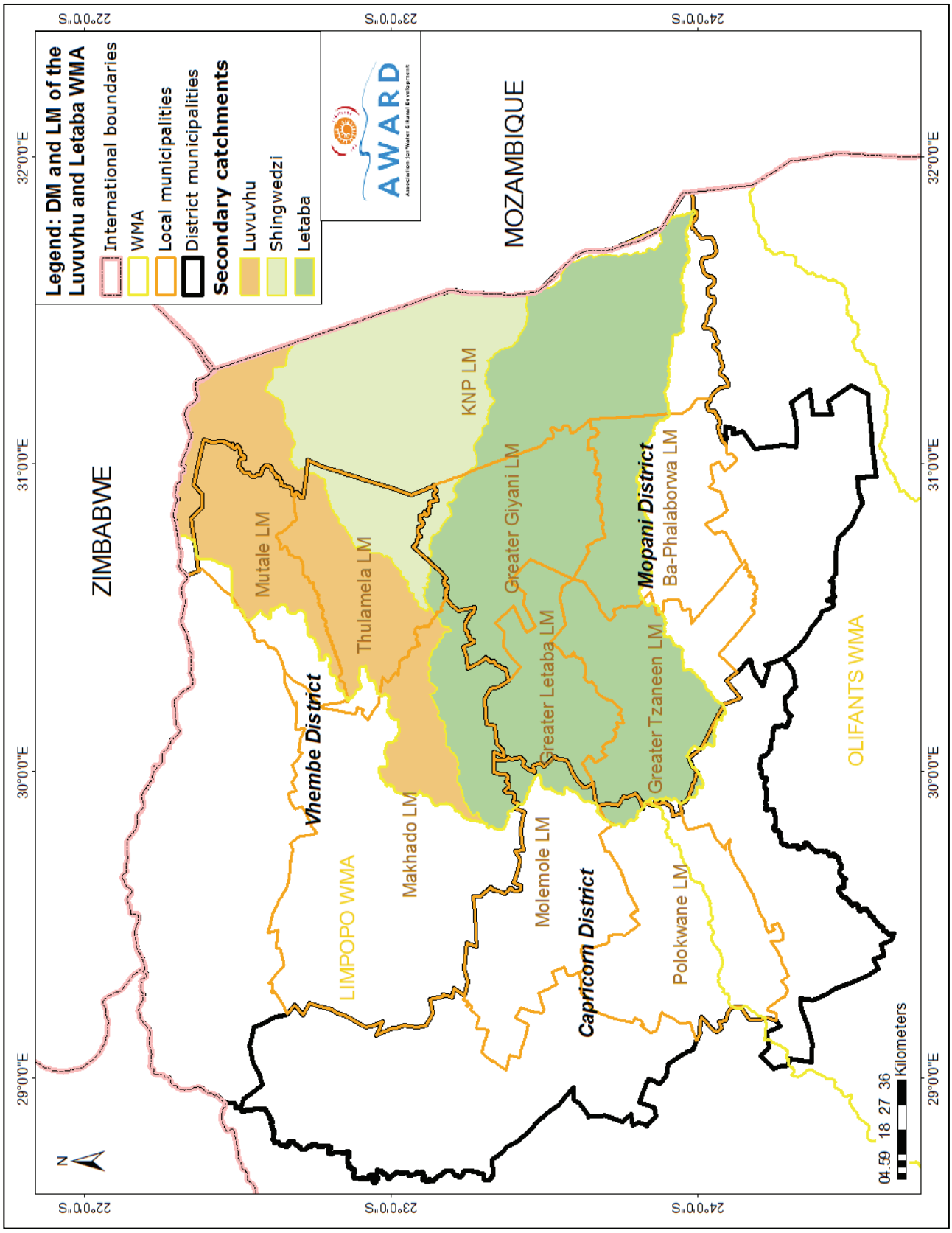

Figure 5.1: Boundaries for WRM and water supply (municipalities) in the Luvuvhu and Letaba WMA

5.5 Organisational arrangements in the Olifants WMA

The water services institutions shown in Table 5.4 include Lepelle Northern Water. In terms of water supply, this WMA falls within Mpumalanga, Limpopo and Gauteng provinces but is administered by the Polokwane RO (unlike WRM under the Nelspruit RO). The Olifants WMA overlaps with eight district municipalities (and one peripherally), and 26 local municipalities (and one peripherally) (Table 5.5; Figure 5.2 and 5.3). As noted in Section 3.2, these WSA and WSPs need to be considered in terms of water resources management and allocations and because their boundaries extend into other catchments, they must consider the water resource availability of each when developing their water services development plans.

Table 5.4: Summary of the water related institutions of the Olifants WMA and sub-catchments.
K2C = Kruger to Canyons. IAPs = Interested and Affected Parties. Based on best available information.

Olifants WMA	
Regional	DWA Area mgr (Groblersdal), DWA Licencing (Lydenburg Satellite office), DWA Monitoring (Bronkhorstspruit), DWA Enforcement (Nelspruit Regional Office), DWA Finances (Nelspruit Regional Office).
Other regional offices	Dept. of Agriculture, Fisheries and Forestry (national) (Enforcement)
Other Strategic	Eskom

Catchment	**Upper Olifants**	**Middle Olifants**	**Steelpoort**	**Blyde**	**Lower Olifants**
Government Departments					
DMR (departments in italics are marginally included)	Regional manager Mpumalanga DMR, Environmental Office DMR (MP) – Witbank.	Limpopo DMR (Chief Directorate: Eastern Regions)	Chief Directorate: Mineral Regulation and Administration – Eastern Regions)	Limpopo DMR (Chief Directorate: Eastern Regions)	Limpopo DMR (Chief Directorate: Eastern Regions)
	Gauteng DMR (Chief Directorate: Eastern Regions)	*Mpumalanga DMR*	Mpumalanga DMR	Mpumalanga DMR	Mpumalanga DMR
Dept. Of Agriculture, Fisheries and Forestry (provincial)	Gauteng and Mpumalanga (main) – interview focus on other catchments (main use)	Limpopo and Mpumalanga	Limpopo and Mpumalanga DA	Limpopo and Mpumalanga DA	Limpopo and Mpumalanga DA
Committees / Forums					
Catchment Committees	(Not formally established)				
	OLLI	OLLI	OLLI	OLLI	OLLI

Catchment Forums	Olifants River Forum	Olifants River Forum			Lower ORF to be established
Water Users					
WUA / IB		Loskop IB		Ohrigstad IB	
		Hereford IB		Blyde WUA	
		Bloempoort IB			
		Olifants River IB			
		Elands IB			
Schemes	n/a	Loskop Irrigation Scheme			
		Flag Boshielo (prev. Arabie)			
		Hereford			
		Coetzeesdraai and Hindostan			
		Veeplaats			
Emerging farmers	n/a	Flag Boshielo (prev. Arabie)			
Other Users					
Forestry			Various	Various	
Industry	Thermal Power Stations			Fruit packaging and processing	
Mining					
Mines (unnamed)	Coal Companies	Coal companies	Platinum mining		Mixed metal mining
			Coal Mining		
Mining industries			Metal processing		Agric chemical
			Ferrochrome		
Conservation	MTPA	MTPA	MTPA	MTPA	KNP
					OGR
Eskom	Power generation	n/a	n/a	n/a	n/a
Consultants (unnamed)	Various	Various	Various	Various	Various
IAPs					
WfWater	Mpumalanga and Gauteng	Limpopo and Mpumalanga	Limpopo and Mpumalanga	Limpopo and Mpumalanga	Limpopo and Mpumalanga
WfWetlands	Mpumalanga and Gauteng	Limpopo and Mpumalanga	Limpopo and Mpumalanga	Limpopo and Mpumalanga	Limpopo and Mpumalanga
Research	CSIR	CSIR	Specialist monitoring (mines)		SANParks Scientific services
	University of Limpopo	University of Limpopo	University of Limpopo		SAEON
	Onderstepoort	Onderstepoort	University of Venda		
		University of Venda			
Biosphere				K2C	K2C
NGO	WESSA				
	Endangered Wildlife Trust				
Other	Oppenheimer Trust		Sekhukhune District Environmental Forum		

WR Infrastructure					
Interbasin Transfers					
IBT (in)	Usutu	Loskop (91)	n/a		Letaba (0.4)
	Inkomati	Ebenezer (Letaba) (0.1)			Luvuvhu (0.2)
	Upper Vaal				
IBT (out)	BHT – Croc west	(3) Polokwane	n/a		New Letaba /Luvuvhu
Water Services					
WSA (LM in italics are marginally included) MP = Mpumalanga LP = Limpopo GP = Gauteng	Delmas LM (MP)	Greater Sekhukhune DM	Greater Sekhukhune DM	Bohlabela DM	Greater Sekhukhune DM
	Emalahleni LM (MP)	Capricorn DM	Thaba Chewu LM	*Thaba Chewu LM*	Ehlanzeni DM
	Steve Tshwete LM (MP)	Waterberg DM	Greater Tubatse LM	*Greater Tubatse LM*	Mopane DM
	Kungwini LM (GP)	Thembisile LM (MP)	Highlands LM (LP)	*Maruleng LM (LP)*	Maruleng LM (LP)
	Thembisile LM (MP)	Dr J.S. Moroka LM (MP)	*Greater Groblersdal LM (LP)*		Ba-Phalaborwa LM (LP)
	Govan Mbeki LM (MP)	Mookgopong LM			*Greater Tzaneen LM (LP)*
	Msukaligwa LM (MP)	Greater Marble Hall LM (LP)			*KNP LM (North) (LP)*
		Greater Groblersdal LM (LP)			*KNP LM (South) (MP)*
		Makhuduthamaga LM (LP)			*Bushbuckridge LM*
		Lepele-Nkumpi LM (LP)			
		Fetakgomo LM (LP)			
		Nokeng Tsa Taemane LM (GP)			
		Bela Bela LM (LP)			
		Polokwane LM (LP)			
		Greater Tubatse			
		Highlands LM (LP)			
WSP	Emalahleni LM	Lepelle Northern Water	Thaba Chweu LM	Thaba Chweu LM	Bushbuckridge LM and Bushbuckridge Water
	Rand Water	Dr J.S. Moroka LM			
	Kungwini LM	Mookgopong LM			
	Steve Tshwete LM	Steve Tshwete LM			
	Thembisile LM	Thembisile LM			
		Magalies Water			
Water Boards	Inkangala – (curatorship)	Inkangala – (curatorship)	Inkangala – (curatorship)	Labelo b – registered as a WUA	Bushbuckridge
	Rand Water	Lepellele		Blyde WUA	Lepellele
		Magalies Water			

Table 5.5: District and local municipalities of catchments of the Olifants WMA.
Those municipalities in italics are marginally included.

Upper Olifants	Middle Olifants	Steelpoort	Blyde	Lower Olifants
Metsweding District	**Greater Sekhukhune District**	**Greater Sekhukhune District**	**Greater Sekhukhune District**	**Ehlanzeni District**
Kungwini LM	Greater Groblersdal LM	*Greater Groblersdal LM*	*Greater Tubatse LM*	*Bushbuckridge LM*
Nkangala District	Fetakgomo LM	Greater Tubatse LM	**Ehlanzeni District**	*KNP LM (South)*
Delmas LM	Greater Marble Hall LM	**Nkangala District**	*Thaba Chweu LM*	**Mopani District**
Emalahleni LM (WSP)	Makhuduthamaga LM	*Highlands LM*	**Mopani District**	Maruleng LM
Steve Tshwete LM	**Metsweding District**	**Ehlanzeni District**	*Maruleng LM*	*Ba-Phalaborwa LM*
Thembisile LM (WSP)	*Nokeng Tsa Taemane LM*	*Thaba Chweu LM*		*Greater Tzaneen LM*
Gert Sibanda District	**Nkangala District**			*KNP LM (North)*
Govan Mbeki LM	Dr J.S. Moroka LM (WSP)			
Msukaligwa LM	*Greater Tubatse LM*			
	Highlands LM			
	Thembisile LM (WSP)			
	Steve Tshwete LM			
	Waterberg District			
	Bela Bela LM			
	Mookgopong LM			
	Capricorn District			
	Lepele-Nkumpi LM			
	Polokwane LM			

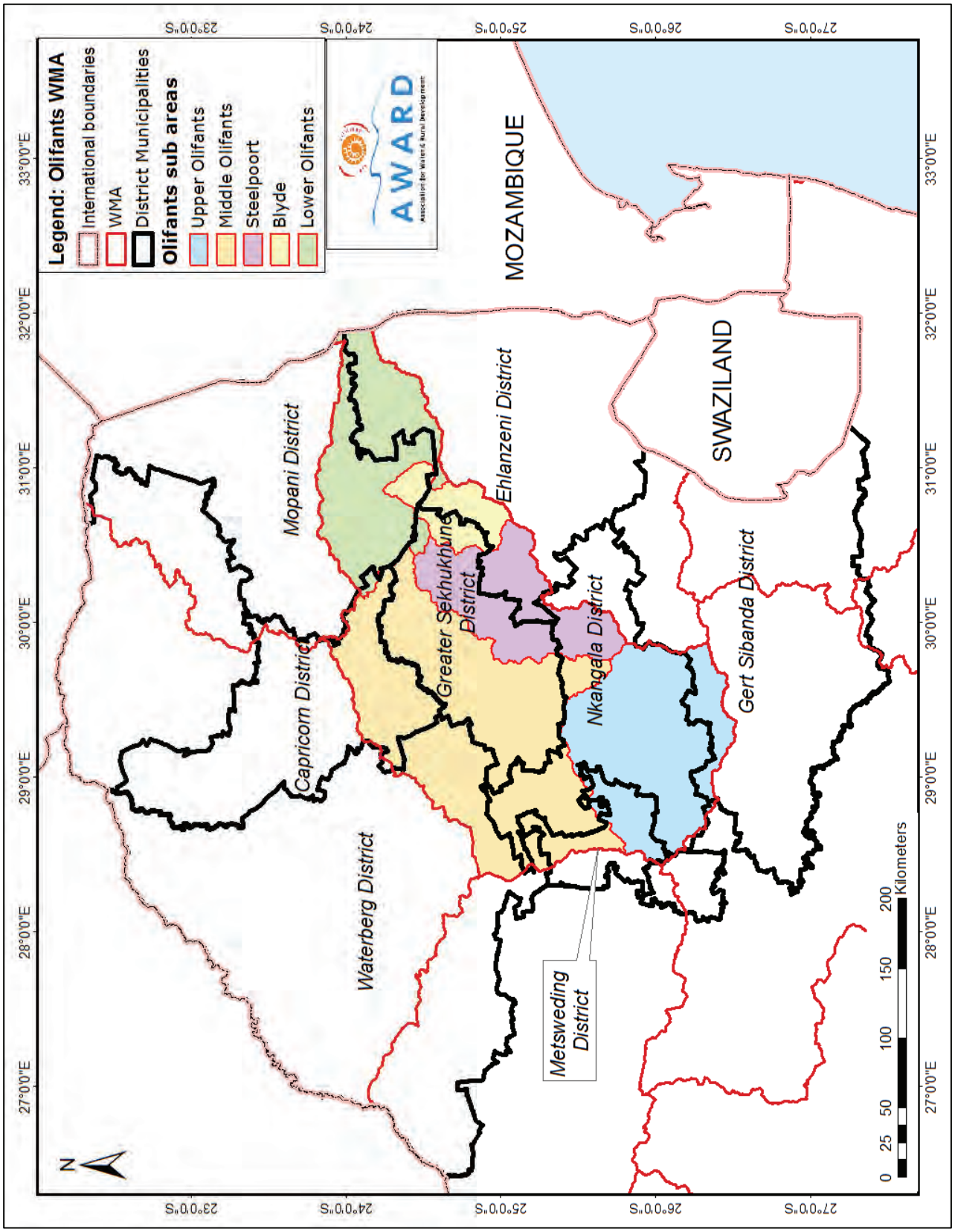

Figure 5.2: Boundaries for WRM and water supply (municipalities) in the Olifants WMA. Local municipalities (LM) are shown in Figure 5.3.

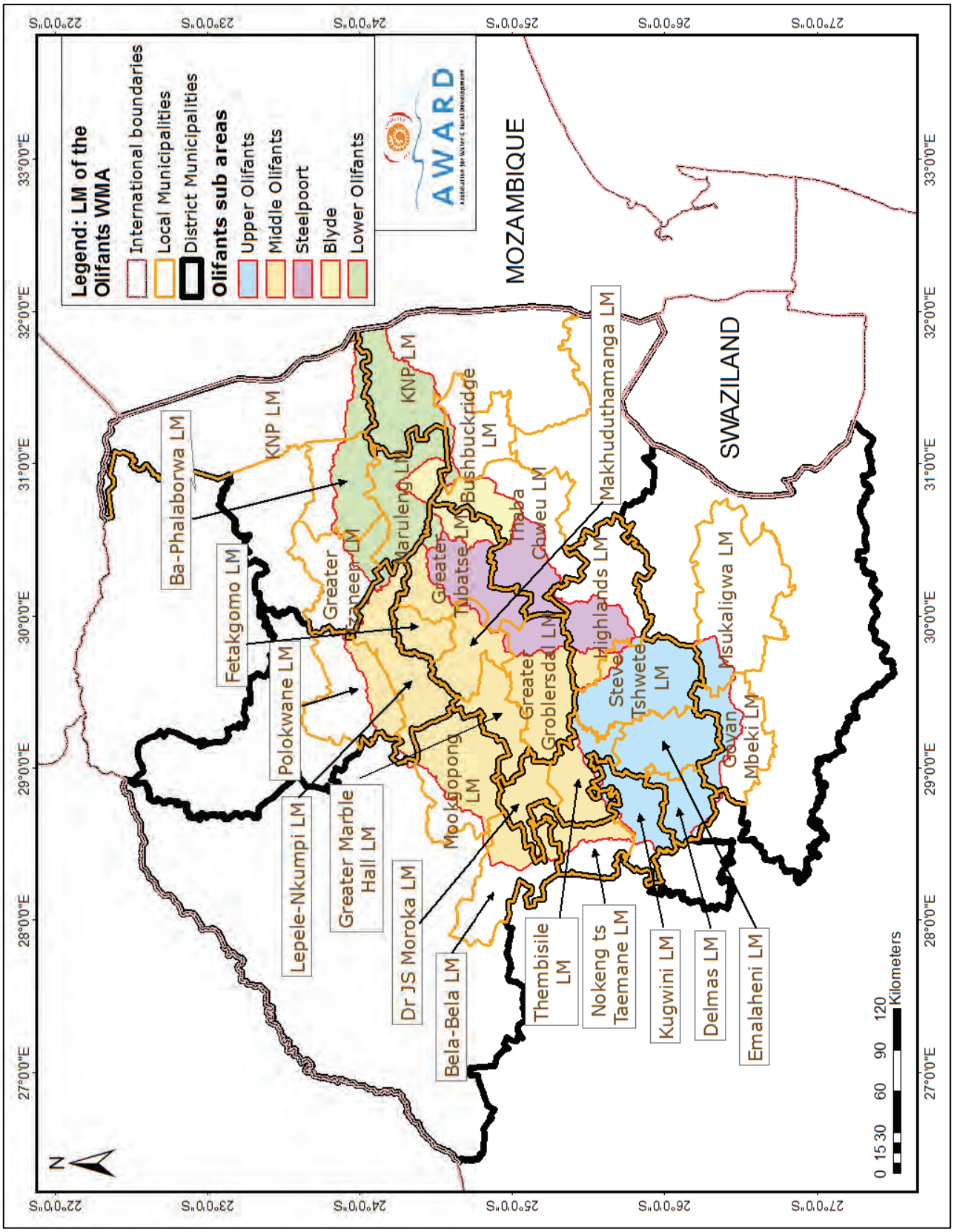

Figure 5.3: Map of the spatial boundaries of the Olifants WMA (water resources management) compared to those used for water supply (municipalities).

5.6 Organisational arrangements in the Inkomati WMA (5)

The water resources institutions are outlined in Table 5.6. There are also various non-statutory bodies such as the Crocodile River Forum and the Low Flows Forum. The overall WRM functions fall under the DWA Regional Office in Nelspruit. However, certain dams[22] and former 'government controlled areas' are managed under the newly-established National Water Resources Infrastructure Branch (B. Jackson, ICMA, pers. comm.). As with the other WMAs, a number of institutions are in the process of being established or transformed in accordance with the NWA. The primary institution is the Inkomati Catchment Management Agencies (ICMA), which is still in the process of being assigned functions. In order to ensure participation in WRM, the CMA is to be supported through Catchment Management Forums (CMF) or Committees, created for each sub-catchment.

Also involved in WRM to some degree are the WUAs which are either newly-established or being established through the transformation of old irrigation boards. This transformation process is being supported in Inkomati WMA through a number of facilitators of the ICMA. The lack of capacity and resources via the ICMA has constrained much of the work.

The situation with regard to regulatory functions is in transition and somewhat confusing. Although the ICMA is established they still await the assignment of functions (Schedule 3 of the NWA, RSA, 1998). Currently therefore they are still only responsible for the initial functions (S80) as well as S19 and S20 which deals with pollution control. Interestingly the last two include some degree of monitoring and enforcement. The initial functions are -

a) to investigate and advise interested persons on the protection, use, development, conservation, management and control of the water resources in its WMA;
b) to develop a catchment management strategy;
c) to co-ordinate the related activities of water users and of the water management institutions within its WMA;
d) to promote the co-ordination of its implementation with the implementation of any applicable development plan established in terms of the Water Services Act, 1997; and
e) to promote community participation in the protection, use, development, conservation, management and control of the water resources in its water management area.

At the time of writing, authorisation still falls under the RO as do finances and many compliance monitoring and enforcement (CME) functions with the exception of pollution control. The national DWA also participates in CME as do the regional offices of Department Economic Development, Environment, and Tourism and Agriculture, Rural Development and Land Affairs.

[22] Flood control; dams that supply more than one sector,

Table 5.6: Summary of the water related institutions of the Inkomati WMA and sub-catchments.
KOBWA = Komati Basin Water Authority; DARDLA = Agriculture, Rural Development and Land Affairs; DEDET = Department Economic Development, Environment, and Tourism. IAPs = Interested and Affected Parties. Based on best available information.

Inkomati WMA	
Regional	DWA Regional Office (RO) Oversight and WRM functions other than those delegated to ICMA
	DWA Satellite offices
	Inkomati Catchment Management Agency (ICMA) – Initial delegated functions (S80) and S19,20
Other regional offices	DARDLA (Agriculture, Rural Development and Land Affairs)
	LandCare and CCAW
	Department Economic Development, Environment, and Tourism (DEDET)
	Department of Mineral Resources (DMR)
Other Strategic	Eskom

	Sabie-Sand Catchment	**Crocodile Catchment**	**Komati Catchment**
Committees/ Forums			
Catchment Committees	(Not formally established)		
Irrigation Management Committees	Dingleydale IMC New Forest IMC Champagne CPA		
Catchments Forums	Sabie-Sand Catchment Forum	Crocodile Catchment Forum	Komati Catchment Forum
WUA/IB			
	Sabie River IB (~10km downstream of Sabie to Hazyview; focus on irrigation canal)	Crocodile Major IB White River Valley Sand River IB Kapp MIB Elands IB See Deli. 7 for minor IBs	3 IB operating in 'districts' Komati IB Kaalrug (Mhlambanyathi River) Lomati ID (Lomati River) Elands River WUA (former IB) Upper Komati WUA (new)
Other users			
Forestry	Various	Various	Various
Industry	Various – small to medium	Various – small to large	Various – small to large
Mining (unnamed)	Various small operations	Various	Various
Conservation	KNP	KNP	MTPA
	Sabie-Sand Wildtuin	MTPA	

IAPs			
	Working for Water	WESSA	WESSA
		FSE	FSE
International			
	Tripartite Permanent Technical Committee (SA, Mozambique and Swaziland; TPTC)		
			KOBWA
Water Services			
WSA			
Municipalities *(Ehlanzeni DM no longer WSA*	Thaba Chweu LM *Mbombela LM* Bushbuckridge LM (WSA and WSP)	Thaba Chweu LM Mbombela LM Umjindi LM *Nkomazi LM*	Nkomazi LM *Umjindi* Gert Sibanda DM
WSP			
Bulk WSP	Bushbuckridge Water Board	Bushbuckridge Water Board	
Utility		Silulumanzi	
Municipalities	Bushbuckridge LM (WSA and WSP)	LM as for WSA Highlands LM	Albert Luthuli LM *Highlands LM*

Table 5.7: District and local municipalities of catchments of the Inkomati WMA.
Those municipalities in italics are marginally included

Sabie-Sand	Crocodile	Komati
Ehlanzeni DM (no longer WSA)	**Ehlanzeni DM**	**Ehlanzeni DM**
Bushbuckridge LM (WSA and WSP)	Thaba Chweu LM	Nkomazi LM
Mbombela LM (WSA)	Mbombela LM	*Umjindi LM*
KNP	Umjindi LM	**Gert Sibanda DM**
Thaba Chweu LM (WSA)	*Nkomazi LM*	Albert Luthuli LM
		Msukaligwa LM
	Nkangala DM	***Nkangala DM***
	Highlands LM	*Highlands LM*

The water services institutions the Water Services Authorities and Water Services Providers (Bushbuckridge Water Board and Silulumanzi). In terms of water supply, this WMA falls within Mpumalanga province. The IWMA overlaps with three district municipalities, and nine local municipalities (Table 5.7; Figure 5.4).

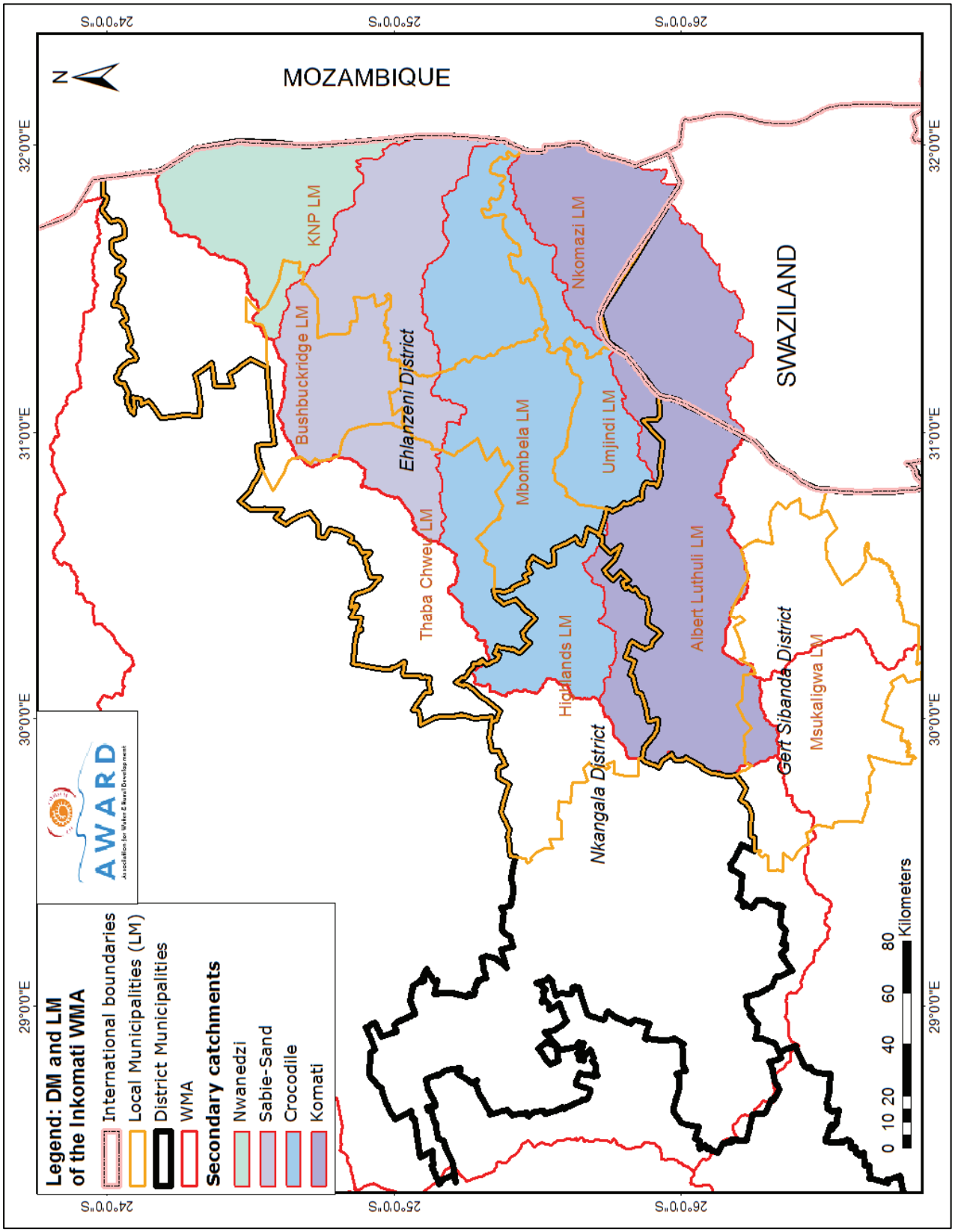

Figure 5.4: Boundaries for WRM and water supply (municipalities) in the Inkomati WMA

5.7 International agreements and cross-border flows

Inkomati WMA and Incomati Basin

The rivers of the primary catchments of the Inkomati WMA are shared with Mozambique and Swaziland thus placing a number of obligations on the basin states in terms of international agreements. The most pertinent of these are summarised below.

Treaty on the Development and Utilization of the Water Resources of the Komati River Basin (The Komati River Treaty)

In 1978 South Africa and Swaziland established a Joint Permanent Technical Committee (JPTC) which became the Joint Water Commission (JWC) when the Komati River Treaty was signed in 1992. The Komati Basin Water Authority (KOBWA) is a bi-national company formed in 1993 through the Komati River treaty and provides for the allocation of water between the two countries.

Piggs Peak Agreement

This agreement between Mozambique, Swaziland and South Africa was signed in Piggs Peak in 1991 to enable Driekoppies and Maguga dams to be built. It requires South Africa and Swaziland to ensure an interim 2 m^3/s minimum cross border flow (near Komatipoort) averaged over three days (upstream of the confluence with the Sabie River).

The Interim Inco-Maputo Agreement[23] (IIMA)

This agreement between Mozambique, Swaziland and South Africa was signed in 2002 sets new limitations on water use in each of the countries, target flows to be maintained to sustain the riverine ecology and water quality standards. It has not yet been fully implemented and will be superseded by a comprehensive agreement (see below; Box 5.1). The intention of this interim agreement is partly to fulfil the requirements of the Pigg's Peak Agreement where $2m^3/s$.

A number of agencies are involved in the regulation of river flows in different sections of the Inkomati Basin including the appropriate Ministerial committees/commissions and Ministries of International Affairs in three different countries. The most pertinent are the bi-nationals: Joint Water Commission with Swaziland (Swaziland JWC) and Mozambique (Mozambique JWC) and Komati Basin Water Authority (KOBWA); the tri-national Tripartite Permanent Technical Committee with Mozambique and Swaziland (TPTC); and country-specific agencies: DNA (National Directorate for Water Affairs) and ARA-Sul in Mozambique, Swaziland Ministry of Natural Resources and Energy (MNRE)[24], DWA, ICMA, Rotec, Komati Joint Operations Forum and various irrigation boards. Long-term water allocation issues on the Incomati River Basin are being discussed by the TPTC through the Incomati System Task Group (ISOTG).

[23] Known in full as: Tripartite Interim Agreement between the Republic of Mozambique and the Republic of South Africa and the Kingdom of Swaziland for co-operation on the Protection and Sustainable Utilisation of the Water Resources of the Incomati and Maputo Watercourses.

[24] includes the Department of Water Affairs and the Swaziland National Water Authority. Under this Department, the Komati and Lomati River Basin Authorities (RBA) have been established, which are similar to the South African ICMA.

Box 5.1:Inco-Maputo Interim Agreement (Swaziland, South Africa and Mozambique)

Signed at the world summit in Johannesburg in August 2002.

The Inco-Maputo Interim Agreement concerns the Incomati and Maputo River Catchments only- that is the Komati, Incomati, Sabie, Crocodile, Lomati, Usuthu and Pongola Rivers and their tributaries (Inco-Maputo Agreement, TPTC, 2002). The agreement is based on the Revised SADC Protocol on Shared Watercourses, and reflects the principle of equitable and reasonable utilization of shared watercourses for economic and social purposes between the three countries, as well as ensuring protection of the environment. The main objective of the agreement is to promote cooperation between the countries and to ensure the protection and sustainable utilisation of the shared water resources. The agreement covers a wide spectrum of aspects, including exchange and access to information, drought and flood controls, water quality and pollution prevention, incidents of accidental pollution and other emergency situations. The agreement also guarantees the water supply for the Maputo for the foreseeable future.

The value of the agreement lies in the setting out of baseline data on current water use in the Incomati and Maputo Basins for each country and the estimation of future requirements for Mozambique. The future requirements are subject to further studies to generate the required information to establish a comprehensive agreement.

The Agreement is supported by a resolution concerning short-term water quality management, the exchange of and access to information and data among the countries, and a framework for capacity building within the three countries (Inco-Maputo Agreement, TPTC, 2002).

Box 5.2: Work packages under the PRIMA project

1- Shared watercourse institutions
2- Review national water policies and legislation
3- Integrated water resource management
4- Augmentation of water supply to Maputo
5- Disaster management
6- Transboundary impacts
7- Exchange and access to information
8- Capacity and confidence building
9- Stakeholder participation
10- System operating rules
11- Preparation for comprehensive agreement
12- Managing the implementation of the IIMA

The most recent of these agreements, and importantly for the purposes of this study, is the Interim Inco-Maputo Interim Agreement[25] or IIMA (see www.dwaf.gov.za). This agreement sets limitations on water use in each of the basin states, target flows to be maintained to sustain the riverine ecology and water quality standards. The IIMA is currently being revised to develop a comprehensive agreement through the PRIMA project (Progressive Realisation of the IncoMaputo Agreement). The goal of the PRIMA project is to realize the objectives and purpose of the IIMA through a number of packages (Box 5.2), by supporting the TPTC (Tripartite Permanent Technical Committee) to promote cooperation among the parties and to ensure the protection and sustainable utilization of the water resources of the Incomati and Maputo watercourses. IWRM is the central theme, and stakeholder participation and communication is essential for implementation of Integrated Water Resource Management policy in the three countries.

[25] Known in full as: *Tripartite Interim Agreement between the Republic of Mozambique and the Republic of South Africa and the Kingdom of Swaziland for co-operation on the Protection and Sustainable Utilisation of the Water Resources of the Incomati and Maputo Watercourses.*

Currently, South Africa is managing the Inkomati rivers to meet the Piggs Peak Agreement of 2 m^3/s at the South Africa/ Mozambique border. In due course this will be replaced with more sophisticated flow pattern requirements of the more recent Interim Inco-Maputo Agreement (IIMA) which has a higher minimum flow requirement of 2.6 m^3/s for ecological purposes plus a further amount for downstream demands (B. Jackson, ICMA, pers. comm.). However this is likely to change once the Comprehensive IMA comes into effect. More detailed descriptions of the cross-border flow requirements can be found in Box 5.3.

Box 5.3 Cross-border flow requirements in the Incomati basin

The IIMA states that a minimum flow of 2.6 m^3/s is required at Ressano Garcia for *environmental purposes,* which is also assumed to be split 55% and 45% between the Komati and Crocodile Rivers respectively (DWAF, 2003a). However working on the Piggs Peak Agreement, the 2 m^3/s to be supplied is made up as follows:

- 0.9 m^3/s from the Crocodile River;
- 1.1m^3/s from the Komati system.
- The Swaziland share of the 1.1 m^3/s contribution is derived as follows:
- 0.21 m^3/s from the Komati System;
- 0.14 m^3/s from the Lomati River.

Target ecological flows for the lower Sabie as required by the IIMA (source: DWAF, 2004b – Table 2.1) are a mean of 200 (Mm^3/a) and a minimum of 0.6 (Mm^3/a). The Agreement does not set specific flow requirements for the Sand River as it is a tributary of the Sabie River.

As noted in the recent Incomati Water Availability Assessment Study (DWAF, 2009), in addition to this, the IIMA also notes the existing water use by the three basin states. In the case of Mozambique, it lists requirements of 29 Mm^3/a and 1 Mm^3/a respectively for irrigation and domestic use in the Incomati River upstream of the confluence of the Sabie River. The study notes that these users have no other source of water other than the flows crossing the South African border at Ressano Garcia and hence it is realistic that in addition to the stated minimum flow requirements, these users must be supplied from South Africa. This amounts to 3.6 m^3/s Assuming the same 55/45% split between the Crocodile and Komati, the following minimum flows are required from each sub-basin:

- Komati: 1.93 m^3/s
- Crocodile: 1.62 m^3/s

A number of international issues have surfaced in the last few years. The intention to increase the height of the wall of Corumana Dam on the Sabie River in Mozambique is a case in point. The dam which lies on the border between has the potential to flood back into the Sabie River. The height of the dam is to be increased to provide more water for irrigation for amongst other things, to grow sugar to be converted to ethanol fuel. In addition to the World Bank feasibility report on raising the Corumana Dam wall[26], a 2008 report suggests that the Committee for Facilitation of Agriculture between Mozambique and South Africa (Cofomosa) has plans to use water from the Corumana dam to irrigate 29,000ha of land to grow sugar cane for ethanol production[27]. The concerns raised by South Africa relate to the insufficient time and documentation to respond (as per the Tripartite Agreement) and the environmental impacts with the flooding of unique habitat in KNP and increased siltation.

[26] World Bank is reportedly funding the raising of the wall ($38M) See also http://www.cgweb.co.za/news.aspx
[27] http://africanagriculture.blogspot.com/2008/03/mozambique-to-invest-in-400-million.html

Photo 7: The gauging weir monitoring flows between South Africa and Mozambique at Ressano Garcia. The international agreement is that a minimum of 2.6 m ^{3}/s should flow over the weir

Luvuvhu/Letaba WMA and the Limpopo basin

The Luvuvhu/Mutale sub-area of the Luvuvhu/Letaba WMA forms part of the Limpopo River Basin (see Figure 3.1) which is shared by South Africa, Botswana, Zimbabwe and Mozambique. However this does not place any specific obligations on the Luvuvhu/ Letaba rivers.

CHAPTER 6. RESULTS: LUVUVHU/ LETABA WMA

6.1 Overview of approach

An overview of the characteristics of the Luvuvhu/ Letaba WMA and the two sub-catchments was given in Chapter 3 and an analysis of the institutional and organisational arrangements in Chapters 5. Based on this analysis, some 30 interviews were undertaken in this WMA with a range of role-players (Table 6.1). This included the regulator (regional and district offices), water users including the water services authorities and providers, researchers and consultants, and other interested and affected parties.

As noted, water resources management and services fall under the DWA Limpopo regional office in Polokwane. The CMA has not yet been established but a proto-CMA is in place. The major water users are agriculture and water services (water supply). In terms of agriculture, transformation is still underway such that not all former irrigation boards or farmers unions/ associations have transformed to water users associations. Thus there are a range of agricultural-sector institutions in place. In terms of water services, there are three district municipalities (DM) within the WMA and ten local municipalities (LM) variously taking on the role of the Water Services Authority (WSA) and Water Services Provider (WSP; see Table 5.1 and 5.2). There is one bulk WSP, Lepelle Northern Water Board.

Table 6.1: Key role-players and interviewees in the Luvuvhu/ Letaba WMA.
LRO = Limpopo Regional Office; DM = District Municipality; M&E = monitoring and enforcement; WUA = Water User Associations

Regulators	
National DWA	RDM, CME
DWA Limpopo RO and DO	Polokwane (regional manager; director WRM; M&E, Thohoyandou (technical, community development, Tzaneen (hydrometry; enforcement, operating rules; WARMs) NIB: Area manager LRO (Giyani) Institutional and Social Development,
Proto-CMA	Limpopo regional office
Water users	
Irrigation boards / farmers unions/ water user associations	Mutale WUA Mutshimbwe WUA Groot Letaba WUA Soutpansberg Farmers Association
Small-scale farmers/ emerging farmers	SAFM: Agric Mgmt Co- Pty (LTD) Mabunda farmers cooperative, Marabemi farmers cooperative
Municipalities as Water Services Authorities or Providers (WSA/WSP)	Vembe DM (WSA) (WSM) Mopani DM (WSM)
Water Boards	Lepelle Northern Water
Other users	Kruger National Park
Forums	Low flows Forum

Operations and maintenance	
Technical staff (Water services and Sanitation manager from DM)	Vhembe DM
Dam operators	
Researchers	
Consultants and academics	Pegasys Strategic Systems Water for Africa KWRCS (Giyani)
Other interested and affected parties	
	Working for Water/ Wetlands Haenetsburg conservancy

As described in Chapter 4, results of interviews were arranged thematically and these form the basis of the following discussion. For a more detailed analysis readers are referred to the respective reports (Deliverables 3 and 4).

6.2 Summary: Status of compliance with the Ecological Reserve

This section provides a summary of the results from an associated project which examined the status of compliance in each of the catchments of the study area. For further details please refer to Pollard et al. (2010) which provides an analysis of the *incidence of failure* (% of time), as well as the *magnitude* of the infringement (volumetric difference) and *seasonality* of failure. Here we focus on the first criterion.

6.2.1 Luvuvhu River

In the last 20 years incidence of failure to meet the EWRs (Figure 6.1) is evident in all months.

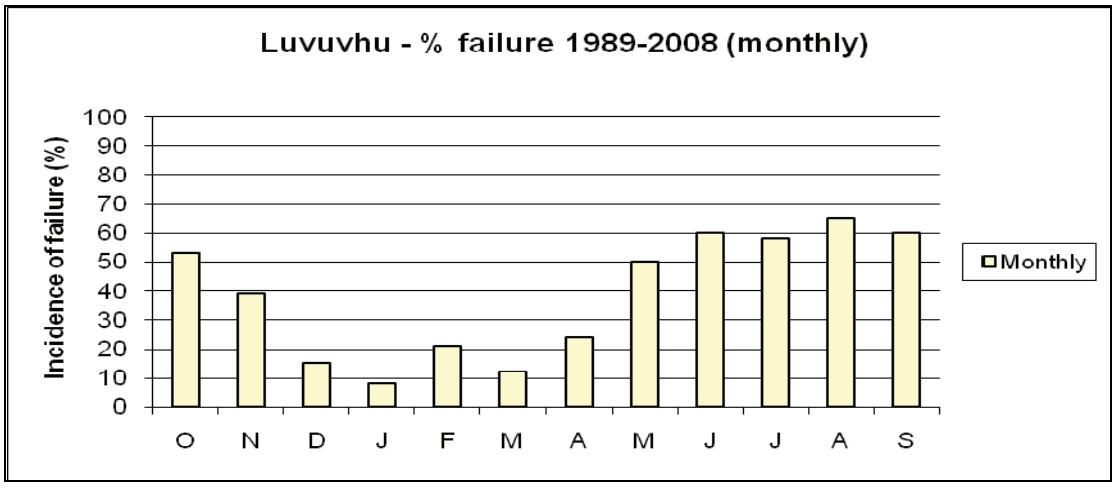

Figure 6.1: Incidence of failure to meet the Ecological Reserve (%) at A91H (based on a desktop estimate) on the Luvuvhu River between 1989 and 2008.
Data are based on monthly averages (from Pollard et al., 2010).

These results indicate non-compliance between 8 and 65% of the time. Failure is evident in all month but is worst in the dry season, when the ER was met less than 50% of the time. The average

incidence of failure across all months is 38%. Since only one period was analysed (1989-2008) no comments can be made as to whether or not this is improving or worsening. However, the completion of the Nondoni Dam is likely to have improved the situation although the operating rules make no specific reference to the Ecological Reserve.

The possible reasons for the non-compliance are as follows.

- There has been an increase in irrigated agriculture most notably in the 80's and 90's placing pressure on the available resources.
- The white paper on the Nondoni Dam is vague in terms of EWRs and did not even make mention of the 1998 in-stream flow requirement (IFR) determination. Thus it appears that EWRs have not been incorporated into the planning for the sub-catchment. The Nondoni Dam was already fully allocated prior to considerations for the ER so it is hard to see how this could be built in to the operating rules. A preliminary analysis suggests that if Nondoni Dam is operated to deliver the EWR requirements in keeping with the National Water Act (NWA), there would be a possibility of securing the ER some of the time but water is now being allocated temporarily to Giyani (Mr. B. Badenhorst, DWA, pers. comm.). Given the domestic shortages in Giyani and the surrounds, and the lack of viable alternatives, it is unlikely that this water will be 're-called" without compulsory licencing.
- To-date attempts to calculate an EWR have been unsuccessful due to a number of setbacks due to technical and biophysical issues (D. Louw, pers. comm.).

All of these factors point to the need for integrated planning that takes into account the need to deliver the Reserve (both the ER and the Basic Human Needs Reserve). This is a challenge that will face the new CMA once their catchment management strategy is developed.

Photo 8: Adequate gauging infrastructure and apparatus is at the heart of implementing the Reserve. A lack of monitoring infrastructure is currently a serious constraint.

6.2.2 Groot Letaba River

Failure to meet the ER is evident in all months in both periods examined except in the January, as well as in December in the most recent period (Figure 6.2). However the results suggest that there is increased compliance since 1994 in comparison to the preceding period. Indeed the incidence of failure declines from an average of 41% to 22% across all month.

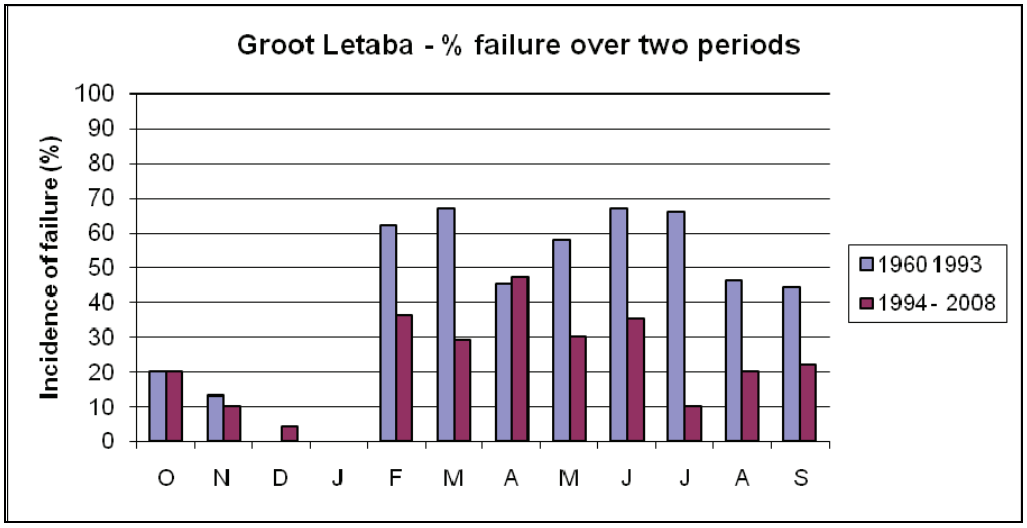

Figure 6.2: Incidence of failure to meet the Ecological Reserve (%) at EWR 4 on the Groot Letaba River over two periods.
Data are based on monthly averages (from Pollard et al., 2010).

The worst cases of failure are evident in the dry season (54% and 27% for each period respectively) when compared to the wet season (27% and 17% for each period respectively). However when data for the latest period based on daily averages are examined, the greatest failure occurs in the wet season (57%) as opposed to the dry season average of 40%. This is a function of amount of amount of data (14 points versus many) and the detail in detail flows. It is noted that these results may represent a conservative estimate of non-compliance since they are based on monthly averages. A more detailed analysis based on daily flows over the last 14 years (since improved WRM) supports these findings. In general the infringements are very minor volumetrically and the large infringements observed during February's are due to the flashy flow regime (high coefficient of variation) of this river system typically during this very wet month Pollard et al., 2010.

The Letaba has benefited from persistent efforts to improve water resources management since 1994. This is detailed in section 6.8 and in Chapter 9. Some of the constraints to meeting the ER include the following reasons.

- In times of stress when the manager is alerted to problems near the Kruger Park it normally takes around seven days for the effects releases from Tzaneen Dam to be felt downstream. A more responsive system is currently being developed.
- The increasing demand for urban consumption has placed further demands on the water resources of the catchment and the dam.

Photo 9: Drip irrigation as a means of reducing water demand in commercial agriculture is one of the ways farmers in the Letaba have responded to water availability pressures

6.2.3 Middle/ Klein Letaba River

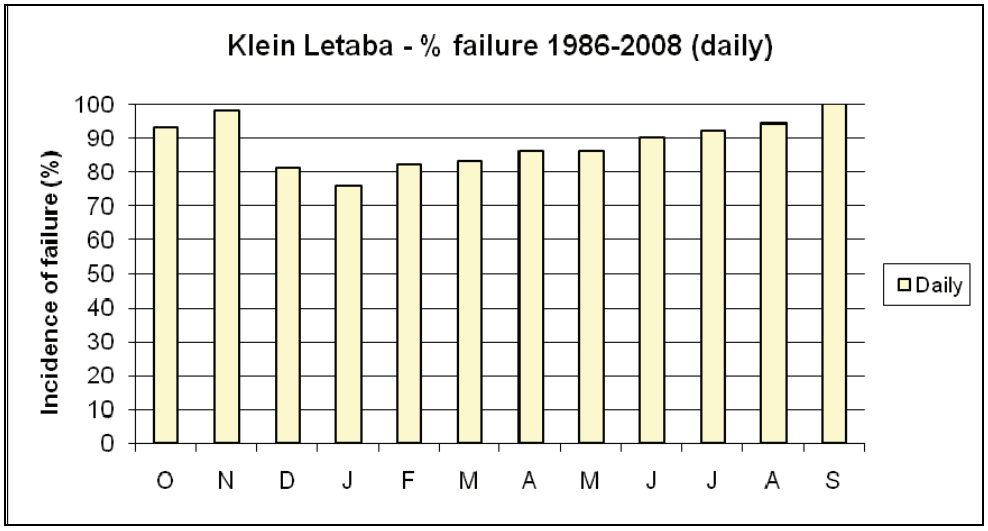

Figure 6.3: Incidence of failure to meet the Ecological Reserve (%) at EWR 5 on the Klein/Middle Letaba River for the period 1986 to 2008 (daily averages) (from Pollard et al., 2010).

All months indicate extremely high incidences of failure (average of 88%). Failure is evident in all month but is marginally worse in the dry season, when the ER was met less than 10% of the time (Figure 6.3). Since only one period was analysed no comments can be made on whether or not this is

improving or worsening. Given the high degree of almost total failure, the volumetric differences were considered unnecessary.

A range of reasons for the non-compliance are apparent and it is worth noting that the poor WRM in the Middle/ Klein Letaba is not new but has been a persistent problem over the last 15 years.

- The Klein/ Middle Letaba system is in almost constant water-deficit or nearly so. There are insufficient water resources to meet even a realistic estimate of domestic water requirements. Given that water services are largely focused on meeting the needs of the rural poor in the former bantustans, this is seen as a priority by the regional office of DWA (see Pollard and du Toit, 2008). For all practical purposes meeting the EWR requirements under the current situation would be extremely difficult.
- Institutional disparity and the lack of cohesive integrated planning undermines managing the system as a whole. In their analysis Pollard and du Toit (2008) pointed out that WRM roles are somewhat confused between the National Water Resources Infrastructure Agency (NWRIA) and the DWA RO (although this conclusion is contested by the DWA RO). If the area manager attempts to institute curtailments these can be overturned by the RO.
- Moreover, there is little understanding of the EWR requirements for this sub-catchment at the DWA RO. Currently there is no monitoring of water use thereby confounding attempts to develop a realistic water balance or to manage the system as a whole.

These factors point to the need for integrated planning that takes into account the need to deliver the Reserve (both the ER and the Basic Human Needs Reserve). Moreover it is important to recognise the spirit and intent of the NWA – to ensure sustainability of the water resources. Thus although the EWR might be met at the EWR site below the confluence of the Groot and Klein Letaba Rivers, this is likely to reflect good WRM in the Groot Letaba only. Not only may this be contested by water users on the Groot Letaba but it was never the intent of the NWA to allow failure on one sub-system or tributary of a water resource to be compensated for by another tributary (Pollard and du Toit, 2009). This is a challenge that will face the new CMA once their catchment management strategy is developed.

Photo 10: The Middle Letaba Dam is incapable of supplying either agriculture or domestic use water requirements with reasonable levels of assurance.

6.3 Current understanding and embeddedness of the concepts of sustainability and the Reserve in water management practices

A general pattern emerged of interviewees reflecting a very rudimentary understanding of the Reserve (Figure 6.4). At the time of the interviews, the DWA regional office and proto-CMA staff displayed a particularly weak understanding especially since they are tasked (together with National DWA) with the regulation, enforcement and compliance of the NWA including the Ecological Reserve. However this is not surprising since only one interviewee reported receiving professional support and awareness-raising in the form of a single workshop. This means that officials are left to develop their own conceptualisations of the Reserve and devise their own means for its operationalisation. In some cases the Reserve is viewed as a constraint to licencing and the sole responsibility of the national office. From this it is evident that there is almost no professional network for addressing sustainability and the implementation of the Reserve. It seems it is not seen as a priority where more pressing developmental needs in terms of services delivery are acutely apparent. However it is a legal obligation of the regulator (DWA/CMA) to ensure its implementation.

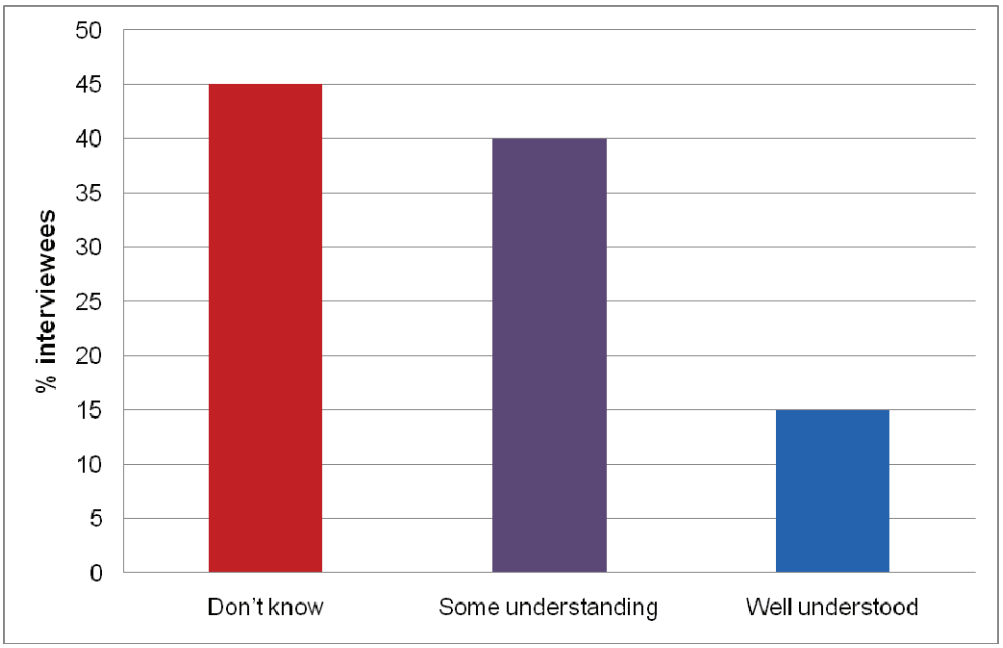

Figure 6.4: Knowledge of the Reserve in the Luvuvhu/ Letaba WMA based on interviews

Turning to the sub-catchments, it appears that a grasp of the concept of the Ecological Reserve was weaker in the Luvuvhu and Klein Letaba than in the Groot Letaba sub-catchment with a poor understanding of ecological security as an important factor in the management of these rivers. Despite interviewees raising concerns regarding the vulnerability of the resource base during dry season, concerns were fragmented and divorced from new management approaches for the catchment as a whole. Clearly Integrated Water Resource Management (IWRM) and catchment scale planning is not part of the discourse of regional management or water users. Even the White Paper for the Nondoni Dam (S. Mallory, IWR Africa, pers. comm.) only makes vague reference to the Ecological Reserve and hence it is hard to see how it could be met without a major re-orientation towards water resources planning for the sub-catchment (see Pollard et al., 2010).

Knowledge and familiarity with the concept of the ER varied considerably in the Groot Letaba sub-catchment. On the one hand the regional manager, some of his staff and some members of the GLWUA are well versed with the concept through attempts to implement a minimum flow but still see it as 'flows for another interest group (the Kruger National Park). Almost all other interviewees had either not heard of the water resources protection tools (and in particular the RQOs and Classification) or if they had, did not regard it as an important aspect of the long-term sustainability of the Letaba Catchment. Moreover, it was never linked in any way to the rights of future generations. Furthermore, in some cases the perceptions regarding flow and the Reserve are incorrect but are quoted persistently. Users claim that what 'the Park's' requirements far exceed the current capacity of the system and is a flow regime associated with pristine catchment conditions. As noted in Chapter 3, this is not the case and the Reserve is extremely low. The Reserve for the Middle/Klein Letaba was almost never mentioned. The fact that the Reserve is persistently linked to the conservation sector is not surprising given that they are the only ones monitoring the ER flows but needs to be addressed. As long as no other sector sees this as an important component of their own future, the responsibility for implementation can also be assigned elsewhere. This 'othering' of

issues of sustainability is not unique to South Africa and remains a challenge for the sustainability discourse (Ison et al., 2004) and is an issue that is picked up later (Chapter 9).

6.4 Change and lags

Setting the Reserve today will not mean that it is met tomorrow. The integrated workings of both water resource protection measures (RDM) with the authorisation of water use (SDC), together with other associated strategies, ensure that the commitment to sustainability and equity can be met (see Chapter 1). This process, to be captured in the regionalised Catchment Management Strategies, is still underway. Thus *lags are an inherent part of the process of reform and change* in a complex environment and are to be anticipated (see also Chapter 2). However it is important to consider which of these lags is unacceptable and why – a hard question to answer given that there is no blueprint and little experience upon which to base judgements (indeed, benchmarking aspects of IWRM so as to answer such questions is the topic of a new DWA/WRC project). Here various aspects need to be considered including the legal discourse that looks at progressive realisation and reasonability tests against which to make judgements (see Pejan et al., 2007). Moreover, the issue of lags requires further examination given that these may vary, reflecting lags in procedures, sequence, and in the development of capacity, skill and social capital (to co-manage and collaborate).

In both the Luvuvhu and Letaba sub-catchments, there do appear to be a number of questionable and problematic lags that lead one to conclude that the Reserve is poorly realised and that progressive realisation is not being achieved. For instance, compliance monitoring and enforcement complete the cycle of the operationalisation of management plans. They are steps that provide the basis for assessing compliance and seeking remediation. Without these two steps there is unlikely to be liability and accountability assigned, ultimately resulting in the non-achievement of strategic water resources management plans. Yet despite the importance of these steps little is evident by way of these actions with the exception of the Groot-Letaba River below Tzaneen Dam. Indeed until 12 months ago the responsibility for this aspect for the entire country was dealt almost exclusively by one person at the national office.

Although the regions have been undertaking some functions related to monitoring and enforcement, they have been severely constrained by a number of factors, not least of which relate to capacity and funds. Over and above this however, it is clear that delays in various aspects of implementation of the water reform process will delay the complete monitoring and enforcement process amongst many things. One of the first steps necessary for a 'compliant IWRM system' is that of validation and verification without which a whole range of steps cannot proceed. For example, without completion of validation and verification, it is difficult for DWA/ proto-CMA to monitor licence compliance as well as unauthorised use. In the Luvuvhu/ Letaba WMA delays in registration as well as the almost total halt in validation and verification is a major constraint. A severe stumbling block appears to be the delays and administrative problems in appointing service providers for the task. This is due to the high turnover rate of senior staff (i.e. directors) that are required to appoint consultants to undertake this process. This must be dealt with as a matter of urgency.

Photo 11: The DWA infrastructure agency staff, based in Tzaneen, are responsible for the operating rules of the Tzaneen Dam. This unit is largely responsible (along with other stakeholders such as GLWUA and KNP) for sustaining environmental water requirements.

6.5 Integration of WRM and water supply

The almost total lack of integration between water supply and water resources management is widely evident. With little consideration of the constraints imposed by the water resource base, this puts the sustainability of water resources in both the Luvuvhu and Letaba (and in particular the Middle and Klein Letaba) into question. Together with the shortage of skilled personnel, this probably comprises one of the most serious problems to achieving sustainable and integrated water resources management.

The lack of integration is particularly evident with regard to municipalities whose unconsidered development and expansion is problematic. Not only are they required by the Water Services Act[28] to undertake water service functions within the remit of water resources management, but not doing so undermines their own long-term sustainability. Some interviewees felt that one of the biggest problems hampering integration was the lack of appropriately skilled persons transferred from DWA[29] to local government. Whilst there is validity in this, we suggest the reasons are more nuanced and at it is rather a combination of political and structural factors that underlies this.

[28] The WSA (Act 108 of 1997) recognises that that although the provision of water and sanitation services is an activity distinct from the overall management of water resources, it "must be undertaken in a manner consistent with the broader goals of water resource management" (provided for by the National Water Act).

[29] In the case of Vhembe DM in the Luvuvhu where approximately 1300 personnel were transferred to the WSA – few were deemed to have the necessary skills to support the roles of a newly established institution.

An immediate issue is that the key focus for water services staff is addressing the inequities and backlogs associated with the apartheid era. They perceive that what water there is must be accessed to meet this goal. In one case where water was fast running out, the response was to turn to additional sources that are largely inappropriate (i.e. prohibitive distances and costs and contrary to policy framework). In the case of the Letaba, monitoring by the Tzaneen area office and discussions with municipalities and the Water Board appear to have had little effect and enforcement is regarded as very difficult given the political sensitivities. In striving to meet these backlogs in domestic demands, little consideration is being given to the availability of water or to the impacts of various works on the resource base. Here the underlying causes reflect a lack of strong leadership in the water services sector that obliges municipalities to do so (through their Water Services Development Plans) combined with the lack of support from the DWA RO (as required legally) and, as many pointed out, the lack of any consequences of not doing so. Given this context and the lack of skilled staff (and the inability to enforce) there is little reason for water services institutions to participate in WRM issues. There are few perceived benefits, particularly in an already over-stretched sector. Local government officials claimed that they did not know of forums where they could discuss water management issues or that they did not see the value in attending, while attempts to involve local government in other forums (e.g. the GLWUA) were met with frustration when the local municipality failed to show up for meetings.

The lack of cohesion between water resources and water use is also apparent in much of the agricultural sector, especially in the Middle and Klein Letaba sub-catchments and sections of the Luvuvhu. In the Middle and Klein Letaba sub-catchments, this is compounded by the fact that different components of the water resources are managed by different bodies: the Middle Letaba and Nsami Dams under the National Water Resources Infrastructure Branch, and the river under DWA Limpopo Regional Office. Moreover it was repeatedly reported that despite repeated attempts to alert the DWA to the critical situation in the Middle Letaba, no action has been taken. The notable exception of the Groot Letaba where water resource constraints are taken into consideration can be traced to a number of factors which is described in Section 6.7.

The implications of not integrating WRM and supply are dealt with in Chapter 9 and includes the risk of unrealistic plans being developed and hence rejected, the failure of implemented projects and ultimately the inability to deliver the Reserve along the length of the river as is intended (see Pollard et al., 2010).

6.6 Unlawful use and legal literacy

As noted in Chapter 5, the Ecological Reserve is persistently infringed in both the Luvuvhu and Letaba catchments.

Specific mention of cases of unlawful use included groundwater usage, unlicenced abstraction for farming and exceeding licence allocations and conditions in the case of water services providers. In the Luvuvhu concerns were raised regarding the legality of groundwater use by commercial farmers but also by mines and towns. In one case a farmers union maintain that their use of groundwater is due to the fact that that their existing lawful allocation has been appropriated for the development of Makhado town. Emerging farmers on the Luvuvhu/ Mutale perceive high incidence of unlawful use in their area claiming that “people just put pumps in to the river”. They also perceive (incorrectly) that they (as WUAs for emerging farmers) have been granted the authority by DWA to authorise water

use. Another sector frequently mentioned regarding unlawful use by the water services, namely the municipalities and Lepelle Northern Water Board[30]. One municipality in the Luvuvhu has no authorisation for abstractions although they do have a licence for a water treatment plant. However this did not appear to be a case on wilful neglect; rather they claimed to have struggled with the application process in the absence of information that DWA had access to (infrastructure, pump capacity) and support.

In general there is a perception that the Groot Letaba is well managed (that area within jurisdiction of the Groot Letaba WUA, GLWUA). However, regulation is weaker in the lower Letaba and Letsitele rivers and most interviewees regarded the situation in the Middle and Klein Letaba Rivers, as "chaotic", pointing to both commercial agriculture and municipalities[31] as being problematic. Indeed, the Mopani DM itself acknowledged illegal use but stated it had no option as it needs to meet growing demands for use by the domestic sector. This tension was echoed throughout the WMA such that whilst the regulator might experience problems with local government compliance, local government has its own internal problems related to chasing service delivery targets.

Ability to regulate

Despite the identification of specific unlawful users in the Middle/ Letaba case outlined above, the lack of leadership for IWRM is the most notable underlying factor. Indeed a crucial aspect of the story on unlawful use is that of the responsibility of the regulator (DWA) and how they are viewed by the public. In many cases a lack of confidence in the regulator's ability to regulate was expressed on a number of occasions and both agriculture and local government asserted that DWA was not performing its duties in this regard. In the Letaba for example, whilst the Groot Letaba has a regulation mechanism in place for meeting minimum flow requirements, there is no regulatory mechanism for the Middle and Klein Letaba rivers. The need to bring water use under control was widely recognized by participants themselves yet the ability of the regulator was seriously questioned. In the Luvuvhu the DWA staff themselves expressed insecurity with respect to their own abilities, noting that they were aggressively dealt with on occasion. Also they talked of the moral dilemma they face in regulating illegal abstraction where poor, small-scale farmers are abstracting water to survive. This issue is recognised by DWA which considers enforcement therefore to be largely a national function J. van Aswegan, Director, Mpumalanga RO, *pers. comm.*).

The importance of the role of self-regulation is described in the case of the Groot Letaba (see Section 6.7). In contrast, this capacity for self-regulation is not as well developed elsewhere. Although the Soutpansberg Farmers Association maintains that they are successfully regulating its members they admit that there are commercial farmers who fall outside of their regulation capacities (i.e. ZZ2 – tomato and avocado producers).

The reasons cited for difficulties in regulation are similar across the WMA. DWA says that it is difficult to establish the extent of the use on many farms in the Luvuvhu and middle Letaba but the reasons for this are unclear and need to be examined. Other constraints were as follows.

1. The incomplete registration database (WARMS) which was discussed in Section 6.3.

[30] Lepelle Water Board has an allocation from Ebenezer Dam of 12 Mm3/a but currently uses 14.8 Mm3/a. Nkowakowa scheme from the Groot Letaba River has an allocation of 3.5 Mm3/a but uses 7 Mm3/a. The latter is likely to be ameliorated with the completion of the Nwamitwa Dam.

[31] Over-abstractions are probably in the order of 13 Mm3/a (S. Mallory, IWR Africa, pers. comm.).

2. The lack of monitoring systems (including technical hardware such as meters) for unlicenced use or for conditions for use was raised on a number of occasions.
3. Additionally, many noted the almost total vacuum with respect to legal support many staff described themselves as having a “lack of teeth” (see next Section).
4. A glaring issue raised by the regulator as well as by users was that of competence and skills amongst the regulators (see discussion staff in Pollard and du Toit (2008; Section 3.3)).
5. Importantly, there appears to be few incentives to comply with legislative requirements. This is particularly so in the case of local government. That some local municipalities are over-abstracting at nearly double allocated volumes and not being held accountable was a serious matter for the regulator. Currently the regulator has particular limitations for legal recourse as it is working with another government structure (as outlined in the Intergovernmental Relations Framework Act (RSA, 2005)), although this appears to be changing.
6. DWA officials contested that they “could not take decisions” and that business plans took a long time to be approved by National DWA.

Photo 12: Dysfunctional gauging along the lower Letaba seriously hampers ability of regulator to ascertain the nature and extent of violations of the Ecological Reserve.

6.7 Skills, capacity, monitoring and legal literacy

The issue of skills and competence has already been highlighted in a number of ways in the preceding discussion. Poor practices with regard to regulatory functions – considered by some to be almost non-existent except in the Groot Letaba – were regarded as particularly acute. Linked to the notion of ‘poor practice’ is the competence of those mandated to carry out a particular task. It was

noted that regulators are unlikely to develop sound WRM practices in their daily routines if they do not have the conceptual grounding or the practical skills to carry out their duties. Once issues require legal advice or intervention the attempts at monitoring and enforcement is even further hampered. A particular issue was that of legal literacy and legal support. When regulatory staff had to take action they noted a lack of legal support and knowledge, describing themselves as having “no teeth”. In the past legal support was provided by legal advisors on a basis of lawyers per region so that legal staff developed knowledge of the local area. Current policy is for lawyers within DWA to provided specialized support on the basis of issues with the result that a legal track history with sound feedback loops does not develop.

Since, up until recently, the option to litigate was not immediately available to the regulator the onus was on them to work co-operatively with local government structures to reduce pressure on the resource through water conservation and demand management as the major strategy for increasing water for delivery. The lack of skills and understanding in local government presents a serious obstacle in this regard.

Finally it is worth noting the failure of the regulator to understand what they are regulating for. Most DWA/CMA officials saw regulation as monitoring of licences. With the exception of the Letaba below Tzaneen Dam, there is little evidence of monitoring to ensure that the system is not stressed beyond its capacity to deliver (i.e. to be in water deficit). This technicist rationality provides little understanding that there are limits to what the resource can provide.

Photo 13: Middle Letaba Dam has an off-take canal feeding agriculture schemes but the use from this canal is to a large extent unregulated and a serious regulation problem

6.8 Adaptive capacity in a transforming worlds (policy changes in order to respond to a degrading system

Feedbacks, self-organisation and self-regulation

Feedbacks are considered as essential components of resilient systems and adaptive management (see Chapter 2). The concept is not a difficult one and at a practical level it means that as something is discovered or learnt as part of a management process, this information is passed on to an (appropriate) body who takes (appropriate and effective) action and feeds this back. This is the basis for a learning and reflexive system. Where systems often fail is where any of these steps fail such as in cases where the learning is not passed on or is passed to an inappropriate body. This emphasis is part of the current WRC/ KNP programme[32] on adaptive management.

In the Groot Letaba Catchment a number of key self-organised feedbacks are evident and these have provided the basis for self-regulation and learning (Pollard and du Toit, 2009; Figure 6.5). The KNP monitors the flow at the entrance to the Park against an IFR requirement (albeit static). If problems are noted the Tzaneen area office manager (who manages the Tzaneen Dam) is alerted, who then alerts the GLWUA to reduce use. Internally the GLWUA informs users with instructions for use and monitors this.

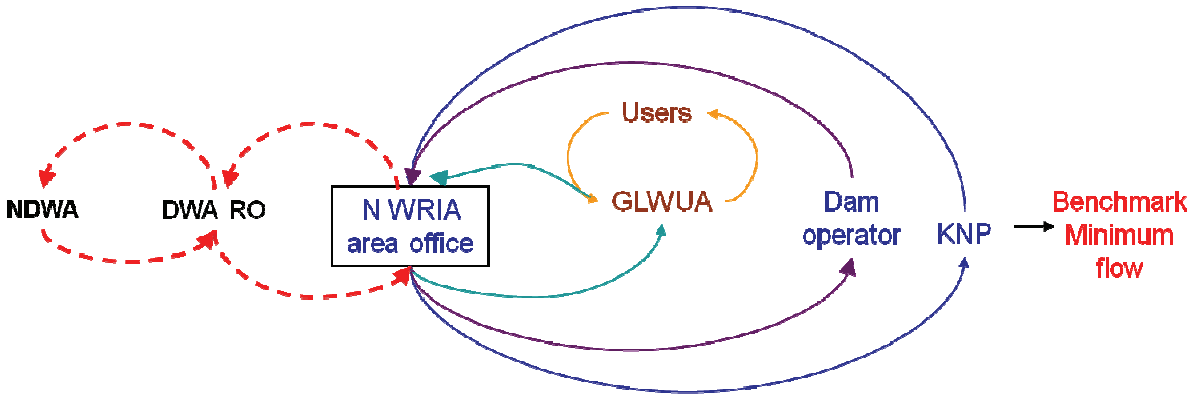

Figure 6.5: Functional feedback loops in the Letaba Catchment.
Note the weak linkages to the regional and national DWA. NWRIA = National Water Resources

Pollard and du Toit (2009) note that one of these feedbacks is potentially quite fragile in that it depends on one key person (the area manager). Were he not to undertake this role, the question arises as to who would do this and whether or not they have the capacity and trust of the users. There are a number of causal factors behind the success of these two loops are further discussed in

[32] Water Research Commission funded project K5/1797 "Application and testing of a Strategic Adaptive Management system for freshwater protection, associated with implementation of South Africa's national water policy" lead by SANParks, commenced in April 2008 and will run over a three year period.

Chapter 9 (Pollard and du Toit, 2009). These include the requirements of the law (the Reserve), the availability of benchmarks against which to monitor (the Reserve), the presence of a 'watchdog', the responsiveness of the manager and users and the ability to self organise.

As with self organization, self regulation has an important role to play in management within complex systems. The general sense from the interviews is that regulatory functions are perceived to reside with DWA and only on a few occasions did respondents recognise that they have a collaborative regulatory role to play when it comes to sustainability issues and the Reserve. No such regulation occurs on the Middle or Klein Letaba with the consequences that such responsibilities fall to DWA (who lacks the capacity to regulate).

The over abstraction by district and local municipalities is indicative of the lack of regulation within this particular sector. So too is the use of purified water for small scale agriculture around Giyani with no effort from the municipality to intervene. However the recent projects of local government to develop water conservation and demand programs that have seen household usage dropping from 96kl/m to 36kl/m is indicative of move towards self regulation.

Photo 14: Homestead gardens are largely rainfed, although irrigation occurs at sites where there is access to bulk supply. Such water use is usually not accounted for by municipalities.

6.9 Implications and recommendations

The shear lack of discourse and practice regarding sustainability and its relevance for catchments and stakeholders of the Luvuvhu/Letaba WMA is worrying. Indeed the discourse amongst stakeholders is fractured and remains as it always has – centring on justification for claims to the major share of a stressed resource. The fact that the regional office has a poor understanding of the Reserve, regarding it as a constraint to licencing and the sole responsibility of the national office, is problematic and requires urgent attention. Likewise the fact that the Reserve is persistently seen to benefit others' (the Kruger Park), needs to be addressed. As long as no other sector sees the Reserve as an important component of their own future (and that of their children), it is likely that the responsibility for the Reserve will continue to be assigned to others (i.e. government) rather than people developing a sense of collective responsibility and interest. As noted, this 'othering' of issues of sustainability is evident in many situations world-wide and remains a challenge for the sustainability discourse (Ison et al., 2004). If this does not change the implications are that sustainability will continue to be compromised.

At a fairly basic level, it is hard to see how sustainability will be embedded in any plans such as the Catchment Management Strategies if both the regulator and stakeholders are not familiar with the concept, its associated tools and relevance for water resources management. The need to facilitate discussion around sustainability and the Reserve warrants serious consideration. The appointment of a lead agent capable of this facilitation is of equal importance. A well-developed and sustained programme of awareness-raising with the regional office and with the proto-CMA by the RDM directorate, which clearly outlines catchment-based responsibilities, is required. Once-off or ad hoc talks (for example, on classification) cannot achieve this and may only serve to confuse and frustrate.

Nonetheless, it is clear that 'awareness campaigns' alone are a simplistic and naïve approach to dealing with complex, transformative environments such as embedding sustainability (the Reserve) into peoples' interest and hence direct responsibility. Whilst they may raise awareness regarding the concept they do little to shift behaviour (see Muro and Jeffrey, 2008). This is not to suggest that it is not important to inform people but that we need to face the challenge of developing a new discourse and practices regarding sustainability in general, and the Reserve in particular. In the preceding section, a tiered approach has been eluded to including broad awareness-raising together with specific technical support as well as a more sustained, collaborative process. Globally, the current recommendations on approaches to natural resource management are strongly participatory, but these are only useful (from a sustainability perspective) if the participants are able to contribute to the common goals rather than protect vested interests. *Social learning approaches* (see Chapter 2) are seen as an important way of developing collective understanding and reducing resource related conflicts. Mentorship approaches and processes, where successes are being registered – such as in the case of the GLWUA – may also provide a valuable co-learning model, and should be explored.

At a more advanced level the almost total lack of any professional network regarding practices for operationalising the Reserve is notable. Whilst the aforementioned awareness-raising orientates stakeholders to the important concepts it is unlikely to be adequate in helping the regulator develop sound and robust monitoring and enforcement practices. For this specialized technical support is likely to be required, for example, in the form of well designed professional development program or an internal mentorship process. The emergent model in the Inkomati – which has been seen at a smaller scale in the Groot-Letaba – reflects the coming together of policy makers, interested parties and researchers and is further explored in Chapter 9.

Without multiple stakeholder platforms for integrated planning at which the *status quo* of the catchment and its water resources are understood, and a common vision is developed, it is hard to envisage how else the issue of sustainability will be embedded in planning. Ultimately the consequence is that if resources are stressed the Reserve will come under scrutiny and will require strong leadership to defend it. Thus it is essential that buy in, and hence directives, from leadership are secured (for example SALGA, DWA/ CMA, DPLG). It is also at such platforms that self-organisation and self-regulation are facilitated. In complex and dynamic environments these are seen as key attributes for building adaptive skills and resilience (see Chapter 2) such as those evident in feedbacks in the Groot Letaba (see Figure 6.5).

From the above discussion the implications of not having feedbacks in place is fairly self evident. Firstly there is no basis on which the system can learn and respond so dealing with dynamic environment and change is highly unlikely. Secondly this makes the development of tools such as operating rules a paper exercise since it begs the question of who will use them. The important part in the feedbacks is that these operating rules must be *managed* by someone with the authority (and skills and interest) to respond to change. Thirdly, 'watchdogs' (be they affected parties, bailiffs or the area manager) are essential and loss of this role makes the management and delivery of Reserve very vulnerable. Finally an important point made regarding enforcement and one that is pertinent to feedback loops is that of a supportive legal system. When all else fails (coercion, incentives, punitive measures) people need to be able to turn to the law. A strong perception exists amongst respondents that the legal system is ill-equipped to support compliance in the water sector. The importance of adequate legal back-up as important contributor to compliance and enforcement has been highlighted. The fragmented support to regions by the national legal division at DWA was seen to be a problem for IWRM in general. A review of legal support within DWA was called for by one of the key legal persons interviewed.

CHAPTER 7. RESULTS: OLIFANTS WMA

7.1 Overview of approach

An overview of the Olifants catchment is provided in Chapter 3 and an analysis of the institutional and organisational arrangements in Chapters 1 and 5 respectively.

As pointed out in the previous chapter on the Inkomati WMA, and the Olifants is no exception, the introduction of a new discourse for water management has meant the introduction of new concepts, practices and approaches. Some of the new concepts conflict with and contradict practices that have been part of previous legislation and water management. In this chapter we consider the situation in the largest of the WMAs of the lowveld and discuss the implications for sustainability and the implementation of the Reserve. The Olifants WMA is somewhat different to the Inkomati and the Letaba/Luvuvhu in that the establishment of the CMA is further behind and the links to the regional DWA is complex in that it involves two provincial structures. These issues will be picked up in this and subsequent chapters but suffice to say the lines of communication for the Olifants catchment are complex. Regulatory and management functions are conducted by different regional offices, namely Limpopo, Mpumalanga and Gauteng. In addition to this the specific functions such as licence applications and water quality reporting are performed by different satellite offices, namely Lydenburg and Bronkhorstspruit respectively.

In addition to this the Olifants WMA suffers intense development pressure from the mining sector with lucrative platinum resources being exploited in the Steelpoort sub-catchment. These pressures need to be reconciled with highly productive commercial agriculture and in the central part of the catchment and the national imperatives for biodiversity conservation (represented by SANParks) and the international obligations (Mozambique) in the lower catchment.

In drafting this WMA profile some 27 discussion sessions where held with representatives from the WMA (Table 7.1). There is however some commonality with the other WMAs in that national and regional structures/institutions apply as well.

As described in Chapter 4, results of interviews were arranged thematically as discussed in the following sections. For a more detailed analysis readers are referred to the respective reports (Deliverables 3 and 4).

Table 7.1: Key role-players and interviewees in the Olifants WMA.
DM = District Municipality; M&E = monitoring and enforcement; WUA = Water User Associations; DEDET = Department of Economic Development, Environment and Tourism.

Sector	Representative interviewed
Regulators	
National DWA	Chief Water Resource Planner RDM
Regional DWA	Regional director: WRM Director: Water Sector Regulation and Use
ICMA	N/A
Water Tribunal	Member

DMR	Regional manager Mpumalanga
DAFF	Director law enforcement
Mpumalanga Development Tribunal	Deputy Chairperson
Water users	
Irrigation boards/ WUA	Loskop IB Blyde WUA Labelelo WUA
Forums	ORF Chairperson and secretary
Small-scale farmers/ emerging farmers / schemes	
Municipalities as Water Services Authorities or Providers (WSA/WSP)	Greater Sekhukhune DM (WSA)
Agriculture (government) now DAFF	
Environment (Government) (Department of Economic Development, Environment and Tourism) former DALA EA	Chief director: Environmental Services Directorate Environmental Impact Management
Conservation and tourism	MTPA Scientific Services
Industry	
Operations and maintenance	
Technical staff (WS and Sanitation manager from DM)	
Dam operators	
Researchers and consultants	
Consultants and academics	

Photo 15: Water use (in terms of s21 of the NWA) by the mining sector is a serious concern for the regulator in the Olifants catchment.

7.2 Summary: Status of compliance with the Ecological Reserve

This section provides a summary of the results from an associated project which examined the status of compliance in each of the catchments of the study area. For further details please refer to Pollard et al. 2010.which provides an analysis of the *incidence of failure* (% of time), as well as the *magnitude* of the infringement (volumetric difference) and *seasonality* of failure. Here we focus on the first criterion.

Photo 16: The Olifants is possibly the most degraded of the rivers of the lowveld with consequences largely being experienced by downstream users. In this case, rural settlements carry the burden of degradation in terms of quantity and quality. Note: sedimentary load

7.2.1 Lower Olifants River

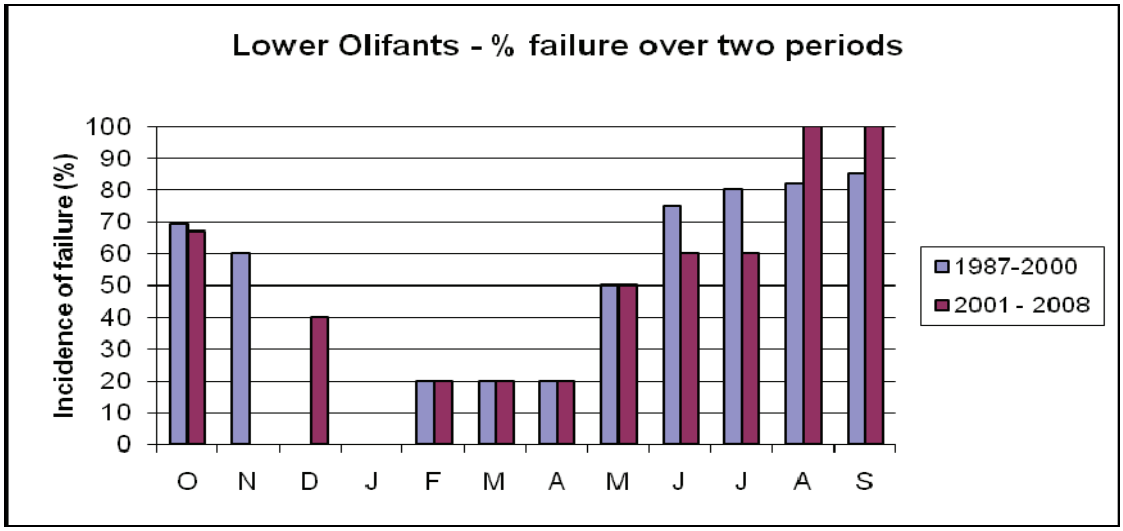

Figure 7.1: Incidence of failure to meet the Ecological Reserve (%) at EWR 16 on the lower Olifants River over two periods.
Data are based on monthly averages. (from Pollard et al. 2010)

Failure to meet the ER is evident in all months in both periods examined except in the January, as well as in December in the first period (Figure 7.1). The results suggest that there is no improvement in the situation with the overall incidence of failure being fairly similar at an average across all month s of 47% and 45% for each period respectively.

The worst cases of failure are evident in the dry season (an average of 67% for each period) when compared to the wet season averages (28% and 25% for each period respectively. However when data for the latest period based on daily averages are examined, the failures in the wet season increase considerably (45%). These results may represent a conservative estimate of non-compliance since they are based on monthly averages. However, all the Reserve determinations for the Olifants catchment incorporated both flows, i.e. there was no distinction made for low flows. The implications therefore would be that non-compliance may be over-estimated, certainly for high flow (rain season) months.

A more detailed analysis based on daily flow over the last seven years indicates failure of compliance in all months, with an average incidence of failure of 56%. The greatest failure occurs in the dry season (67%) but that of the wet season is still high at 46%. The dry-season months of August and September indicate a nearly complete failure to meet the ER. Indeed concerns have been raised about the recent flow cessations. For example, the hydrological record indicates that the lower Olifants (B7H015, A01) ceased flowing[33] for a total of 33 days in the two driest months in 2005 (10 days in September and 23 days in October 2005).

The amount (as a volume) by which the ER was not met for the last period (i.e. since 2001) indicates that in the dry season almost the total amount required by the ER is not met pointing to the seriousness of the situation.

[33] Flows < 0.01 m3/s

In terms of the lower Olifants, the possible reasons for the non-compliance stem from a severely stressed catchment and the dire need to integrated planning and management. Agricultural and urban demand has increased in the last decade. Overall, the Olifants catchment face severe water resource constraints since the catchment is in water deficit of an estimated 179 Mm^3/a (with the EWR). It is noted that an IBT is planned from the Olifants (despite it being in water deficit) into the Letaba. Non-compliance with the water quality aspect of the Reserve is likely to be high and requires examination.

Meeting the ER will require compulsory licencing amongst other strategic and management interventions since there is no surplus water in the catchment. Currently, Integrated Water Resource Management (IWRM) appears to be weak (Pollard et al., in prep).

7.3 Current understanding and embeddedness of the concepts of sustainability and the Reserve in water management practices

The levels of understanding to the Reserve in the Olifants catchment vary considerably (Figure 7.2). A fair, and on the rare occasion – good, understanding is limited to specific sectors/groups. The best understanding is to be found amongst DWA, some IBs/WUAs and consultants. In general however, there is a disturbing pattern of participants reflecting a rudimentary or narrow understanding of the Ecological Reserve [the BHNR is more widely understood than the ER]. Only specific members of the regulatory structures have a good understanding of the Reserve and how it might be realised. However, this knowledge resides with a few members, with big disparity in conceptual grasp within these institutions.

It is interesting to note that those with the greatest understanding of the ER have had some past involvement in the process of setting the Reserve, or contact with the scientific community responsible with its conceptual and practical evolution. This provides an important clue to the link between familiarity and practical involvement rather than understanding from theoretical explanation.

In general, a number of challenges for implementing the Reserve were offered by various stakeholders (those familiar with the concept). These where articulated as: the ability to implement the Reserve in stressed catchments will mean reclaiming water from users, methods and approach are too complicated to be accessible, not calculated properly, conditions [RQOs] are perceived of as too strict, methodologies are changed leading to confusion (e.g. salinity methodology), serious financial implications for meeting the RQOs – profit motif is the main driver in the mining sector, mining houses don't sit around the same table and plan together. In conclusion to these points, there still appears to be a lack of a comprehensive understanding of what the Reserve actually represents and what is can offer the Olifants catchment in terms of water security.

The persistent opinion that the "environment and development must be reconciled" points to the ongoing polarization of the two – with negative implications for realizing the Reserve and sustainability. That "some benefit [from the Reserve] more than others" is an argument that is less prevalent in the Olifants than other catchments. However there is still a sense that that ER stands to "benefit someone else and disadvantage us". The apparent conflict of the apportionment of benefits to the various sectors represents a shallow understanding and a misrepresentation (wilful or

otherwise) of the intention to provide for ecological stability, water security and ultimately sustainable development of a catchment. What should be sought is the collaborative involvement of all users in designing principles for practice that are grounded in the long term sustainability of the resource. We hold a position that integral to development should be the principles of sustainability – not that there is a compromise of one over the other.

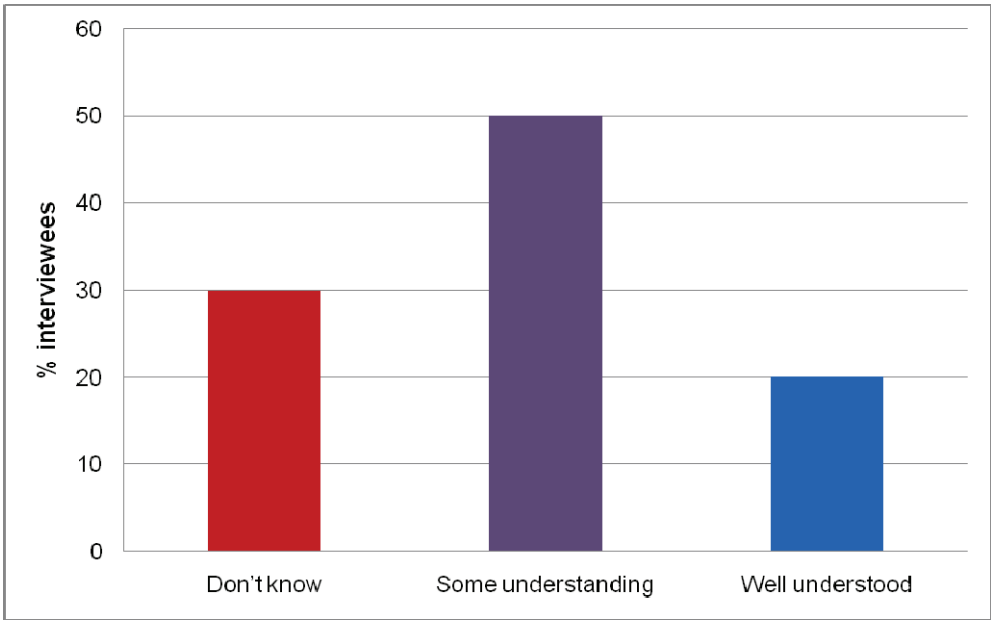

Figure 7.2: Knowledge of the Reserve in the Olifants WMA based on interviews

7.4 Change and lags

Although we should be seeing evidence of progressive realization of the Reserve after 12 years, the stumbling blocks reported are very similar to the other catchments – the lack of capacity, high turnover rate of senior staff (i.e. directors), delays in appointment of relevant service providers, problematic interpretation of the concept of the Reserve, familiarity with the Reserve methodologies by water managers (DWA, water boards and WUAs) and the lack of and/or poor maintenance and management of infrastructure (esp. municipalities) along all stretches of the river.

One of the objectives of IWRM in South Africa is to ensure sustainability of water resources through strategic planning, management and implementation of plans Pollard and Toit, In press. When an administrative action is not being carried out and legal obligations not being met, plans will fail. This however can only be detected through adequate compliance monitoring and enforcement. The importance of monitoring is recognized by the more organized users in the Olifants. It is seen as a critical issue by the major IBs/WUAs that understand the achievement of sustainability and equitable allocation is not likely to be possible without reasonable and reliable data, as well as follow-through with enforcement plans.

Meeting the Reserve within a reasonable time frame is tightly linked to ability to regulate users within the parameters of sustainable use. The regulation of users is once again a problematic and complex affair with the problems of regulation not being apportioned to a specific sector or group of users.

Although a fair amount of monitoring and self regulation is reported along the Olifants it is the sheer enormity of cumulative impacts that the significance of efforts is reduced. Here it is the scale of monitoring and enforcement that needs to match the scale of the problem if the Reserve is to be realised in the near future.

The over allocation of water resources in the catchment is perhaps the biggest threat to meeting the Reserve. Although most respondents were aware of the over allocation status, few were able to present any coherent plans for its amelioration. What is clear from discussions with the different sectors is that the 'closed' or over allocated status presents a major challenge to the regulator in relation to achieving the Reserve and planning for sustainability in general. It came to light that certain sectors fear compulsory licencing will be used to appropriate existing entitlements to achieve the Reserve. How sectors will react to the implementation of compulsory licencing remains to be seen but the outcome is likely to be influenced by how people perceive the Reserve and the value it brings to the catchment over the long term. Not going the route of compulsory licencing could lead to longer 'lags' in meeting the Reserve as many iterations of management and stakeholder interaction will be required to bring water-use in line with sustainability parameters.

Photo 17: Farmers downstream of Loskop Dam have deep concerns around water quality as they are dependent on international accreditation of GLOBALG.A.P to sell their produce

7.5 Integration of WRM and water supply

Water management activities and water supply actions are highly polarized in the Olifants due to the stressed nature of the catchment. Lack of integration between water management and supply stem

from tensions between management objectives (for equity and sustainability) and the determination of conditionality of use (authorisation). One of the key challenges facing the integration of water management and use relates to effects of authoring s21 uses in a vacuum of IWRM principles. For example the standards for use (broadly all the S21 uses) are derived from the RDM strategic objectives (classification and RQOs). The conditions for use are then set for individual licences. Whist individual authorisation might be compliant with the objectives of management it is the cumulative effects that can present problems, both from a quality and quantity perspective.

Other issues were identified as a breakdown/confusion in the approval and regulatory process both associated with the EIA processes and water licencing; pressure from rampant small-scale mining in the upper catchment; expansion of urban areas associated with mines, poor communication and the lack of appropriately skilled persons. Also absent is the intention to share equitably, that which is available.

Sectors/institutions involved in water supply in the catchment include IBs/WUA, municipalities, and mining houses are ostensibly involved in the business of making water available to users.
This represents an entire field of practices and procedures that include service delivery contracts, legal contracts, memoranda of understanding and formal agreements. Contracts to water services providers and bulk suppliers currently act as an incentive for escalated use as this represents increased revenue. The economic drivers here are likely to present a serious challenge to integrating water management and water use as this approach to planning for delivery is devoid of consideration for what a particular catchment can provide. Without a regulatory intervention (in the form of DWA or the CMA) the principles of sustainability are likely to be compromised and efforts for achieving the Reserve are likely to be undermined.

Although water allocation plans (part of the CMS) are a proposed instrument for bringing water use in line with what is available, they have not yet been attempted for the Olifants. Additional instruments such as the WSDPs and the sectoral WCDM plans also provide such an opportunity. However there is no evidence in the Olifants that these instruments are indeed referenced against overarching water resources planning and what is available within the catchment. The overall responsibility for ensuring that such instruments are integrated lies with DWA/CMA

One of the key discussions regarding integration of water management and supply relates to how water use is being categorized and consequently dealt with by local government. Part of local government's claim to an allocation is based on its obligation to provide water for basic needs as set out in the Constitution as a right to "sufficient water". This apportionment is known as the Basic Human Needs Reserve and its availability must be guaranteed by the Minister. However Local Government can, and does, provide water to users over and above this obligation. For instance, it may act as a services provider to industry, mines and the commercial sector. This allocation does not qualify as water for basic needs and should be authorised by the competent authority. Understanding local government's growing needs (to supply) must be taken in this light. There is currently a tendency for local government to express its requirements as a Constitutional right but this is only so for the BHNR component.

The primary tool in remedy of a situation where water management and supply are not aligned is compulsory licencing. A remedy which, in itself, is not without challenges, legal and practical. A comprehensive discussion of compulsory licencing is beyond the scope of this report.

Photo 18: Olifants River (Lower) at high flow showing serious sedimentation and sediment loads originating in the middle part of the catchment

7.6 Unlawful use and legal literacy

As with other catchments in the lowveld, unlawful use is largely regarded as unauthorized abstraction and discharging of polluted water into the resource. But by far the most common in the Olifants is the latter, pointing to a major crisis of water quality along this river. The key culprits are identified as the mining sector and municipal sewage treatment plants. Commercial agriculture's contribution to the problem by agric-chemicals, fertilizers, herbicides was also noted.

The mining sector is consistently indentified as the source of unlawful practice with DMR being blamed for not regulating the sector. Some even felt that the DMR is "driving unlawful use by urging mining companies to go ahead with mining in the absence of water use licenses" [this to be verified]. Some however maintain that the sector is vilified and used as a "scapegoat". That the sector is a source of problems cannot be denied but the analysis needs to be more focused and specific. It appears that the larger operations are making a concerted effort to be compliant. The Controlled Release Scheme and proposed shared waste-water treatment plants are two areas of progress in this regard. Unlicenced (and unregulated) smaller mines however, and the cumulative effects of the sector as a whole, appear to be a source of concern.

Totally dysfunctional, neglected or under-capacitated waste-water treatment plants in the upper catchment are reported to be spilling raw sewage and waste water directly into the river with serious consequences for downstream users. The Loskop Irrigation Board has raised concerns that farmers stand to lose their Global Gap accreditation (having lost it in 2009) due to *E.coli* contamination of

agricultural produce. This provides just one example of how unregulated practices can detrimentally affect the security of the entire catchment (economically and ecologically).

The regulation of municipalities is once again pin-pointed as an issue with the IGRFA being cited as a legal obstacle in this regard.

The location of tourist lodges along stretches of the river is cited as a suspected source of sewage and effluent discharges into the river. It is alleged that many do not have any other means of disposing of sewage and waste water and go unregulated in this regard.

Other unlawful issues relate to diverting, damming and unlawful use of riverbeds.

Problematic authorisation processes

Firstly the perception that the legislative frameworks for authorising use are adequate was articulated on a number of occasions. However the majority of other stakeholders believe something is "still going wrong". That there is more than one regulatory body involved in managing access to natural resources is both a problem for the regulators and for the users. Three departments play a role: Department of Environment, Department of Water Affairs and, especially prominent in the Olifants, the Department of Mineral Resources. Additional regulators include the Department of Agriculture, Fisheries and Forestry (DAFF) and the Department of Land Affairs. Each of these departments has particular requirements for authorisation with the principles for approving applications being based on sometimes varying principles. That these principles and authorization procedures are not synchronized and streamlined presents tremendous problems for the regulatory process.

Power dynamics between departments and conflicting decisions have polarized the decision/approval process and, where declined applications are challenged, additional bodies in the form of tribunals are brought on board to mediate disputes. Here different legal instruments may be pitted against each other and approval granted on technicalities rather than on principles of sustainability. These processes, in the case of the Olifants, have been a serious source of tension, and at the same time, paralysis amongst departments. That departments should not be seen to be publically challenging each other was noted as a source of frustration.

Users on the other hand, expressed frustration with the need to deal with a number of departments (and sometimes more than one section of a department), comply with a number of legal requirements determined by different legal instruments and carry out various tasks in sequences that are not always made clear. Where users can afford it, consultants are brought in to advise, but it is small-scale users that, do not have the resources, flout the law. This also creates a situation where confusion supports opportunistic operators who function amongst the uncertainty but by keeping a low profile are not detected. Those that attempt to be compliant complain that they are victimized. The will to comply is therefore eroded with the feeling that complying has no real benefits to the user in the end. This means that people do not feel the need to comply because, as it was put, "others will simply be getting away with non-compliance anyway". This mindset is particularly problematic as the collective is not aimed at achieving sustainability but rather focused on protecting individual interests. It was implied that the responsibility of the regulator is to "catch" transgressors but where the effort of one regulator is undermined by another regulator the task is perceived to be impossible.

Additional factors relevant to the authorisation process were cited as:

- High staff turnover at DWA resulting in discontinuity and frustration for the applicant as they would have to re-establish relationships with each new official.
- Mining officials were accused of not understanding their own sector
- Pollution potential of new developments incorrectly assessed
- The relationship between DWA regional and national was inconsistent around authorisation
- The loss of documentation and letters. The perpetual request for updates from the regulator
- Times to respond to documents out for public comment unreasonable
- Communication systems weak

All of the factors above taken together point to a highly problematic authorisation process and one which severely hampers the attainment of sustainability planning over the long term. We will come back to these matters in the final discussion

Ability to regulate

DWA is consistently cited as failing to deal with the challenges of regulation due to: lack of conditions for use (licences), lack of monitoring systems (including meters), the dearth of capacity and funds, the lack of legal support, incorrect understanding of who is responsible for authorisation amongst users, and few incentives for users to comply (users continue with unlawful use until they are caught).

Fundamental to the problem is failure of the regulator to understand what it is regulating for. Most DWA officials expressed the opinion that licences are the reason for regulation. Licences are a means for conducting IWRM processes and one tool of many. The lack of poorly developed practices is proposed to be a major obstacle to addressing sustainability in all catchments of the Lowveld. We draw the reader's attention to other catchment profiles for more details in relation to this point.

It is the smaller, less formalized, less organized users that present a challenge to the regulator. Virtually all sectors express frustration with smaller concerns that are "fly-by-night" operations (meaning: short-term operators) that either do not follow authorisation procedures or simply ignore the regulator, hoping not to be noticed. Although single small-scale operators are not an immediate concern in terms of their pressure on the resource, it is the cumulative effects of such uses that can have an overall negative impact on the resource (specifically transgression of the conditions of the Reserve). That DWA (along with DWE and DMR) is able to successfully regulate small-scale users in ALL sectors is doubtful given the staff shortages. However the opportunity for sectors to set norms and standards for use within that particular sector, collaboratively with DWA, provides an opportunity to be explored. Sector representatives have suggested that participation in such regulating bodies should be made a condition of a licence as it gives such bodies some power to enforce standards.

Compliance with RQOs (water quality standards) was a serious source of dissatisfaction for industry and mining users. Even the regulator expressed concern that the RQOs were "too strict" leading to consistent transgressions by a large number of users. The regulator in this case felt that their job was being made impossible by the setting of standards that cannot be attained without serious conflict and legal implications. The mining sector, and some associated consultants, felt that the "unreasonable" nature of the RQOs was economically constraining and unfair to sectors trying to meet licence conditions. They expressed the request for stricter conditions to be phased in over time to allow users to upgrade technology and management practices.

Self Regulation – a valuable contribution

Where regulation is successful there is always an organized functional institution, with a high level of self regulation in evidence. There is also collaboration between DWA and the institution. Examples of this are evident in the WUAs and sector forums who assume responsibly for regulating a collective of members by monitoring flows and controlling abstraction for a particular use. The LIB IB has developed sophisticated systems of self regulation for abstraction in the commercial agriculture sector. Again, such a body only has jurisdiction over its members, leaving stretches of the river unregulated.

Mines too demonstrate high levels of self regulation but this time in waste water management. Self regulation in the Olifants is demonstrated by the adoption of the Controlled Release Scheme (CRS). The CRS sets up internal self-regulation within the mining sector, towards specific goals. However the involvement of DWA in initiating and providing support for the scheme is critical. Through collective, monitoring and feedback the CRS has brought sulphide levels down from 250mg/l to less than 50mg/l. Although the success of the scheme cannot be denied the appropriateness of managing current cumulative polluting effects of return flows is being questioned. However the CRS represents the kinds of management actions that can have considerable positive impacts in the long run. They also set sector standards that can be improved over time, an example of which is being demonstrated by the larger mining operations that are moving towards "zero release schemes" as the CRS is failing to respond to increased cumulative effects.

As far as standard setting is concerned it was pointed out by the mines that they have their own self regulating standards. For example, international standards (ISO ratings) were cited as being currently a far greater source of guidance for managing practice in the mining sector than local standards.

7.7 Skills, capacity, monitoring and legal literacy

The skills issue is once again highlighted as a major problem area, not only for compliance with the Reserve, but with respect to almost every aspect of water management in the Olifants. Local municipality water services managers are struggling to cope in their work environments due to lack of skilled supporting staff and also a lack of understanding and support from council members. Once again technical staff is burdened with internal capacity development of councillors who raise expectations amongst constituents without checking on the realities of the situation.

There is very little confidence in DWA and the skills crisis in the department is identified as critical. The picture painted of DWA and its ability to function in the Olifants is extremely gloomy. Respondents from virtually all sectors claim that DWA has very little capacity, their staff are under-skilled, don't know the legislation and are incapable of dealing with questions posed to them a forum meetings. This situation does not inspire a sense of confidence in the water management processes in general.

The statement that there is a 'lack of skills' is too generic to be meaningful and needs to be 'unpacked'. In the context of the discussions the lack of skills refers to a host of issues including:

- Staff who lack specific skills and experience
- The complete absence of skilled staff at the appropriate level of appointment
- Too few staff to conduct specific functions

- The loss of skilled staff from the sector to other sectors (particularly mining)
- The failure to attract new appropriately qualified staff to the sector
- A general lack of skills across all sectors and departments involved in water management functions
- A lack of continuity in dealing with particular functions (creating the perception of a lack of skilled staff)
- Inappropriate in-service training and professional support

All of these taken together result in a sector that is struggling to cope with its basic functions and one in which the public/business has little confidence. Programs that address this situation are of utmost urgency.

Photo 19: Badly installed and managed infrastructure is a serious source of inefficient water use leading to severe stress on the resource and a threat to Reserve compliance

7.8 Adaptive capacity in a transforming worlds (policy changes in order to respond to a degrading system)

Feedbacks, self-organisation and self-regulation

A basic requirement for feedback loops to function is that of good communication. We see a good example of intersectoral communication in the form of the Olifants River Forum (ORF) but the general

day-to-day communication between users and regulators is highlighted as a 'bottleneck' that retards progress. As mentioned, absence of communication channels renders a system incapable of learning and therefore incapable of responding to change.

One of the most important sources of feedback for improving the health status of the system (and achieving compliance) is provided for by reporting required under EIA regulations and water use licences. However a number of users complained that they never received feedback on these reports and doubt whether reports had been read by the various regulators – "there is no feedback on the reporting – no issues are picked up and remedied".

Another example is termed 'authorisation chains' in integrated licencing where different department communicate the status of authorisation applications with each other would allow the collective of authorising bodies to respond to new applications as a whole instead of in a fragmented atomistic manner. However the state of such chains is said to be weak with authorising bodies approving applications without adequately consulting each other.

From the above discussion the implications of not having feedback loops in place is evident. Firstly there is no basis on which the system can learn and respond so dealing with dynamic environment and change is highly unlikely. Secondly this makes the development of tools such as operating rules a paper exercise since it begs the question of who will use them. The important part in the feedback loops is that these operating rules must be managed by someone with the authority (and skills and interest) to respond to change. Thirdly, 'watchdogs' (be they affected parties, bailiffs or the area manager) are essential and loss of this role makes the management and delivery of Reserve very vulnerable. Finally an important point made regarding enforcement and one that is pertinent to feedback loops is that of a supportive legal system. When all else fails (coercion, incentives, punitive measures) people need to be able to turn to the law. A strong feeling from respondents was that the legal system is ill-equipped to support compliance in the water sector.

7.9 Implications and recommendations

In summary, attempts to establish a discourse of sustainability and embed the Reserve in actual WRM practices warrants serious consideration at this point in time. Globally, current approaches to natural resource management are strongly participatory, but these are only useful (from a sustainability perspective) if the participants are able to contribute to the common goals rather than protect vested interests. Social learning approaches (see Muro and Jeffrey, 2008 are seen as an important way of developing the collective understanding and for reducing resource related conflicts. The real challenge lies in developing a new discourse regarding sustainability in general, and the Reserve in particular.

The national development of generic 'awareness campaigns' is a poor response to the needs emerging around the implementation of the Reserve. The 'raising' of awareness might do much to help practitioners and stakeholders recognise the term "Reserve" but do little to support the development of skills and practices that ultimately lead to its implementation. This situation has clearly come to light in the Olifants. Participants in the ORF maintain that the forum is valuable for raising awareness but less useful of driving action. This is not to suggest that it is not important to inform people of policy changes but of more importance is the need to take action.

Specific information gaps where identified as potentially problematic e.g. information for water conservation demand management, the status of unlawful use, data and figures for new users entering the mining sector, the need for evidence for holding unlawful users accountable, additional studies on pesticides and herbicides from agriculture sector, low pH and the risk of acid mine drainage. Information for monitoring purposes is consistently mentioned as an important gap in the enforcement process.

Setting up a data sharing system in the mining sector was proposed. Despite there being issues of trust and completion amongst different mining houses, some claimed that the situation has improved with a growing interest in information sharing. Some of the key issues (articulated by the mining sector) in this regard are:

- Concerns of expense and who carries it,
- It could interfere with perceptions of competitive advantage,
- Some have a 'bad attitude' to this kind of collaboration

Attention to the authorisation process is paramount. Authorisation processes are complicated by the fact that the different authorities operate according to different authorisation instruments and procedures. Clearly there is a need for some level of integration (although 'integrated licencing' is purported to be functional). This integration is important because there are a number of authorising bodies all of which are providing 'permission to operate' in the catchment. Although 'chains of authorisation' are supposed to streamline decision making processes, they do not appear to function, with one authorising body granting conditional authorisation outside of due process. It has been noted that conditional authorisations are difficult to revoke when investments run into millions.

Feedback within the system is sorely lacking. Responses to reports submitted by users need to be standard procedure so that important issues can be picked up and management interventions designed.

There was resounding support for the ORF but some were concerned that it does not have any mandate to drive action. The concerns are that the forum gets caught up in trivial issues and that the opportunity to conduct meaningful IWRM is lost. The ORF currently acts as a 'knowledge hub' by co-ordinating stakeholders and keeping them informed of scientific studies and ongoing projects in the catchment.

Many recommendations and inputs for better functioning of the ORF were tabled in discussions. These are summarised as:

- DWA should take greater leadership of the ORF
- All licenced users should be mandated to attend through conditions in licences
- ORF should be platform for future-looking, strategic planning and action, not problem-based
- Better communication
- Clearer roles for members
- Civil society needs to be supported to participate
- Lack of funds hampers action
- Poorly resourced groups need to be subsidised

That licenced users be obligated to attend forum meetings as a condition of a licence was a novel idea that surfaced in the research. It was also requested that DWA play a much greater role in the strategic directions of the forum specifically in preparation for the development of the CMS.

The fact that the ORF has no ‘political or legal clout’ was bemoaned as an issue hampering action. However the intention is not for the Forums to have statutory powers but rather that they act as feedback systems to the regulatory bodies. That these communication systems are weak is a first source of potential problems obstructing management and administrative action.

CHAPTER 8. RESULTS: THE INKOMATI WMA

8.1 Overall approach

An overview of the characteristics of the Inkomati WMA was given in Chapter 3 and an analysis of the institutional and organisational arrangements, in Chapters 1 and 5 respectively. Based on the analysis in Chapter 5, some 60 interviews were conducted in the Inkomati WMA with the regulator (regional and district offices), water users including the water services authorities and providers, researchers and consultants, other interested and affected parties (Table 8.1).

As noted, water resources management and services fall under the DWA Nelspruit regional office in Mpumalanga. The Inkomati Catchment Management Agency (ICMA), established in 2005, has been assigned initial functions according to Section 80 and two other functions dealing with the prevention and remedying of pollution (S 19 and 20). After meeting obligations to international cross-border flows strategic needs of Eskom (Komati River), the major water users are agriculture, forestry and water services (water supply) as well as industry and mining. In terms of agriculture, transformation is still underway with some former irrigation boards still to transform to water users associations. Thus there are a range of agricultural-sector institutions in place. In terms of water services, there are three district municipalities (DM) within the WMA and nine local municipalities (LM) variously taking on the role of the Water Services Authority (WSA) and Water Services Provider (WSP; see Table 5.1 and 5.6). There are two bulk water service providers: Bushbuckridge Water Board and Silulumanzi.

Table 8.1: Key role-players and interviewees in the Inkomati WMA.
RDM = Resource Directed Measures; KOBWA = The Komati Basin Water Authority; KIB = Komati Irrigation Board; DM = District Municipality; WUA = Water User Associations; DEDET = Department of Economic Development, Environment and Tourism)

Sector	Representative interviewed
Regulators	
National DWA	Chief Water Resource Planner East
Regional DWA	Regional director: WRM Director: Water Sector Regulation and Use BBR water quality technician
ICMA (see Inkomati)	Executive Manager: Water Resources Planning and Programmes Institutional development Sabie-Sand Community Officers
KOBWA (see also below)	Maguga Dam – Environmental and resettlement officer; Environmental manager – Social economic and displacement
Mpumalanga Development Tribunal	Deputy chairperson

Water users	
Irrigation boards	Representative from KIB and LIB TSB (sugar) Crocodile Major Irrigation Board (chair) White River Valley IB White River Conservancy Sabie Irrigation Board Secretary to IBs on Crocodile, Komati, White River) KJOF, KIB, LIB and CIB KIB- water manager, metering and monitoring
Small-scale farmers/ emerging farmers / schemes	Sabie emerging farmers (750 ha scheme) Dingleydale scheme Champagne Scheme New Forest Scheme Small Scale Growers: Lomati IB, Emerging farmers Malelane Sugar Cane Committee Komati IB, small-scale farmers Phiva (part of KIB) (rep of 1300 emerging growers on Komati, Lomati and Kaap)
Municipalities as Water Services Authorities or Providers (WSA/WSP)	Bushbuckridge LM: Water Services Manager Bushbuckridge LM: DBSA engineers (Nkomazi LM; Ehlanzeni DM; Albert Lithuli LM) Ehlanzeni DM: Dep. Water Services and sanitation mgr Manager: Infrastructure Planning Mbombela LM Nkomazi LM: Water Services and Sanitation mgr
Other WSI	Silulumanzi Bushbuckridge Water Board (water services)
Forestry	Komatiland Forests SAPPI – SHEQ manager ; forestry manager
Agriculture (government) now DAFF	Director of Research and Development in the Mpumalanga of the then-DoA Deputy Director Engineering Services Chief engineer CCAW chair and Regional Manager Maintenance co-ord; District head,
Environment (Government) (DEDET	Chief director: Envir Services Directorate Environmental Impact Management Environmental Inspector
Industry	Manganese Metal Co. Assmang Chrome Pty Ltd
Other users:	Eskom and Rotec Kruger National Park Federation for Sustainable Environment (on mines and farming) Hazyview /Kiepersol Conservancy
Operations and maintenance	
Technical staff Dam operators	WS and Sanitation manager DM Injaka Dam Rotec – Upper Komati
Researchers and consultants	
Other interested and	

affected parties	
	Working for Water/ Wetlands
	Federation for Sustainable Environment (on mines and farming
	Mpumalanga Lakes District Protection Group
	Escarpment and Environmental Protection Group
	Geosphere
	Private attorneys/ lawyers

As described in Chapter 4, results of interviews were arranged thematically as discussed in the following sections. For a more detailed analysis readers are referred to the respective reports (Deliverables 3 and 4).

Photo 20: Crocodile River near Malelane showing extensive sugar cane cultivation in the background.

8.2 Summary: Status of compliance with the Ecological Reserve

This section provides a summary of the results from an associated project which examined the status of compliance in each of the catchments of the study area. For further details please refer to Pollard et al. 2010 which provides an analysis of the *incidence of failure* (% of time), as well as the *magnitude* of the infringement (volumetric difference) and *seasonality* of failure. Here we focus on the first criterion.

8.2.1 Sand River

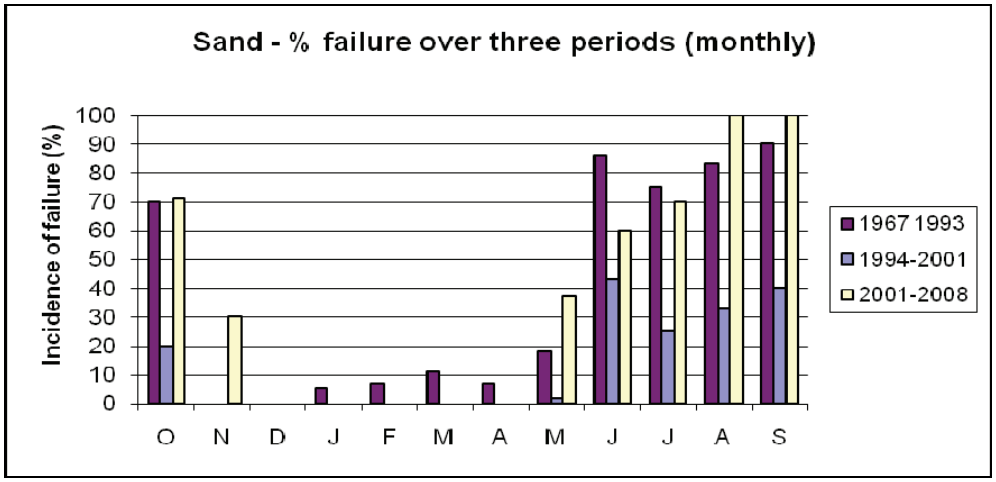

Figure 8.1: Incidence of failure to meet the Ecological Reserve (%) at EWR 8 on the Sand River over three periods.
Data are based on monthly averages (from Pollard et al. 2010).

Failure to meet the ER is evident in all dry-season months in all periods examined (Figure 8.1). Wet season failures were only evident in the earliest period between 1967 and 1993, with the exception of November in the last seven years. The average incidences of failure are similar in the first and third periods; 16 % and 72% for the wet and dry seasons respectively. The period 1994 to 2000 has a far lower incidence of failure of 3% and 28% for the wet and dry seasons respectively, possibly reflecting the inclusion of extremely high flows from the 2000 floods. These results may represent a conservative estimate of non-compliance since they are based on monthly averages

A more detailed analysis based on daily flow over the last 14 years (after 1994, see Pollard et al., 2010) indicates failure of compliance in all months, with an average failure incidence of 58% across all months for the last seven years (from 2001), which is worse than 1994-2000 at 37%. The amount by which the ER fails shows a high degree of variability. However, an intra-annual pattern indicates that the dry season months appear to have lower volumetric infringements than summer months whose volumetric infringements appear greater. This requires statistical validation.

In general the results suggest that there a persistence in non-compliance over the last seven years despite the completion of Injaka Dam and the design of detailed operating rules. A number of studies have elaborated the reasons for failure in the Sand. The most recent Agterkamp, 2009 Pollard and Agterkamp, in prep-a point to poor overall integrated management, weak co-operative governance actions coupled with increasing demands. This case is further elaborated in Chapter 9.

Photo 21: Injaka Dam was designed to contribute to Sand River flows, however an off-take for BBR Municipality has resulted in none of this water reaching the Sand river.

8.2.2 Sabie River

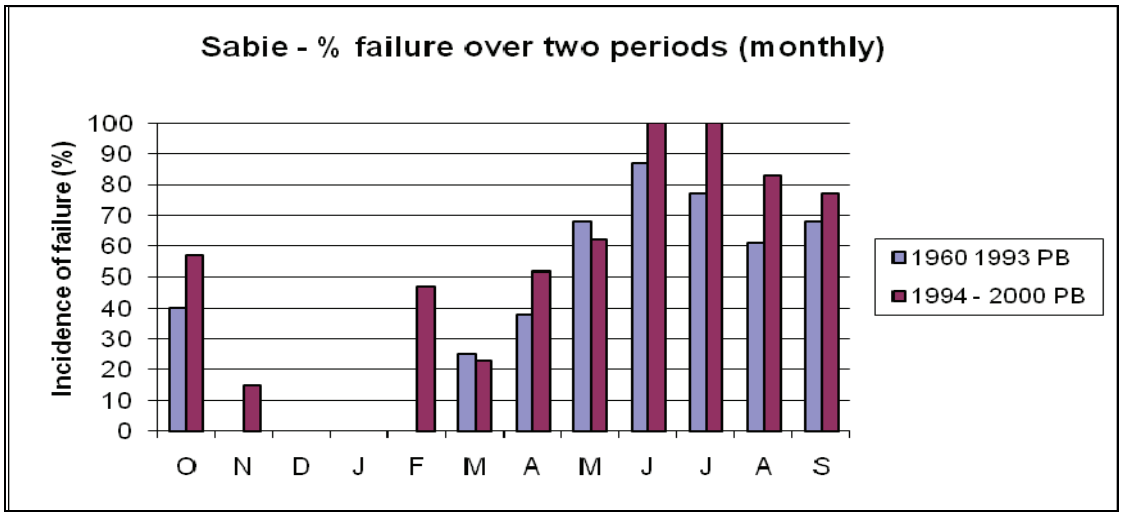

Figure 8.2: Incidence of failure to meet the Ecological Reserve (%) at EWR 3 on the Sabie River over two periods.
Note this analysis is based on data from the gauge at Perry's Bridge (see text for details). Data are based on monthly averages (from Pollard et al. 2010).

Failure to meet the ER is evident in all months in the two periods examined (Figure 8.2) with the exception of December and January, and November and February in the 1960-1993 period. The average incidences of failure were 39% and 51% for the two periods respectively. The average dry season failure was higher (72%-84%) than that of the wet season (11% and 24% for each period respectively. In general the results suggest that non-compliance is persistent in the dry season and potentially worsening over the last seven years despite the completion of Injaka Dam and the operating rules. However the volumetric analysis indicates that the amount by which the ER fails is relatively small and mitigatory measures could be relatively easily implemented.

The possible reasons for the non-compliance are as follows.

- The Injaka White Paper intentions and the operating rules have not been adhered to. This situation may change with the recent DWA project to develop an operational system for the Sabie-Sand catchment.
- Other reasons may include the increasing demand for urban consumption. The lack of co-ordinated water resources management has meant that municipalities are expanding infrastructure with little consideration for the water resources or of the legal requirements to do so.

Finally it must be noted that monitoring the Reserve for compliance will be difficult given that the new EWR site is some distance from the gauge station. Thus data needs to be calibrated to account for the losses or new gauge instrumentation needs to be established at the EWR site.

Photo 22: Sabie River during low flow. Under such conditions the Ecological Reserve is clearly not met

8.2.3 Crocodile River

In the last 50 years there is increasing incidence of failure to meet the EWRs (Figure 8.3)

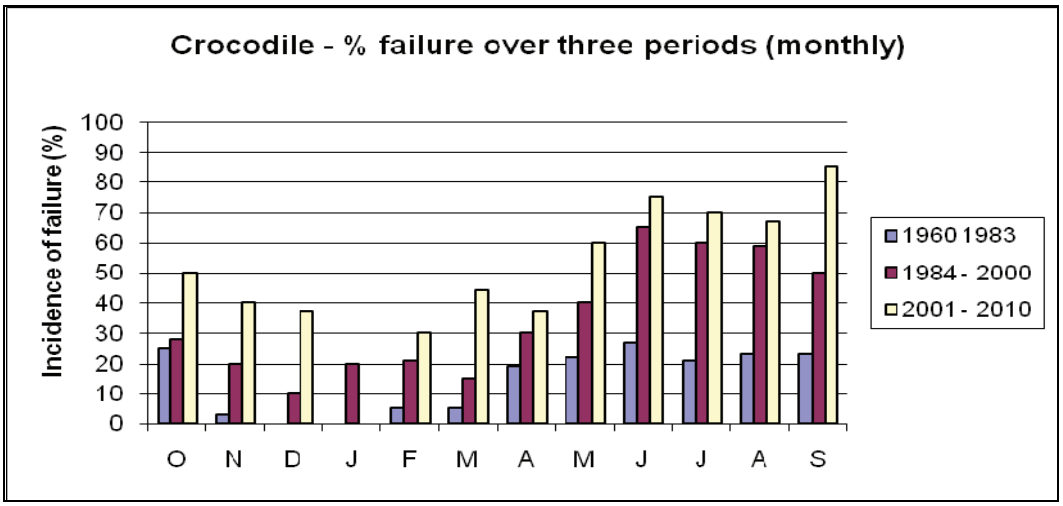

Figure 8.3: Incidence of failure to meet the Ecological Reserve (%) at EWR 5 on the Crocodile River over three periods.
Data are based on monthly averages (from Pollard et al., 2010).

These results suggest that there is a pattern of increasing non-compliance over the three periods since 1960. The average incidence of failure across all months is 14%, 35% and 46% for each period respectively. In each period failure is evident in every month with the exception of the wet season in the earliest period. Failure is highest in the dry season where it varies between 40 and 80%. The worst cases of failure are evident for the latest period starting in 2001 between June and September (dry season) where there is non-compliance for at least half the time. In this period the ER was only met in January all of the time. Note that these results may represent a conservative estimate of non-compliance since they are based on monthly averages.

The amount (as a volume) by which the ER was not met for the last period (i.e. since 2001) indicates that in 2002-2004 and 2006 almost the entire ER requirement was not met. The period 2003-2006 was a dry one. However once the operating rules started in earnest in 2008 there is some indication of improvement.

The Crocodile catchment is severely stressed and has experienced a reversal in flow seasonality as a result of the operation of Kwena Dam. The likely reasons for the high levels of non-compliance are as follows.

- There has been an increase in irrigated agriculture and the last decade has seen an increasing demand for urban consumption associated with expanding development in the Nelspruit area as well as a demand for improved levels of domestic services.
- The current abstraction regimes can reduce flows to near zero on a daily basis during the course of the day. Irrigators have an agreement with Eskom to pump in off-peak times (rate can double causing huge fluctuations)

Improved technical and management systems since 2008, together with greater collaborative efforts between the Inkomati CMA and the irrigators give reason to believe that the situation will improve in the foreseeable future (see Chapter 9). Moreover, the Crocodile River is a focus of the PRIMA project designed to realise international water sharing agreements (see Chapter 5).

Photo 23: Large parts of the Lower Crocodile catchment are dedicated to sugarcane plantations. The improved efficiency of water use is an ongoing challenge that farmers are aiming to address with the assistance of the ICMA.

8.2.4 Komati River

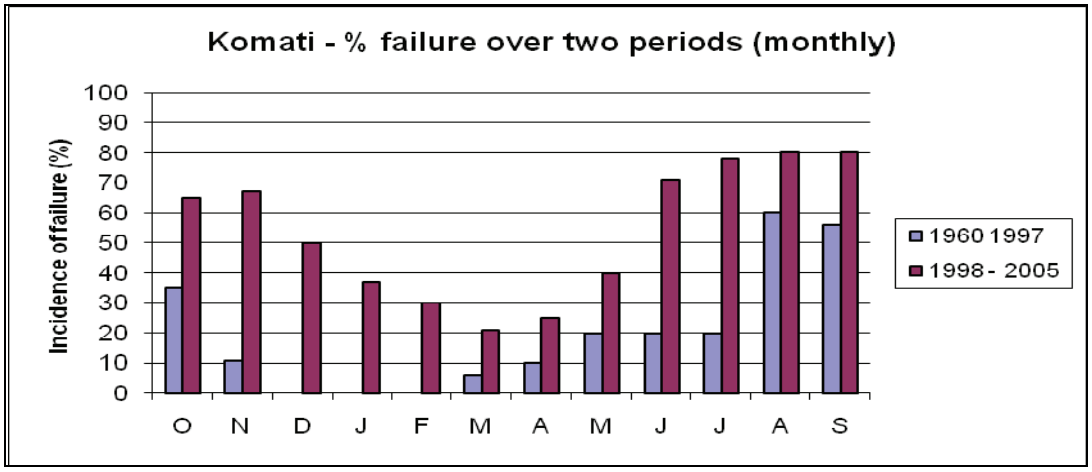

Figure 8.4: Incidence of failure to meet the Ecological Reserve (%) at EWR K3 on the Komati River over two periods.
Data are based on monthly averages (from Pollard et al. 2010).

Failure to meet the ER is evident in the dry season in the first period (1960-1997) with an average failure of 19% across all months and a dry season average of 35% (Figure 8.4). In the following period up to 2005, failure is evident in all months with an average failure of 54% across all months, a dry season average of 70% and wet season average of 45%. Note that these results may represent a

conservative estimate of non-compliance since they are based on monthly averages. The volumes by which there was failure suggest that the severity was worst in 2006 in June and July, and in July in 2007.

The possible reasons for the non-compliance are as follows.

- The high incidences of infringements in the last period probably reflect the fact that the Komati ceased flowing frequently during the construction of Maguga Dam from 2000 onwards.
- In 2006 a new operational system was implemented for the Maguga Dam. As stated, the period prior to this experienced a number of zero flow or near zero-flow situations partially explaining the lack of compliance in the period 1998- 2005.
- However, despite improved operational systems there are still considerable evidence of non-compliance and this is concerning. Currently the ER requirements are not part of the operating rules; the dam is only being operated to deliver the international requirement (of $1.1m^3/s$). There are two studies underway that may address this issue: (a) a study underway to examine ER requirements in Swaziland and (b) a study to determine the operating rules for all the weirs.
- Eskom have persuaded irrigators to operate at off-peak times. This will result in highly variable river flow.

Like the Crocodile River, there are signs that infringements may improve. Firstly as the ICMA gears up to better Integrated Water Resource Management (IWRM), the Komati will receive greater attention. Secondly the aforementioned ER study in Swaziland is likely to address integrating of the ER into the operating rules. Thirdly, the Komati River is part of the recent PRIMA project designed to realise international water sharing agreements (see Chapter 5).

Photo 24: Increases in urban settlement and standards of living have resulted in an escalation in water demand that municipalities have had difficulty planning for and managing

8.2.5 Lomati River

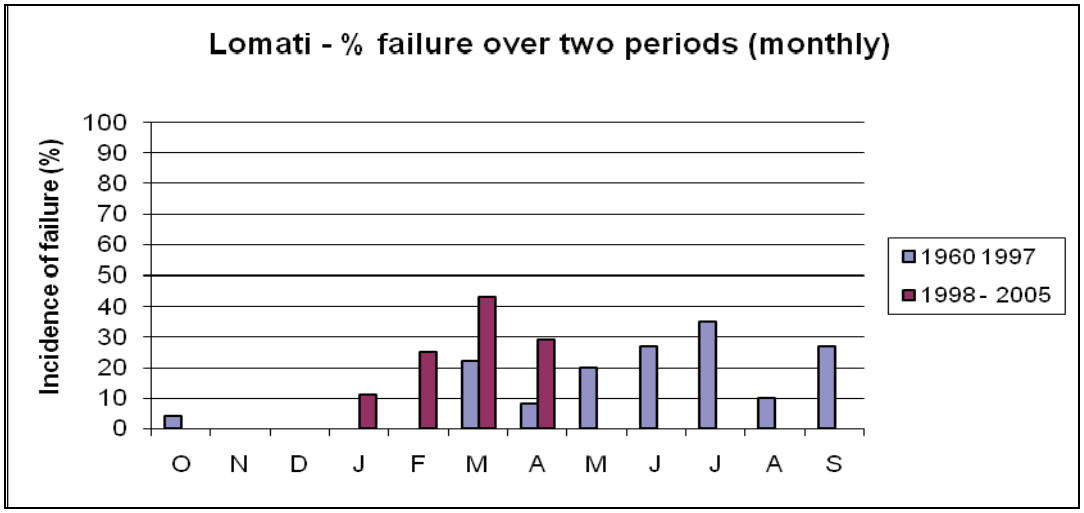

Figure 8.5: Incidence of failure to meet the Ecological Reserve (%) at EWR L1 on the Lomati River over two periods. Data are based on monthly averages (from Pollard et al. 2010).

Failure to meet the ER is evident principally in the dry season in the first period (1968-1997) with an average failure of 13% across all months and a dry season average of 24% (Figure 8.5). In the following period up to 2005, the incidence of failure appears to shift to the wet months with an average failure of 9% across all months and wet season average of 13%. Note that these results may represent a conservative estimate of non-compliance since they are based on monthly averages. The volumes by which there was failure (see Figure 8.5) suggest that non-compliance is relatively low and could be addressed with judicious management.

8.3 Current understanding and embeddedness of the concepts of sustainability and the Reserve in water management practices

Knowledge and familiarity with the concept of the ER varied considerably in the Inkomati WMA but was generally better than in the Olifants and Luvuvhu/ Letaba WMAs (Figure 8.6). This in part reflects the fact that the CMA has been operating for sometime but more importantly, it reflects the explicit acknowledgement by the Inkomati CMA (ICMA) of the obligations to meet the requirements of the Reserve (both the basic human needs and ecological components). The water resources manager of the ICMA and some of his staff are well versed with the concept as is the director of WRM at the regional office. At the ICMA in particular, knowledge and commitment to the Reserve is good. However, in practice the focus for the ICMA to date has been on the high-profile, stressed Crocodile River and, to a lesser extent, the Komati (see later). Here efforts are being made to incorporate EWRs in planning and operational procedures in the Crocodile and Komati rivers. Indeed the real-time system shows promise and is discussed in Chapter 9. However meeting the environmental water requirements for the Sand River has largely been overlooked despite a history of policy and paper commitments. This has manifest in a series of lags, some of which are unacceptable and is further discussed under the following section.

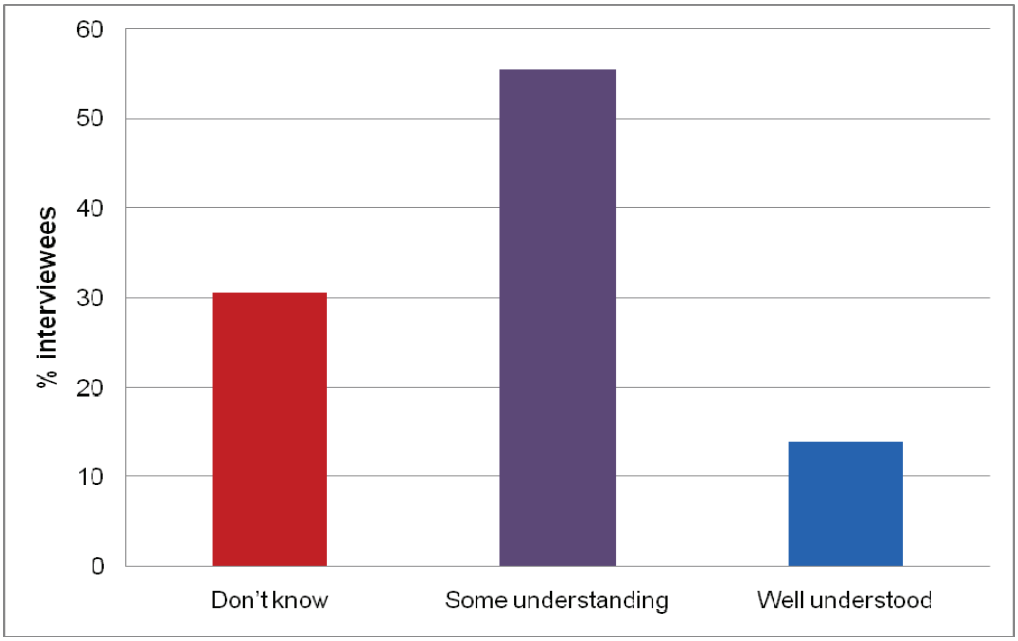

Figure 8.6: Knowledge of the Reserve in the Inkomati WMA based on interviews

Outside of the ICMA and some DWA staff, some understanding of the Reserve exists in the larger commercial sectors such as agriculture and industry and to some extent forestry (with the exception of the Komati Catchment). Although there is a higher level of understanding of the Reserve in the Crocodile catchment than other catchments it is limited to particular sectors or groups (some irrigation boards and/or consultants). In general however, interviewees appear to have a rudimentary understanding of the Ecological Reserve [the BHNR is more widely understood than the ER]. In other sectors such as small-scale farmers and the municipalities, interviewees had either not heard of the water resources protection tools (and in particular the Resource Quality Objectives and Classification) or if they had, did not regard it as an important aspect of their work nor of the long-term sustainability of the water resources. Paradoxically, the stressed nature and over allocation of water resources was evident to most respondents yet few were able to present any coherent plans for amelioration of the problems being faced at a catchment scale.

Like the Letaba Catchment, a dialectic emerges that some benefit from the provision of the Reserve (KNP and game reserves) whilst others do not (commercial irrigation). Indeed some commercial sectors feeling that an allocation for the Reserve jeopardizes their ability to be economically viable thereby oppositionalising the Reserve. This 'disaggregation of benefits' into 'benefits for sectors' from the Reserve is in direct contradiction to the spirit of the National Water Act (NWA) and planning for sustainability at a catchment level and was discussed in Chapter 6. This is a challenge for awareness raising and communication rather than a technical one. Exacerbating this is the fear in certain sectors in the Crocodile and Komati catchments that compulsory licencing will be used to appropriate existing entitlements to achieve the Reserve. What is clear is that the 'closed' or over allocated status of the catchment presents a major challenge to the regulator in relation to achieving the Reserve and planning for sustainability in general.

The question arises as to how stakeholders are learning about sustainability issues and the new orientation to resources management. Interviewees reported that the catchment forums are the key source of knowledge on IWRM and presumably also the Reserve. This includes for example, the Crocodile Forum and the Low Flows Forum. Those private attorneys and legal practitioners that participated in the research had informed themselves of the NWA and its provisions and had a fairly comprehensive understanding of the Reserve. Like the other WMAs, more support is needed for multi-sectoral professional networking around sustainability and the Reserve which currently is skewed towards sector-specific interests, water allocations and licencing. Nonetheless the seeds of such networking are seen in forums such as the Crocodile Operations Forum.

Photo 25: The impact of exotic plantations in upper parts of catchments has been a controversial issue with studies claiming that such plantations result in the reduction of water flows downstream. Land degradation is also a potential issue

8.4 Change and lags

As noted in the Chapter 6, *lags are an inherent part of the process of reform and change* in a complex environment and are to be anticipated. However it is important to consider which of these lags is unacceptable and why and, despite the difficulties in answering this, there do appear to be a number of questionable and problematic lags in the Inkomati WMA.

Meeting the Reserve is subject to progressive realisation and in some cases such as the Crocodile progressive steps are being put in place. However, in the case of the Sand River Catchment (Box 8.1), the situation can be categorised as an unacceptable lag because of the almost total lack of progressive realisation in operation despite a history of policy and paper commitments.

Box 8.1: Case study: Lags in the commitments to meeting the Reserve in the Sand Catchment

The Sand Catchment has a long history of paper commitments to meeting the Reserve. The first of these was the Injaka White paper on the interbasin transfer (IBT; DWAF, 1994) which clearly outlined a commitment to augmenting flows in the Sand River; second was giving effect to the policy intention through determining the Instream Flow Requirements (DWAF, 1996); and third, was the more recent planning projects for operation and decision support (Sellick and Bonthuys, 2003; Sellick et al., 2002) which set out the operating rules.

None of these have come to fruition to date. The reasons for this have been discussed at length (see Pollard et al., 2010 and; Pollard and Agterkamp, in prep-b) but, in summary, reflect a complex failure in integrated strategic planning and management, lack of authority and action, un- coordinated planning and implementation between various government departments, the lack of institutional realignment and the failure to undertake technical rehabilitation and maintenance.

That the lag is unacceptable is signalled by the intention of the Sabi-Sand Wildtuin to litigate against government for its failure to ensure the implementation of the operating rules after the agreements reached in 2003/4. Why the White Paper has not been adhered to cannot be adequately explained by any of the senior official interviewed but in short point to a lack of leadership such that the intentions have 'slipped between the cracks'.

It is instructive to examine the case closely as there are many lessons to be learnt from the case and because a detailed examination indicates that many more factors than simply infrastructural rehabilitation need to be in place before this commitment can be met (see Pollard and Agterkamp, in prep-b). This is not to suggest that it is insurmountable however; a viable and effective catchment forum or better still, a catchment committee with strong skilled leadership would go a long way in addressing many of the issues. (This lack of any functional stakeholder platform in the Sabi-Sand Catchment also meant that the 'forestry issue[34] (the possible intention by DAFF to re-plant the area recently cleared) has not been addressed in any co-ordinated way). A major step forward is the recently initiated study by DWA to develop a real time Decision Support System for the Sabie River Catchment, which will include the Sand River as a major tributary.

Other substantive delays – as persistently presented by interviewees – is the sheer lack of capacity, high turnover rate of senior staff in the regional office (i.e. directors), delays in the appointment of relevant service providers, familiarity with the Reserve determination outputs by water managers (DWA, ICMA, water boards and WUAs), and the lack of and/or poor maintenance of monitoring equipment along stretches of the river. Furthermore these factors also constrain compliance monitoring and enforcement – one of the pivotal steps upon which effective water resources management hinges. This has only received limited attention by the Department and ICMA until very recently. One of the first steps necessary for a 'compliant IWRM system' is that of validation and

[34] The Save the Sand Catchment Report (Pollard et al. 1998) showed the impacts of afforestation on already stressed low flows. Government then committed to remove forestry and convert the land to conservation under the newly-established Blyde National Park. Although most of the forestry has been removed almost no progress is evident on the Park. This, together with community complaints about the lack of beneficiation, has meant that the Department (Forestry) as exploring the possibility of re-forestation (DWAF 2009)

verification without which a whole range of steps cannot proceed. This process has been beset with problems not least of which is the tardy appointment of service providers. Today the database is nearly a decade old and this will be problematic.

8.5 Integration of WRM and water supply

With some exceptions, the almost total lack of integration between water supply and water resources management is widely evident. With little consideration of the constraints imposed by the water resource base, uncontrolled development jeopardises the sustainability of water resources in all catchments. Many of the issues and underlying reasons echo those described in the Luvuvhu/ Letaba WMA. All of the Inkomati sub-catchments are bedevilled by major issues with regard to municipalities whose unconsidered development, expansion and lack of effluent control is problematic. Some of this appears to be wilful; in other cases the orientation for water services staff is to address the inequities and backlogs associated with the apartheid era. Again the lack of commitment from strong leadership in the water services sector obliging municipalities to plan in an integrated manner (through their Water Services Development Plans, as required by the Water Services Act) combined with the lack of support from the DWA RO (as required by the NWA) is starkly evident. Importantly not doing so currently carries no consequences. This highlights the urgent need for co-ordination where each sector appears to operate in a vacuum "doing as it so pleases" as one interviewee stated.

In addition there are some distinctive cases that illustrate the lack of integration. In the Sabie-Sand, it appears that Injaka Dam which was completed in 2004 so as to improve water security in the catchment now – somewhat paradoxically – acts as a "buffer" (at least for local government) against any perceived need to address the issue of water resources constraints. One interviewee stated that "if we need more water, Injaka will deliver it". The municipalities' response to meeting the increasing demand is simply to increase their own bulk demand to Bushbuckridge Water Board, and/or to increase the capacity of Injaka Dam. In contrast the Water Board expresses frustration over the constant increases in demand, noting that neither is the basic information that is needed to calculate such demands been collected nor are the constraints of Injaka Dam understood. The BWB is currently owed some R92 M by the BLM.

Photo 26: Backlogs in water services provision are common to those catchments that were part of former 'homelands'. In this picture we see a woman collecting water for basic needs. This is her only source of water.

In the Crocodile Catchment one of the biggest issues illustrating the lack of integration is the pressure from rampant housing developments and "eco-estates". The Development Facilitation Act (DFA, Act 67 of 1995, RSA, 1995) is used to fast-track water use licences for these and effectively trumps to NWA

and other statutes. In this context economic drivers may work against sustainability in that the sale of water represents a form of revenue for the WSA and WSPs. Curtailing water use is potentially being read as "a reduction in income potential". At the same time examples of clear moves on the part of the ICMA to integrate WRM and water use for agriculture is seen in the Crocodile and Komati through the development of operating rules and schedules (see Chapter 9).

In the Komati Catchment there is a clear demonstration of how water that is managed for different purposes can create particular problems if each does not recognise sustainability as a founding principle. The divergences are management for irrigation (mainly sugar), management of water for Swaziland (with its own legislation and developmental priorities) and management for electricity generation (by Eskom[35] in the upper catchment). Integrating and aligning management practices with sustainability planning for all three is likely to be one of the challenges for implementing the Reserve in the Komati and is being addressed by the ICMA.

Perhaps one of the most recent and pressing concerns regarding the need for integration relates to the escalating needs and impacts of the mining sector. With a growth of mining in Mpumalanga there is expected to be an accompanying demand for water with a concomitant impact on the quality of the resource. An assessment of the current and projected rehabilitation liabilities of a degraded water resource needs to be conducted as a matter of urgency. Some preliminary figures are provided in the Box 8.2. It appears that the Department of Mineral Resources (DMR) takes account of land rehabilitation issues only whilst the rehabilitation of water currently falls to the State – and it appears that neither DWA nor DMR has a plan for dealing with the liabilities for water in the mining sector. The cumulative impacts will be experienced by the whole catchment and negative quality issues will be transferred to other users in the near and long term.

Box 8.2: The growing demands and liabilities of mining

(Data provided by the Foundation for Sustainable Environment)

- Of the estimated 34 mines in the Komati catchment only 2 have water licences
- Water liabilities include the rehabilitation of 2 M l/d, dealing with the production of 20 tonnes of brine per day.
- Costs are R7/ m^3 for treatment of water.
- There are massive acid mine drainage risks
- There are a current estimated 5000 prospecting rights granted in Mpumalanga – granted for period of 5 years with possibility of renewal for 3 years.
- Some 500 mining applications per year are expected as from 2011 (as prospecting licences lapse)
- DWA must approve closure plan and financial provisions which is not being done

The mining example highlights the need for attention to integrated authorisation, allocation planning, remediation and accountability/ liability for high risk activities. Economic drivers behind allocation planning need to be carefully assessed against the long term and cumulative risks that may be

[35] In the upper Komati Eskom regulates flow with high precision by operating the two main dams (Vygeboom and Nooitgedacht) to serve the needs of the power generating plants in the upper Vaal. In fact the specifically appointed company Rotec, operates the dams and water flow as part of the upper Vaal system and has not really considered the Komati catchment as the unit for management.

introduced at the level of the catchment. The question remains as to whether the EIA process is able to perform such a function.

Photo 27: Underregulated mining is a problem for water-use regulation throughout the Crocodile and Komati catchments, now spreading to other areas such as the communal areas of the Sand catchment.

8.6 Unlawful use and legal literacy

At a systems scale, wide-scale non-compliance with the Ecological Reserve is evident (see Section 8.2). This is partly due to unlawful use in some rivers such as the Sand and Crocodile.

Unlawful use raised concerns regarding both specific cases and more general issues and questions regarding the ability of the regulator to regulate. Specific mention was made to the legality of farm storage dams, unregulated deforestation of riparian zones, invasion of forestry into riparian zones, wetlands and source of sediment the validity of developments in the face of ongoing land claims

Municipal activities are singled out by all sectors as major transgressors of the NWA. Issues raised include over-abstraction, tampering with the river course to access water, the unregulated abstraction of water for informal settlements, wastage (running/leaking taps in residential areas), and spillage of sewage from water treatment plants into the river. The DEDET stressed the need for guidelines and standards for the development and regulation of sewage treatment plants. Eskom raised concerns that reduced water quality has a negative effect on power station operations and is costly to mitigate. Moreover, the status of licences for the expansions to bulk supply infrastructure have been questioned (e.g. Hoxane weir) and the municipality seems unable to answer this. The lawfulness of using the DFA (RSA, 1995) by local government through the Mpumalanga Development Tribunal in

the drive to 'fast track' housing developments was questioned, particularly since a moratorium had been placed on new developments by the DWA RO some seven years ago due to water shortages in the Crocodile Catchment.

As outlined earlier, there is non-compliance with the operating rules in the Sand River. Their operationalisation is the joint responsibility of DWA, the ICMA, the DAFF and the farmers. However, ensuring that water reaches EWR 8 means also bringing municipalities on board (see Pollard and du Toit, 2009c Sabie-Sand Profile). Recently the intention to reduce gauge stations nationally has been raised by DWA and Exeter gauge may be one that will not be included (Mr Swart, Sabi-Sand Wildtuin, pers. comm.). This needs to be verified but if it is the case, will pose additional challenges on monitoring.

Disparity of opinion regarding the nature and extent of unlawful use was raised in the Crocodile Catchment. Commercial agriculture maintains that reports of unlawfulness are overstated and that the abstraction of water for agricultural use is well regulated by the major irrigation boards. The forestry sector differs, claiming that "unlawful use is bigger than we think." They maintain that the agricultural sector is the biggest transgressor and that it is inadequately regulated, in particular planting "up to the river banks and clearing of new land". On the other hand some sectors asserted that the lawfulness of small plantation ventures is unclear. Adding to the lack of clarity are concerns raised by industry who maintain that unreasonable licence conditions 'create unlawfulness' that is not wilful. The standards for monitoring quality were noted. The example given was of the conditions for monitoring a slag dump which were perceived to be a direct 'cut and paste' from those for municipal dumps. It was felt that monitoring for gases such as methane is inappropriate.

Other incidences of potential unlawful were identified as saline return flows from Tsb (sugar) and unregulated small industries such as abattoirs (often chicken) and fruit pulping. The unlawful damming of rivers was identified as a problem that continues despite the promulgation of S21 of the NWA. The "Joubert Dam" in Schoemanskloof is cited by a number of respondents as such a problem. In one case a small-scale grower reported that the lack of good monitoring results in farmers over abstracting (especially where communal metering occurs). Of particular concern in the Crocodile and Komati is the lawfulness of the storage of floodwater in off-stream dams which farmers maintain should be legal. The status of these needs to be investigated as many farmers maintain that they have permission, under E.L.U, to store such water.

In the Komati some water users expressed the view that they have no concerns with unlawful use or its remediation. This creates a picture that there is little regard for regulation tools and procedures or even that regulation and enforcement can protect them through the regulation of other users in the catchment.

In general, the challenges for regulation in the Crocodile are similar to those of the Luvuvhu/ Letaba WMA, namely, lack of conditions for use (i.e. licences), lack of monitoring systems (including meters), the dearth of capacity and funds, the lack of legal support, incorrect understanding of who is responsible for authorisation, and few incentives to comply (users continue with unlawful use until they are caught). The main reasons, raised by DWA for poor regulation relate to unreliable or unclear registration data. One DWA official claimed that it was very difficult to challenge farmers on the status of the registration of dams, in particular, when farmers claim that their dams had been registered.

Compliance monitoring and enforcement

Compliance monitoring and enforcement – one of the pivotal steps upon which effective water resources management hinges – refers to a range of activities some of which have only received limited attention by the Department and ICMA until very recently. Monitoring may include giving effect to policy intentions (such as the White Paper on Injaka Dam), monitoring conditions of licences or cases of unauthorised use, adherence to operating rules, and meeting key obligations such as the Reserve and international obligations. It is important to note that unlawful use refers to the full range of eleven uses listed under Section 21 of the NWA.

Although the regional DWA office and the ICMA have been undertaking some functions related to monitoring and enforcement, they have been severely constrained by a number of factors, not least of which relate to capacity, funds and the assignment of duties. This means that issues inevitably fall between the cracks or are not followed up. More recently a CME (Compliance Monitoring and Enforcement) unit has been established at the RO in Nelspruit signalling the increased regulatory intentions of the Department. However, even though DWA RO responds to specific complaints, all interviewees expressed deep frustration at the lack of follow-up. On the Sabie River for example, farmers have reported excessively high *E.coli* levels with no regulation taking place.

However, as has been pointed out on a number of occasions, there is effective compliance monitoring and some enforcement at a more localised level such as within the scope of the Irrigation Boards on the Crocodile, Sabie and Komati Rivers (together with KOBWA) where water users are regulated. The DWA also monitors flow and water quality at certain gauges and dams and the bulk water service providers (Bushbuckridge Water Board Silulumanzi[36]), also undertake quality monitoring. Monitoring of the environmental flows is largely undertaken by the conservation sector. For example, the KNP technician monitors the Sabie and Crocodile rivers and keeps a log daily and if the flows fall below the IFR, he alerts supervisors. In 'bad' cases DWA are contacted who respond on occasion[37].

Two problems arise. Firstly, despite various efforts in the Inkomati WMA, the current monitoring is undertaken on a sector-specific basis – and only by some sectors – and for different purposes. It is not co-ordinated or at least the results are not available in a centralised or integrated database. Compliance needs to be achieved at the level of the catchment not only for stretches along the river and for one sector. Secondly, not all monitoring leads to regulatory actions such as dialogue and enforcement. The monitoring data by Silulumanzi for example, may be logged but they have no power to act and rely on DWA to do so. Stakeholders repeatedly expressed a lack of faith in the ability of the regulator to regulate.

[36] The monitoring responsibilities are considerable with Silulumanzi reporting 1718 samples logged on to the WQMS site daily. They also monitor water losses and leakages from the system.

[37] For the Inkomati this used to be the former head of the DWA RO. Now the NWRIB (Groblersdal) is contacted even though their responsibility is limited to dam operation.

Photo 28: Broken or stolen borehole equipment is part of the management crisis faced by a number of municipalities in reaching service delivery targets. Meeting the ER is not seen as a priority

Ability to regulate

As with the other catchments of the lowveld, the ability of the regulator was questioned reflecting a lack of confidence in how users feel about compliance and regulation. Many of the issues were dealt with in Chapter 6 and will not be repeated here.

The DWA RO, specifically, came under criticism by nearly all sectors. It is seen to be unfair and inconsistent in the application of the law, resulting in suspicion and victimisation in the enforcement process (specifically in relation to water quality issues). The industrial sector claims that the lack of skills and capacity at DWA has lead to a situation where reports are not read or are lost. This sector feels that they should be responsible for developing their own monitoring systems and best practices with an independent inspector as a moderator. Many expressed concerns that the Department of Minerals Resources does not regulate the mining industry with serious consequences for water quality in the catchment.

Environmental officers (regulating under NEMA in terms of the EIA process, note that people use the application process as approval (wilfully or unintentionally). Consequently developers go ahead without authorisation and are therefore acting unlawfully. The frustration is that such users cannot be held accountable in the absence of formalised conditions. Three other areas of concern are: the wilful confusion of terms and concepts by consultants (e.g. “DWA endorsed" versus “DWA authorised” in relation to water treatment apparatus); the difficulty in regulating BBBEE projects because of their political nature; and the fact that the cumulative effects of developments are under-reported or not fully recognised in the EIA approval process. Other issues included a poor communication and even breakdown in the regulatory and approval process between EIAs and water licencing (especially for the mining sector).

One of the issues relates to confusion regarding roles and responsibilities. Many turn to the ICMA who in practice have no assigned CME functions except for those related to pollution. Also a large part of their task relates to ensuring stakeholder engagement which is at odds with taking a strong regulatory function. In recognition of this the enforcement functions will remain with DWA RO and national. On a number of occasions it was mentioned that there is inadequate data from which to carry out regulatory monitoring. DWA consultants report that the validation and verification processes on which enforcement rests is still incomplete. However recent reports suggest that the current WARMS register will shortly be available for use.

The legal system and judiciary was identified by commercial irrigators as problematic. They voiced concerns relating to how the legal sector deals with transgressions. These include charges being dropped, courts ruling in favour of transgressors, the problematic appeal process, suspended sentences, insignificant sanctions and small fines. They claim that this had led to a situation where transgressors simply ignore the law, citing an example of a farmer who cased has now been referred to the Bloemfontein Supreme court (see Deliverable 7). The farmer in question is allegedly still not complying with the law.

A major legal issue was raised in relation to the 'suspension' of NEMA and the NWA by invoking the DFA (see above). The DEDET staff was perplexed by this process and questioned the justifiability of the Mpumalanga Development Tribunal to “suspend” the procedures set out under NEMA and the NWA. Recently, the constitutional court found that portions of the DFA are unconstitutional to the extent that they usurp municipal powers (City of Johannesburg Metropolitan Municipality vs. Gauteng Development Tribunal and Others, [2010] ZACC 11 (CC). See Chapters V and VI of the Development Facilitation Act 67 of 1995. How this ruling affects the above issues remains to be seen. This warrants detailed investigation.

8.7 Skills, capacity, monitoring and legal literacy

The imperative to address sustainable water resources management appears to be severely hampered by the lack of skilled staff within regulating structures. However unlike the Luvuvhu/Letaba WMA, in the Inkomati there is a greater recognition that it is not just DWA that is the regulator. Both Water Affairs and Environmental Affairs (which are split in the province) are important institutions mandated to oversee sustainable resource management by means of tools such as EIAs and the Ecological Reserve. However staff in both structures report a severe crisis in relation to availability and appropriate skills, so much so that it appears to be one of the major issues confronting the implementation of the Reserve. The loss of technical staff means that even the most basic procedures associated with water use regulation (validation and verification) cannot be completed internally.

The lack of skilled staff within DWA is a major issue. The dearth of technical staff led industry claims that DWA is uncooperative in assisting with legal requirements and one respondent accused DWA of making “immature decisions” and incorrect interpretations of the NWA by staff. As noted above, enforcement of conditions in licences was seen as weak. Similarly in the Directorate of Environmental Affairs, a lack of qualified staff compromise CME. There are only two qualified Environmental Inspectors in the Ehlanzeni region (they need five) and there are problems with budgets. Officers feel they are left to make decisions at their own discretion without professional support and in particular, legal support. With respect to water management they report that they do not receive “meaningful comments” in the EIA approval process making it difficult to reach reasonable decisions.

The situation in many local municipalities is as alarming in terms of staff. In one district the water services section maintains that that they cannot operate as a WSA has they have only 4 of 11 posts filled. A senior engineer claims that the appointment of technical staff appears not to be a priority and that appropriately qualified staff are difficult to come by. The Department of Agriculture, Fisheries and Forestry (DAFF) reports an engineering skills shortage with only one engineer at provincial department level and no single individual tasked with issues of water resource availability despite this being one of the major inputs into viable agricultural systems.

8.8 Adaptive capacity in a transforming worlds (policy changes in order to respond to a degrading system)

Feedbacks, self-organisation and self-regulation

Readers are referred to discussions in Chapters 2 and 6 on the importance of feedbacks as a basis for self-regulation and learning as background to this section. In all catchments feedbacks internal to the irrigation sector have been operational for some time thereby ensuring that water users stay within their allocated amount. However what is now changing is the addition of wider feedback loops that more firmly embed agriculture and other users in a broader socio-economic and biophysical system (the catchment).

The irrigation boards assume responsibly for regulating use by monitoring flows and controlling abstraction for irrigation in much the same way as that described for the Groot Letaba WUA (see Chapter 6; and see deliverables 5-7). In the case of the Crocodile and Komati Rivers the driver of the system is the obligation to meet cross-border international flows. The Crocodile River management is focused on Kwena Dam whilst that of the Komati is focused on the Driekoppies and Maguga Dams along the middle and lower stretches of the river. Here the feedback is interesting in that it requires the collaboration between Swaziland and South Africa involving a specifically established institution in the form of KOBWA (along with the Komati Irrigation Board, the ICMA and DWA). Enforcement is an important component of the success of these systems in which the role of bailiffs and good monitoring systems are central.

Transformation has introduced changes and additions to these feedbacks specifically in terms of scale and stakeholder participation. Firstly the KNP has taken a much more active role as ‘watchdog’ in the Sabie and Crocodile River so that reduction in flows to different levels elicits different management responses. In both cases the communication is to the dam bailiff (Injaka and Kwena dams respectively) but via different means. In the Crocodile River communication is via the ICMA whilst in the case of the Sabie it is to the Water Resources Infrastructure Branch. It is unclear how this system was established but it seems likely that once the RO Director left in 2006, this responsibility “fell between the cracks” and was taken up by someone who was prepared to or who was earmarked as a temporary option. In the case of the Sand River, the Sabi-Sand Wildtuin contacts the ICMA directly. Despite repeated efforts in the Sand regarding flows at the Exeter gauge (the starting point for a feedback loop), no actions is taken whatsoever (see Box 8.1). Thus few of the key elements necessary for feedbacks are present (see Chapter 9).

Secondly, in all cases regulation and feedback is only for specific river sections rather than for the system as a whole. In this regard, the ICMA water resources manager is currently in the process of

establishing a river flow management system for the Crocodile River as a whole, including real-time operation for better management. This will be an integrated system and in addition to international obligations, it will include the Reserve requirements as drivers. Thus in addition to international obligations the requirements of the Reserve will be formally included as well as the ultimate incorporation of all users on the system not just agriculture.

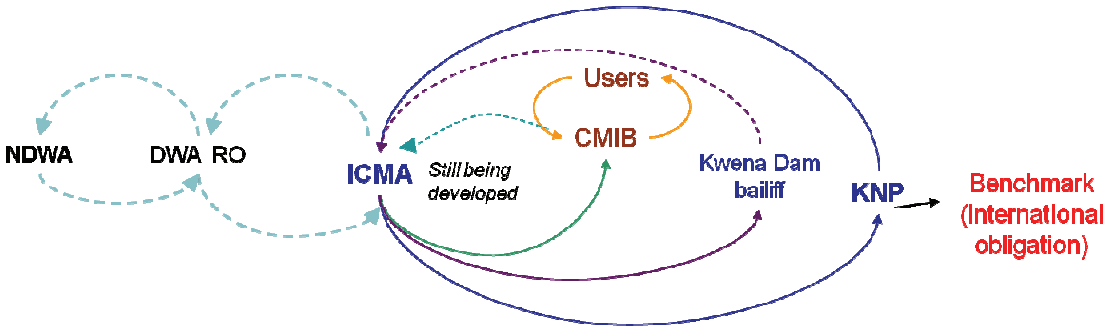

Figure 8.7: Feedback loops in the Crocodile Catchment.
Dashed lines indicate linkages that are still being established. Note that the international linkages currently happen through NDWA. CMIB = Crocodile Major Irrigation Board; KNP = Kruger National Park,

Finally it is notable that there are other instances of self-regulation in individual sectors focusing on practices that will enable them to meet with the kinds of conditions and standards that the Reserve and IWRM require. For example, in terms of water conservation and demand management, one member of the industrial sector is aiming to devise closed water systems and improve water recycling, and one bulk supplier mentioned that it was busy conducting research in water leakages and wastages in the catchment. Unfortunately no comprehensive plan for dealing with water conservation and demand management was articulated by the municipality directly.

8.9 Implications and recommendations

The degree to which the issue of sustainability is present in the discourse of water management and the Reserve specifically, is of central concern to the implementation of the Reserve. Where there is no or little focus on management of water for sustainability there is likely to be poor attention to the Reserve. Earlier exploratory work in the Crocodile River catchment (Biggs et al., 2008) indicated that there is little consensus as to the set of goals, objectives or values associated with water resources management. However, in a positive light, the recent development of the catchment management strategy may be the first step in the process of addressing this (ICMA, 2010). Although sustainability and the Reserve were dealt with briefly it is still too early to see, or expect, a sophisticated, collective understanding to have emerged. Nonetheless, if the energy is maintained through the multiple stakeholder processes already available, and focus is directed to issues of sustainability on a regular basis, such a discourse is likely to emerge.

In this vein, it is noteworthy that in examining how stakeholders are learning about sustainability issues and the new orientation to resources management, stakeholder platforms such as forums are

key. This points to the need for strong support in this regard. Equally support for professional networking around sustainability and the Reserve has already started in the Crocodile Catchment.

Currently the generally poor integration of WRM and supply has the potential to undermine the intentions of the NWA since meeting immediate, individual needs without consideration for the wider picture will lead to heightened water insecurity. In the Inkomati WMA key changes are needed to address this and bring all water use into an integrated framework. Many of the options for this were discussed in Chapter 6 and are summarised here. Firstly political will and buy-in from the water services sectors (for example SALGA, DWA (Water Services), DPLG) and others (DAFF and DMR) is essential. This must lead to clear directives from leadership to participate in IWRM as guided by the law (see earlier). Such options include the integration of planning instruments, such as the WSDPs and the sectoral WCDM plans, and monitoring of these. Secondly appropriate platforms for integrated planning (as outlined above) must be available and used. In considering how this might be done, we argue that in order to avoid participation fatigue, involvement must focus on actions that will assist in advancing other IWRM functions. Examples include developing the water allocation plan and collaborative monitoring and enforcement systems which, without stakeholder involvement, will be very difficult to tackle in any event. Finally a greater regulatory role is required. The overall responsibility for ensuring integration lies with DWA and the CMA and the overall integration should express itself in Catchment Management Strategies.

Concerns regarding unlawful use and regulation are a pervasive in all WMAs. Users in the Inkomati WMA have high expectations from the resource, both in terms of quality and quantity. A system that is not well regulated is unlikely to be able to meet such expectations. Since the cumulative effects of unlawful use are experienced at the level of the catchment, they collectively compromise the system's ability to meet these expectations. Multiple challenges for regulation have been detailed. Not only is the ability of regulator questioned but confusion surrounds definitions of lawfulness, as well as roles and responsibilities in terms of CMA functions. How these are shared between the DWA RO and the ICMA, let alone with Environmental Affairs, is a great source of confusion and apportionment of blame. In some cases this situation means that people do not feel the need to comply because, as it was put, "others will simply be getting away with non-compliance anyway". This mindset is particularly problematic as the collective discourse is not aimed at achieving sustainability but rather focused on protecting individual interests.

All in all, these factors point to a compromised state of legal literacy and the need for support in this respect is also apparent. This offers a "low-hanging fruit" in the sense that there are opportunities for a focused action-research initiative which seeks to understand the needs of staff and that deepens understanding of concepts and responsibilities amongst stakeholders.

Although the regulator is once again blamed for poor regulation it is clear that the responsibilities for maintaining compliance will fall collectively to all major users. The lack of skills and staff in the state highlights the need for the collaborative regulatory role that stakeholders must play. Already some sectors regulate their users but it is important that self-regulation be extended to other sectors and that all users collectively subscribe to the strategic plans set out in the catchment management strategies.

CHAPTER 9. CASE STUDY ANALYSIS: EXPLORING FACTORS THAT LIE BEHIND SUCCESSES AND DIFFICULTIES

9.1 Introduction

In essence, Integrated Water Resource Management (IWRM) seeks to build sustainable and equitable futures for freshwater resources by developing the resilience of the system to cope with and adapt to change and to buffer shocks and stresses. Charting such a path is not a blueprint. Rather the strategies for each catchment may involve different configurations of plans and actions all of which strive for a sustainable future. Importantly then is that they are responsive to context since what may work in one may not work in another (Pollard et al., 2008). Essentially however, they are guided by the same foundational principles which are given by the National Water Act (NWA) and the Constitution (DWAF, 2007b. But what is it that helps to build adaptable, resilient systems? This question lies at the heart of the work being undertaken by the resilience alliance (see for example Walker and Salt (2006). As noted in Chapter 2, scholars and practitioners have sought to understand for example why it is that – despite an fairly supportive policy efforts – salinisation has continued in western Australian (Allison and Hobbs, 2004) for example. More recent work in the Sand River Catchment in the study area examined the scarce water-based ecosystems services through the resilience lens to see if they could be mobilised and maintained in a sustainable and equitable manner (Pollard et al., 2008). Again the policy changes have yet to be realised given the persistence of resistant, reinforcing feedbacks (see below).

Photo 29: A group of farmers learn about the importance of catchments and the role of planning at this level for sustainable Water Resource Management

Although work in progress, the range of attributes that are believed to confer resilience according to Walker and Salt (2006), includes feedbacks, diversity, innovation, polycentric and overlapping governance, social capital, ecological variability, and transparency (see Chapter 2). From the work in the Sand River, the authors suggested a number of additional important considerations including the *impacts of cross-scale factors*, the *recognition of variability* both in policy and in management and the *nature of learning* – which have been elaborated in Chapter 2. In this work we have grouped and incorporated these into attributes that allow us to as the question: what aspects of management and practices confer resilience and adaptability? Thus

for example, in considering the attribute of *diversity*, it can be reformulated to reflect the practice-based aspect of IWRM, so that one may ask: do current management actions recognise the importance of diversity as an attribute of a resilient system?

In the following sections we examine these attributes through a number of cases that emerged during the course of the research and that merit consideration in light of the central question posed above. It would be simplistic and naïve to assume that cases demonstrate 'success' or 'failure'. Rather each encompasses – to varying degrees – aspects of both. The important enquiry for the purposes of this work is in understanding *why* this is so, thus providing the basis for future work which is discussed in Chapter 10. The attributes examined in the case studies include management and practices based on an integrated systems view, the development of feedbacks, self-organisation, self-regulation, as well as collective action, learning and competence as the basis for transformation. Cases in which difficulties and even failures are examined are not presented as a critique but rather, it is hoped, because they provide the basis for learning.

9.2 Developing an integrated, systems view as the basis for planning and action

A persistent issue that emerged from all of the catchments was the lack of integrated planning based on an understanding of the system as a whole; that is the socio-economic, political and biophysical factors that collectively comprise the catchment – or system – characteristics. Both the NWA and the catchment management strategy guidelines (DWAF, 2007a) clearly point to the importance of a systems understanding. Without this it is easy to see how municipalities may seek to resolve water shortages by placing demands on water-stressed catchments that are unrelated to their area of operation, or how plans are afoot to transfer water out of the Olifants – despite it being in water deficit – into the Letaba.

A number of cases discussed in the preceding chapters provide excellent examples of how a systems view is informing the way water resources are being managed. In the Groot Letaba water resource constraints and the needs of the Reserve serve as the basis for planning but, as is the case in all the areas of operation of irrigation boards or Water User Associations (WUA), this is only for a section of the river. However in the Crocodile River the catchment management strategy (ICMA, 2010) makes clear reference to the wider context as the basis for planning and developing a vision and this is reflected in the expansion of the river-management system to the catchment as a whole. In particular is the near-real time **system for integrated planning and operations of river systems** currently being tested and rolled out on the Crocodile River (Box 9.1). The purpose is to develop a decision-support system to improve the decision making on river systems planning and operations utilising the DSS recently developed by DWA (B. Jackson, ICMA, pers. com.). At the moment the international agreement drives the system (see below). ICMA is waiting for the comprehensive Reserve Determination to be finalised and then will be incorporated. This process will follow a stakeholder-driven consensus method to enable the progressive realisation of the Reserve.

Box 9.1:
Case study: Integrated systems management in the Inkomati WMA: The development of a near real-time system for integrated planning and operations of river systems
(Jackson pers. comm.)

Monitoring of river flows and dam levels is currently on a daily basis and reporting is currently on a weekly basis with audits being done by the IBs weekly. Water use data is collected by the IB on a weekly basis and sent to the DSS software *via the internet* on a weekly basis.

The Decision Support System (DSS) comprises hardware as well as software. The hardware consists of stream flow gauging stations, rainfall gauges, water abstraction meters and telemetry. These must all be reliable.

The software serves two purposes: long-term planning and day-to-day operations. The former takes into account climatic predictions, volumes of water in Kwena dam and river flow to generate annual expectations of water availability and potential restrictions. The day-to-day component uses short-term rainfall and runoff monitoring, rainfall predictions and flow data, to anticipate how much water will be available for abstraction over periods of days or weeks, and along which stretches of the river it will be available. Thus, the DSS feeds data to the stakeholders and relevant decision making authorities as defined in the NWA (DWA, ICMA, WUA's) to enable them to make informed decisions about dam releases, abstractions and restrictions according to addendum attached.

The DSS provides the flow hydrograph for releases that will satisfy the water quantity demand schedules at the different locations and times along the Crocodile East water system on a short term (daily or weekly) basis while ensuring compliance with the long-term operational rules determined annually and reviewed quarterly to ensure the correct assurance of the specified water supply to all users along the main stem of the Crocodile East River. The result will be a much refined time-scale for system operations that better informs water users of the volume of water available and when, to ensure efficient, equitable and sustainable use while meeting international obligations.

The Sand River Catchment (see Chapter 8) offers some useful lessons as to the potential outcomes in cases where there has been a failure to adopt a systems view as the basis of governance and management. At a policy level issues of sustainability and equity are clearly articulated in the white paper for the construction of additional storage (the Injaka Dam;) and the transfer of water into the system (DWAF, 1994). However without leadership these intentions have failed to materialise in practice. Interpretations of the problems of extremely low or zero flows ranged from the 'impacts of forestry on base flows' to the 'poor condition of the irrigation canals,' whilst issues related to the poor levels of domestic service to the rural populations are largely interpreted as a 'problem of infrastructure'. Working in isolation and without a wider understanding of the system as a whole, the solutions to each are seen to be the rehabilitation of the canals and further construction of bulk infrastructure. The fact that neither of these – separately – will render the catchment water secure, does not appear to have been considered. In an analysis of the situation Pollard and Agterkamp (in prep-b) suggested that without a different and systemic approach, isolationist 'solutions' may represent a case of throwing 'good money after bad', given that each of the proposed solutions is

extremely costly in their own right. This is because there is a strong inter-dependency between water for domestic and agricultural purposes and between their sustainability and the ability to the deliver the Reserve (both the ecological and basic human needs Reserve). Giving effect to both of these through strategic and integrated planning and action relies on strong systems of leadership, regulation and enforcement, stakeholder buy-in and resources. As noted below, there are currently few feedbacks in place that would support such change on the ground (Figure 9.1).

Photo 30: The first drafting of the ICMS was challenging as it represents the first time in South Africa that diverse stakeholders have been involved in water resources strategy development

Box 9.2:
The need for an integrated systems view for planning and action in the Sand River Catchment

The potential to secure the commitment to sustainability and equity in the Sand River Catchment are intimately interlinked and is predicated on recognising, developing and strengthening a number of important feedbacks. Importantly, this requires recognising their interdependencies. Ensuring flows lower in the system relies on 'compliance' and good practice further upstream, as well as improvements to domestic supply throughput the middle reaches of the catchment (equity). Both of these rely on revised operating rules, authorisation that is cognisant of the operating rules (and hence system constraints), stakeholder participation and lawful use. Adherence to the 1994 white paper is also important. Cascading from are a number of key factors illustrated schematically below. To-date no institutional arrangements exists to provide overall governance for such integrated, systematic planning that would take account of these factors. This may however be provided for by the ICMA in the future.

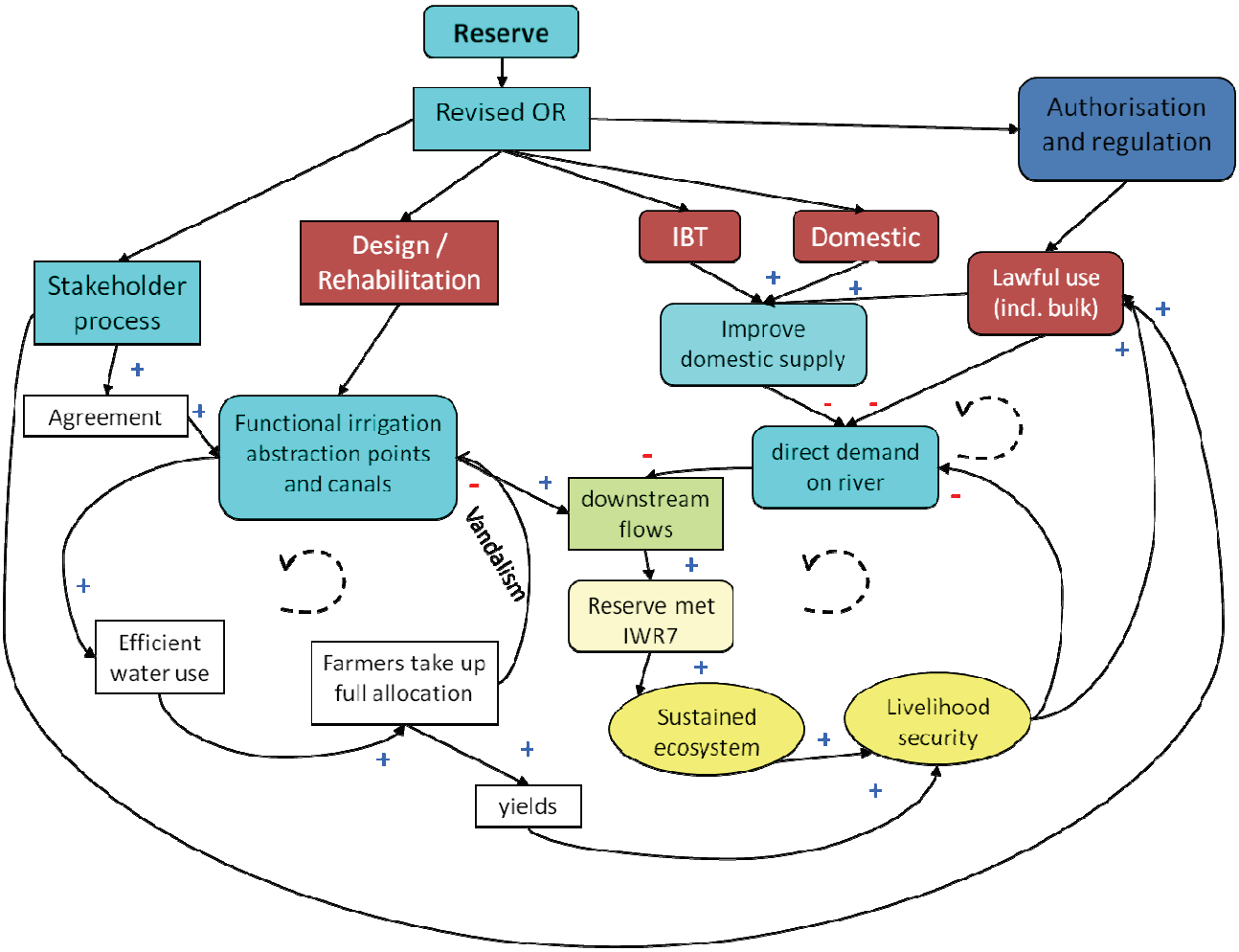

Figure 9.1: Schematic of key factors and their interlinkages and interdependencies for meeting the commitment to equity and sustainability in the Sand River Catchment.

9.3 The adaptive cycle: Feedback loops, leadership and self organisation

As noted in Chapter 2, feedback loops and self organisation are considered to be essential components of resilient systems and adaptive management (Holling, 2001; Gunderson and Holling, 2002) since they provide the basis for collective action, learning and self-regulation amongst other things In many cases throughout the WMAs there were cases of fragile, incomplete or even non-existent feedbacks and these are as instructive for our purposes as those that are working. In the case of IWRM, it seems that it is the multiple, interacting feedbacks that operate at different scales that confer a more resilient outcome. Thus whilst there may be small-scale feedbacks at a localized scale, if part of the outcome is reliant on a wider feedback that is weak, the entire system is rendered vulnerable. For example, in the Luvuvhu some feedbacks are operative between local DWA staff and emerging farmers but not between the local DWA office and commercial farmers and wider to the regional office. Important elements such as trust, leadership and self-organisation are virtually non-existent leading to a situation of antipathy and even open aggression. For all intents and purposes this severely undermines any management actions aimed at meeting the wider objectives of IWRM.

In other cases such as the Groot Letaba, the Sabie, Crocodile and Komati rivers, some aspects of feedbacks are functional and strengthening through improved management and action. In the Groot Letaba the feedbacks (see Figure 6.5) although fragile, are functional at a certain scale (the section of the river below Tzaneen Dam). The systems displays inherent self organisation between the regulator, the watch-dog and the users and the operation of the dam releases to mitigate flow infringements is undertaken by a manager that is trusted. Moreover, the capacity for self-regulation amongst long-standing WUA members (users) is high – although bringing new, emerging farmers on board has proved more difficult. In contrast the same manager is involved in operational systems in the Klein Letaba system but here feedbacks are virtually non-existent and the system is in an almost permanent state of crisis and water deficit. This is because feedbacks at a wider scale are needed to secure lawful use through an integrated approach. Despite repetitive attempts to secure action through the regulator no meaningful action has been taken to date and unlawful use continues (see Pollard and du Toit, 2008). In section 6.2 certain reasons for this were offered including the inherently precarious water security of the area exacerbated by the lack of leadership and integrated planning against requirements of the NWA (Figure 9.2a). Essentially such planning would seek to strengthen feedbacks at multiple scales as indicated schematically in Figure 9.2b.

Like the Groot Letaba, some feedbacks are evident in the Sabie, Crocodile and Komati Rivers all involving irrigation boards and the ICMA. In the cases of the Sabie and Crocodile, the Kruger National Park plays the role of ‘watchdog’, monitoring flows and interacting with the ICMA. The strongest of these feedbacks is evident in the Crocodile (see Chapter 8 and Box 9.1) reflecting the fact that it is the most stressed system of the Inkomati WMA and, as an economic hub and transboundary resource, it has the highest profile. The water resources manager for the ICMA is currently in the process of establishing a river flow management system for the Crocodile River as a whole, including near real-time operation for better management. This will be an integrated system and – in addition to international obligations – the requirements of the Reserve will be formally included as a system driver. Equally it will incorporate of all users on the system – not just agriculture.

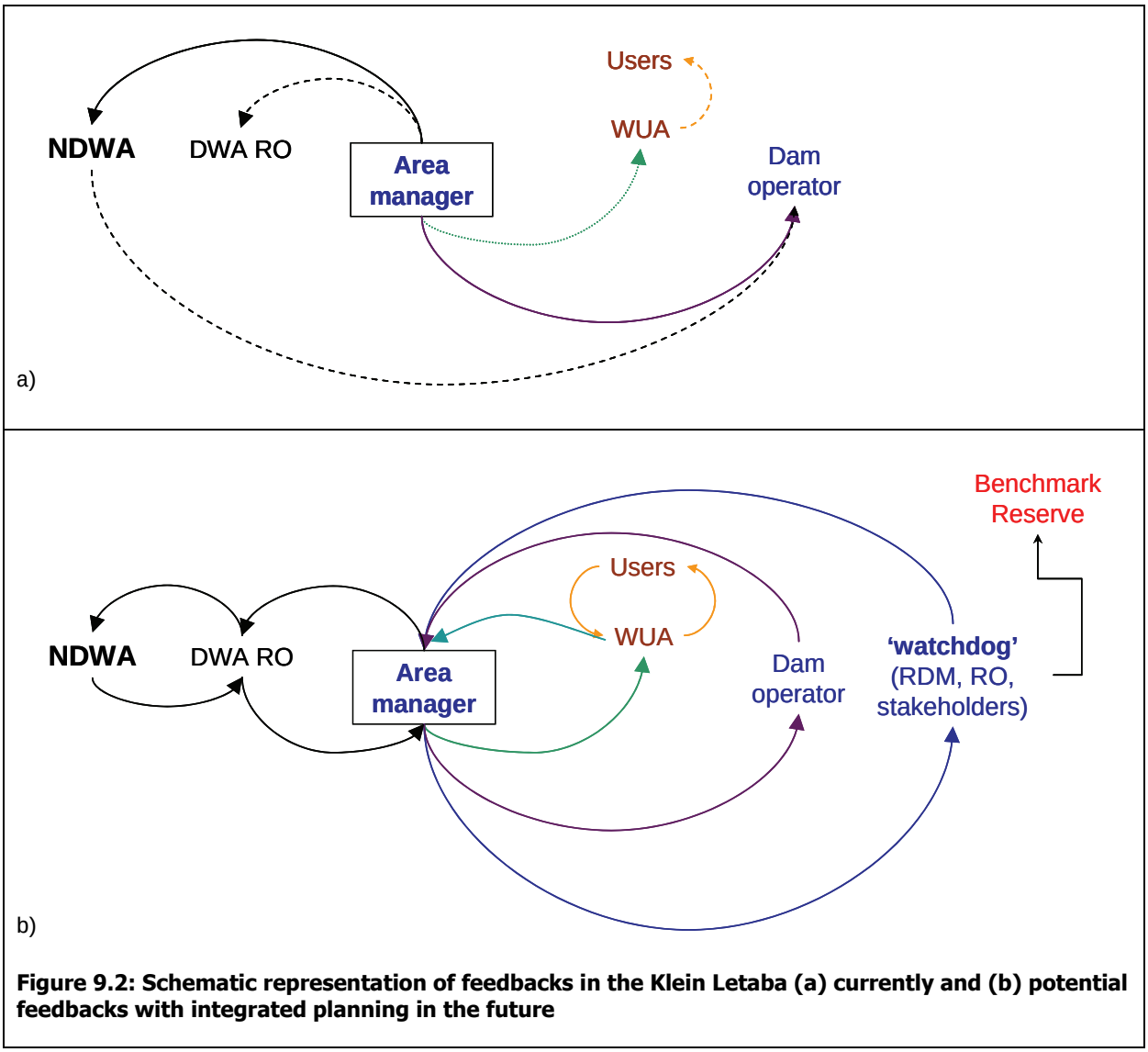

Figure 9.2: Schematic representation of feedbacks in the Klein Letaba (a) currently and (b) potential feedbacks with integrated planning in the future

Interest has grown over the course of this work in what makes feedbacks work and Pollard and Toit (2008) traced the success of feedbacks to a number of factors (Box 9.2). These include an understanding of the legal requirements on the part of the regulator and stakeholders (the WUA and the KNP); the availability of benchmarks against which to monitor (the Reserve, albeit a minimum static value); the presence of a 'watchdog'; the role of leadership with authority (a champion), responsiveness of the manager and users and the ability to self- organise; the development of trust and collaboration over a decade between the role-players; the internal mechanisms for monitoring and action; and the development of a flexible management system that is understood and respected by the users. The trusted point of contact – the manager – can and does respond appropriately whilst considering the risk that this may pose to other users (in this case agriculture). Enforcement is an important component of success and bailiffs (as another example of 'watchdogs') – are imperative. Self-organisation and regulation are key features and are elaborated below. In terms of leadership, Kotter (1996) cautions against conflating the two (leaders and managers), asserting that leadership produces change. However the managers in some of the cases examined display leadership qualities and certainly the process underway in the Crocodile River to introduce a real-time systems approach is transformative in nature complying more with Kotter's definition of leadership.

Box 9.3:
Key elements necessary for feedbacks

- the requirements of the law (supportive legal and institutional milieu (the Reserve*)
- the availability of benchmarks against which to monitor (the IFR*/ Reserve),
- the presence of a 'watchdog' (* although intermittent),
- the buy-in of users (also assume that they are getting a share)
- accountable leadership together with effective governance
- the responsiveness of the manager and users;
- the ability to act (staff, skills, capacity, tenable Reserve statements; infrastructure and so on)
- the ability to self regulate (bailiffs*, incentives to comply, authority to act*)
- the ability to self organise, and thus
- the ability to reflect and learn

Unlike the feedbacks that exist in the primary rivers of the Inkomati, those in the Sand River catchment are extremely weak and some key interactions are non-existent. Despite the policy commitments on paper, the status of the Sand continues to decline (see Section 8.2.1) and a number of factors point to delays that are unacceptable (see Box 8.1). Despite the presence of a watchdog (the Sabi-Sand Wildtuin), few responses are evident. Indeed, few of the key elements necessary for feedbacks that have been identified through this work (Box 9.3) are present (indicated by *). More importantly however, there is no single individual ***with authority*** (i.e. within DWA) *tasked with the governance of the Sand River* ***highlighting the critical role of leadership and appropriate and effective governance. This is equally true in the Olifants, the Middle/ Klein Letaba and the Luvuvhu rivers.*** In effect any issues that may be raised by stakeholders 'fall on deaf ears' in the sense that the leadership role and function is absent or is shared (and lost) between a number of departments and individuals. Returning to the discussion on feedbacks, the communication and action *loops between stakeholders and authority are weak or non-existent*. This needs to be addressed as a matter of urgency.

An important element of these loops is the ***ability for self-organisation*** (Doll, 1993). This means that elements of a system have the potential to organise themselves within a complex system so that it need not tend towards disorder. Over time the users of the WUA have developed and organised themselves into a system that is responsive to – although not always supportive of – the needs of downstream users. An important driver of these loops has been the need to share a scarce resource internally. This is a well-recognised determinant of co-operative management around natural resources (e.g. Alchian and Demsetz, 1973, cited in Meinzen-Dick and Nkonya, 2005; Murphree, 2004; Pollard and Cousins, 2008). Thus the driver is primarily one of self-interest (in a non-pejorative sense) that has allowed wider interests (the Reserve) to be served. Most importantly, the locally-developed operating system that responds to conditions of resource scarcity is sufficiently flexible to accommodate change and surprise. Nonetheless, transformation has introduced changes to feedbacks specifically in terms of scale and stakeholder participation. For example, the role of the KNP as 'watchdog' is not only more active but is more widely recognised than it was 15 years ago. Also, although regulation and feedback is only for specific sections of the river rather than for the system as a whole, this is changing in some areas, notably in the Crocodile River as described in Box 9.4.

Box 9.4: Case study:
An example of sectoral self-organisation for resource sharing along the Crocodile River

In the Crocodile Catchment there are a number of well established feedback loops that function to keep the management process responsive to contextual changes. Probably the most clearly defined feedback system was established and is maintained by the Crocodile Major Irrigation Board (MIB). In their attempt to remain responsive to contextual change they have assembled a highly functional network of water managers and users that interface with the current infrastructure, policies and regulations (see Actor Network theory for analytical framework). In setting up this network a sophisticated flow of information is maintained in order for responsivity and resilience to be built into the system. A detailed analysis of this network is beyond the scope of this profile. However, we have identified key areas that have been part of their attention to the management process and networking:

- Within the MIB there is a technical management committee. The committee develops and defines a strategy that is fed through to an operational manager who implements the operating rules;
- There is a chairperson (of the Technical Committee) who is knowledgeable of the system and the management processes, from both a technical and social perspective. During dry cycles when special management measures need to be put in place, special management committees are set up – comprising MIB chairperson, ICMA, DWA;
- A “mini- forum” is being established between the Irrigation Boards and the ICMA to deal with issues that are of direct interest to these parties
- There is attention to medium and longer term planning not just response to current issues and crises. Strategic planning is an important focus of the network;
- There is a designated person/s responsible for the day-to-day management
- The last (downstream) farmers to receive water are usually involved in the monitoring and reporting;
- Adequate and operational monitoring weirs: specifically key or critical weirs are identified. For example, management is largely dependent on the Van Graan Weir;
- Real time data is critical for the management process. Day-to-day management involves visiting the real time DWA website to see what volumes are crossing the weirs.

These components were noted as central to the effective management of the river and for maintaining compliance. Each component needs to function effectively with interactions and feedback remaining focused (hence the call for “mini-forums”). The flow of information is highlighted as an important part of the process with blockages and bottlenecks presenting a problem for the management process. In this regard it was noted that the DWA website is not always reliable with hydrological data sometimes missing [this can happen if weirs and monitoring gauges are broken]. It was highlighted that a planned 60% cut in Hydrometry budget at DWA will have serious consequences for monitoring and management.

The implications of not having feedback loops in place are self evident. Firstly, there is no basis on which the system can learn and respond so dealing with dynamic environment and change is highly unlikely. Secondly, this makes the development of tools such as operating rules a paper exercise since

it begs the question of who will use them. Importantly operating rules must be led by someone with authority and managed by someone with the responsibility, skills and interest to respond to change. Thirdly, self-regulation is important and 'watchdogs' (be they affected parties, bailiffs or the area manager) are essential in the loop. Finally a supportive legal system is needed. When all else fails (coercion, incentives, punitive measures) people need to be able to turn to the law. Many respondents all the catchments consider the legal system to be ill-equipped to support compliance in the water sector.

As we move into these relatively unchartered waters, an important feedback loop requiring attention is that between academics, practitioners and managers and in particular the need to develop tenable methodologies (even if not perfect). Failure to do so adequately will simply frustrate turning one-time supporters into critics – thus breaking the loop of learning and action.

As water resources in the lowveld come under increasing pressure, regulators and users will need to find 'solutions' to oversubscribing the resource. The challenge will be to develop appropriate practices that address directly unsustainable use – this, arguably, can only be done with a certain level of self organization within and between the various sectors. In addition to this the need for learning as a key component for organisation and innovation is critical

We still do not know really understand how self–organisation occurs but Doll (1993) speculates that it might depend on reflective action and social interaction. A central question is how do people respond to, and learn from processes that are unpredictable? The issue of learning picked up in a later section.

9.4 Self regulation: different players in a system take responsibility for actions

As with self-organization, self-regulation has an important role to play in management within complex systems. This is because, due to their openness and unpredictable nature, complex systems cannot be managed only from the outside. The responsibility for aspects of the regulation needs to fall within the system itself. This requires a shift in how a regulator is perceived. Throughout all the catchments some degree of self-regulation is apparent offering useful learning opportunities and the foundations for strengthening such work. For example within some sectors there are instances of self-regulation aimed at meeting quality standards through monitoring activities. In terms of water conservation demand management (WCDM), some industries are aiming to devise closed water systems and improve water recycling. Here we highlight two cases: the development of a WCDM plan by the Giyani Local Municipality as a way to bring water use under control (Box 9.5) and secondly, the regulation of agricultural users by the Groot Letaba Water Users Association (Box 9.6). Although the latter deals with one WUA, it is an example of the self-regulation evident in many of the WUAs and irrigation boards that were interviewed. The sound regulation of the agricultural sector seems to be dependent on functioning WUAs. This is important because many interviewees believe that regulatory functions reside with DWA alone; only on a few occasions did respondents recognise that they have a collaborative regulatory role to play when it comes to sustainability issues and the Reserve.

Box 9.5: Case Study:
Experiences with water conservation and demand management (WCDM) in the Letaba catchment

The municipal town of Giyani is located in the lower part of the Letaba catchment. The legacy of Giyani is that of a R293 apartheid town located in the former homeland of Gazankulu. This status has had a particular impact on the ability of the new municipality to implement IWRM policies.

One of the main challenges has been for the council to implement a WCDM plan. The water infrastructure and allocation was inherited from the former DWA without accurate records or any water meters. Giyani Local Municipality was, in 2003, still unaware of what water services had been transferred to it and no reliable records were kept by the water control officers. Since the data was not used the water control officers failed to enter it into a system. Only 45 % of water use in Giyani was accounted for, with business using about 5%. One of the main issues confronting the municipality was settlement expansion and the increase standards of living in surrounding villages both factors leading to an increase in water demand. It was found that planning for 25 l/p/d was not realistic as villages consume double that. Other issues identified as problematic were poor planning, lawns being watered in a dry climate, the lack of municipal capacity and the fact that there are no systems in place for approval of expansions and schemes.

In 2003 the municipality appointed consultants to address a particular suite of issues in order to seek compliance and to rectify the unregulated use of water. The municipality complains that too many consulting companies worked on the data systems for the town leaving a system that is full of incorrect data and a serious source of confusion for the municipality. The aim of the consultancy was to introduce an end-user program to manage demand. At this time there were 7000 households that were part of the reticulation with an average consumption of 94 kl/hh/m. Each household paid a flat rate each month that was not linked to consumption. Of the 7000 households billed approximately 100 paid.

By July 2003 a WCDM plan was put in place with the following key actions:

a) Fix non-functional water infrastructure
b) Meter unmetered use
c) Expand user database and send out bills (build up credibility over time)
d) Awareness campaign in the residential area and surrounding village

The consultants maintain that with these actions the average usage was reduced from 96 kl/hh/m to 36 kl/hh/m with 65% payment for services billed. Although this case study is not comprehensive these efforts provide some experience of what WCDM planning within such contexts can achieve.

In the case of the Groot Letaba the GLWUA works closely with DWA to ensure that the dam operating rules for the Tzaneen Dam are adhered to in order to meet the requirements for the Reserve. In this case DWA plays an important role in ensuring that the Reserve is addressed in management practices (see Section 9.2). The success of this system can be traced to a number of factors including the need to share common resource (a stressed river, infrastructure), an understanding of the legal requirements on the part of the major stakeholders, the development of trust and collaboration over a decade internally and between the manager and the stakeholders and a flexible management system that is understood and respected by the users

Box 9.6: Case study:
Self regulation in the Letaba catchment

A high level of self regulation occurs along the Groot Letaba with the GLWUA acting as the main regulator for the commercial agriculture sector. No such regulation occurs on the Middle or Klein Letaba with the consequences that such responsibilities fall to DWA (who lacks the capacity to regulate as described earlier).

The WUA interacts with three main resources and regulates use from these: the Ebenezer Dam, Tzaneen Dam and the Letaba River. The self regulation is a sophisticated process that entails managing canals to distribute water to legal users. There are three types of water abstraction systems: water abstracted through canals using measuring plates, metered pumps, and abstraction from the river using small pumps without meters (according to the management committee, the size of the pump is self-restricting). The WUA operates 153 water measuring instruments. There is a chairperson, vice chairperson, secretary, assistant secretary, treasurer and representatives from the five voting (zones according to the size of water use). The WUA has its own bank account and raises funds through member contributions.

Essential components of the self-regulatory system include: a) operating rules for dam management that takes a minimum flow (regarded as synonymous with the 'Reserve') into consideration, b) different regulations for cash versus permanent crop areas c) protocols for when to impose restrictions, and d) enforcement procedures with water bailiffs, metering of use and options for legal recourse. This desire to regulate from within creates a healthy environment for collaboration where users are supportive of the management actions not undermining of them. Although the regulation of use is not always popular with farmers the system is respected and adhered to by the GLWUA members.

A prerequisite for self regulation is that of willing participants, without which there is likely to be weak or non-existent incentives to self-regulate. In this respect the former 'homelands' are troubled with very little self-regulation occurring and weak control and regulation by DWA. The Nkowakowa scheme, for example, is reported to be using more than double what it was established to use with no attempt to bring this in line with actual allocations. The vandalism associated with the Nkowakowa purification plant indicates a breakdown in self regulation and management. Instead of exploring self-regulatory options the yet-to–be established CMA is being identified as the legitimate regulator typifying a system where there is no will to self regulate but rather to shift the responsibility to an outside agent.

In all cases regulation and feedback are only for specific river sections rather than for the system as a whole. Monitoring for compliance along the Crocodile, Komati and tributaries is taking place to varying degrees for which the irrigation boards have developed sophisticated instruments and models that can be an important contributor to achieving compliance with the Reserve. In this regard, the ICMA water resources manager is currently in the process of establishing a river flow management system for the Crocodile River as a whole so as to truly give effect to IWRM, including real-time operation for better management. This will be an integrated system and in addition to international obligations, it will include the Reserve requirements as drivers of the system.

Photo 31: DWA carries the responsibility for managing dams and canal systems until such time that these tasks are assigned to a CMA or WUA. Management for purposes of sustainability (i.e. meeting the Reserve) has however not emerged as a priority

The role of state regulation and enforcement

Finally, although here we have focused on self-regulation which normally occurs within a sector, it is important to note the key role of external or state regulation with respect to unlawful use and non-compliance with the Reserve or with financial arrangements. Even prior to enforcement other regulatory measures are at the disposal of the regulator (such as dialogue) so that not all monitoring leads to regulatory enforcement but this is very sporadic. All interviewees raised cases that had been reported but no action had been taken. For example, the monitoring data by Silulumanzi may be logged but they have no power to act and rely on DWA to do so, which rarely happens. The Sabie River Irrigation Board has repeatedly reported major water quality infringements on the part of the municipality to no avail. Even internally such failure is evident such as in the case of the Middle/Klein Letaba reported above where DWA fails to take heed of concerns raised by the local office. This points to a lack of self-organisation within DWA. Nonetheless with the establishment of the National and regional CME directorates some regulation does take place for example, the DWA RO claims that there are some 23 criminal cases (which is very vague).

Photo 32: The ICMA staff is challenged with having to develop new practices and implement national policies on the basis of catchments. Drawing stakeholders into this process is part of the challenge

9.5 Learning, understanding and competence as the basis for transformation

Learning is critical for coping with change but what is its role within complex systems such as catchments? And, more specifically, does learning have a role to play in moving catchments towards more resilient, stable and sustainable states and what are its benefits and consequences for the system as a whole? Clearly learning is a critical component of functioning feedback loops and self-regulation (above).

Complexity theory proposes that socio-ecological systems derive their essential properties, and in fact their existence, from their relationships (Capra, 2007). The character of these relationships is influenced by interactions around events, communication and **learning**. The resilience, and hence sustainability of a system, is not an individual property, but a property that is held by the whole. One would assume that a vulnerable (unsustainable) system would have weak networks where feedback plays little or no role in organizing or regulating the system. This means that learning (from mistakes for example) cannot – or does not – occur. On the other hand, a system that is able to experience events, reflect on them and so learn is assumed to be responsive and capable of adapting to changes that are inherently part of complex systems.

As pointed out earlier, one of the main issues bedevilling sustainability in the lowveld rivers is that of a poor 'understanding' of the Reserve. Here we take 'understanding' to equal 'meaning' as poor understanding can in fact be 'divergence in meaning' or 'alternative meaning'. Dealing with rudimentary understanding is very different to dealing with a situation of multiple divergent meanings.

'Poor practice' is usually associated with rudimentary understanding. Here the issues of skills and competence of those mandated to carry out a particular task are raised. Practitioners are unlikely to develop sound WRM practices in their daily routines if they do not have the conceptual grounding or the basic competences to carry out their duties. A glaring issue raised by the research was that of skills and competence within the regulating sector. In the case that follows we will discuss these issues in relation to regulation of water use in one catchment.

Building regulation competence ('the challenge of learning to regulate')

That the "regulator cannot regulate" was raised in every catchment of the lowveld. Despite and enabling legislative environment and the establishment of relevant authorities the majority of respondents felt that there was "still something going wrong" and this appears to be in relation to competence and capacity of the regulator to regulate. Specific examples of under-regulation and lack of enforcement are provided in Chapter 6 and will not be repeated here. We will focus discussion on the issues of learning/competence in relation to implementation of compliance monitoring and enforcement (CME) policy. Important to note here is that by regulation we are referring to a suite of actions related to compliance monitoring and enforcement.

The perceived lack of competence of the regulator was expressed as the "lack of skills" at DWA. However this needs to be 'unpacked' as the "lack of skills" may cover a host of issues including:

- Staff who lack specific skills and experience
- The absence of skilled staff at the appropriate level of appointment
- Too few staff to conduct specific functions
- The loss of skilled staff from the sector to other sectors
- The failure to attract new appropriately qualified staff to the sector
- A general lack of skills across all sectors and departments involved in water management functions
- A lack of continuity in dealing with particular functions (creating the perception of a lack of skilled staff)
- Inappropriate in-service training and professional support

So we see that the lack of competence to perform a particular task can have a number of underlying causes. All of these taken together are expressed as 'failure'.

That said, the research identified a number of features of CME that are functioning and, that if supported through learning processes, will enhance regulatory practice (Box 9.7).

Box 9.7:
Cases of where building competency for CME is emerging in the Inkomati WMA

- There are shared training programs for DWA law enforcement officers ('Blue Scorpions') and environmental management inspectors ('Green Scorpions') where collective regulatory competence can be built.
- Integrated licencing and 'authorisation chains' can streamline authorization procedures where multiple authorizations are required.
- The major IBs/ WUAs have a high level of competence and capacity to regulate user members. They have sophisticated monitoring schemes with water bailiffs and competent staff. Considerable amounts are invested in remote monitoring and pump management.
- The Silulumanzi water board is a competent authority in water distribution with a high level of compliance (see Blue Drop report, DWAF, 2010) and success in cost recovery.
- Industry, forestry, and mining make a contribution to compliance by employing environmental officers or allocate water related tasks to SHEQ managers
- The industrial and forestry sectors are willing participants in the development and implementation of industry standards and best practice and they are willing to collaborate on water quality standard setting. The industrial sector is investing in "zero demand" water recycling schemes in a number of areas.
- District municipalities are picking up responsibilities for assisting with monitoring and regulation of local municipalities
- Strong civil society involvement (through WESSA, EWT, NGOs) can augment monitoring and assist in raising the collective experience for reviewing scoping reports and EIAs.

Although the need for broad awareness raising was mentioned as the way forward, it may do little more than to orientate users to the importance of particular issues. Such programs are unlikely to be adequate in helping the regulator develop sound and robust monitoring and enforcement practices. For this specialized technical support is likely to be required. An appropriate response to this is a well designed professional development program or an internal mentorship process.

A number of approaches and frameworks are available that could assist in the development of IWRM and regulatory competence. Work by Senge (1980) claims that we need to see institutions as **learning organisations**. The process here has been to understand how learning occurs effectively in organisations in order to design interventions that can help create 'learning organisations'. Whilst Argyris and Schön (1978) talk of the process focused more on **organisational learning** where there is a focus on learning and 'unlearning' in organisations. The central concerns of the two are somewhat different. Scholars and practitioners of organisational learning focus on the observations and analysis of the processes involved in the individual and collective learning inside organisation; whereas the learning organisation literature has an action-orientation focusing on specific diagnostic and evaluative tools which can help promote the quality of learning processes in organisations (Tsang, 1997 quoted in Easterby-Smith and Araujo, 1999).

The importance of reflection in learning

The importance of reflection as part of a learning process has been emphasised by prominent authors such as Dewey (1933), Habermas (1971), Kolb (1984), and Schön (1987; 1983), Although they apply the concept differently they all elaborate on the topic of reflection as increasingly important to professional development and life-long learning. Moon (1999) has drawn a considerable amount of the work on reflection together. She provides a summary of the four main theoretical perspectives on reflection. For Dewey (1933), reflection is thinking about 'me' as the individual and 'my functioning' as an individual. Kolb's (1984) incorporates reflection into a cycle of experiential learning. The 'learning by doing' approach has its roots in this cycle – but some challenge this as a narrow interpretation. Schön's (1987) focus was on the development of reflection and reflexive practitioners. Professionals build up expertise through reflection, not necessarily by applying the training provided in formal settings. Schon suggests that two types of reflection occur: 'reflection-in-action', such as remembering a similar problem and recalling its solution, and 'reflection-on-action', which occurs after the event. According to Habermas (1971), reflection is about how we process knowledge and construct new knowledge or build theories. Reflection is essentially a problem-solving or decision-making process. The purpose is to enable the individual to understand *where they have come from, where they are and where they are going*. Alternatively put: reflection *identifies* the problem, *creates* the strategy to solve it and *monitors* progress towards the goal. A reflective habit is then integral to planning for improved professional and personal development.

Other valuable theoretical frameworks for supporting learning and competence development are considered in Chapter 10.

9.6 Collective action

The role of bringing stakeholders together to negotiate the management of limited and limiting resources has been discussed in earlier chapters. In this section we describe two cases of where multiple stakeholders are using the legislative framework for collective action where collective action and collaborative planning can be defined as ''collective process of involving diverse stakeholders for resolving conflicts and advancing shared visions'' (Gray, 1985).

Securing participation in the management of the rivers of the lowveld provides a unique opportunity to explore the assumption that with decentralisation, local actors are better able to assess the situation, have better access to information, understand appropriate responses and are more easily held accountable. Here the challenge is for stakeholder groups to explore potential options in a supportive environment and dialogue around the opportunities that exist.

Photo 33: Collective action is an approach where different sectors, departments and stakeholders plan and work together for the achievement of a particular goal.

The last decade has seen the establishment of a number of participatory platforms but whether they provide a real opportunity for collaborative engagement remains to be seen. These platforms are affiliated to a number of departments with a number of functions. Although not all of these platforms are multi-sectoral, they have in common the aim to create a co-operative environment where the regulator can work with users. An example of collective efforts to address issues in the upper Olifants is given in Box 9.8.

Like many forums, the fact that the ORF has no 'political or legal clout' was bemoaned as an issue hampering action. However the intention is not for the forums to have statutory powers but rather that they act as feedback systems to the regulatory bodies. That these communications systems are weak is a first source of potential problems obstructing management and administrative action. More importantly however, there is no single individual ***with authority*** (i.e. within DWA) ***tasked with the governance of the Olifants.*** The critical need for leadership and governance was underscored in section 9.3 and needs to be addressed as a matter of urgency.

`

Box 9.8: Case study:
Efforts at collective action through the Olifants River Forum (ORF)

The evolution of the ORF provides for an interesting case study of differences in the perceived value of the forum to stakeholders which varies widely. On the one hand, some feel that the forum is important for addressing common concerns and for getting feedback, whilst on the other some feel that the forum has failed to tackle the degrading water quality issue through a lack of focused action.

A number of participants have expressed dissatisfaction with DWA representation stating that the regulator is unable to provide inputs or answer questions. Despite these problems some felt that the ORF represented some of the most important progress in relation to WRM in the Olifants. The chairperson claims that initially the forum focused on problems but that has shifted now to action. Initially people were invited to provide presentations to members but now efforts are focused on collective activities. A representative of a major water use saw things differently claiming that the ORF seemed to struggle making decisions, and focused on own internal (sector) issues rather than issues of the river. Another critique was that the ORF "doesn't seem to have a plan" (e.g. for the year). These issues will be fed back to relevant persons in subsequent phases of this project.

The DWA feels the ORF is valuable as it has been able to raise money for projects and is able to sustain itself through membership fees. However there was a feeling that the forum should move away from the 'interest factor' to an agenda of achievement of objectives. As one conservation respondent expressed it rather humorously: "I have spent lots of time and money, I had to eat lots of boerewors and pap with other stakeholders". The question is whether these investments, at considerable costs to stakeholders, have delivered a healthier river?

The Department of Mineral Resources (DMR) recognises the ORF but does not believe that it (the DMR) needs to "negotiate" with stakeholders as it reserves the right to decide on licence applications on the basis of their legislation. The withdrawal of the DMR from the forum is a major problem for collaborative action at the level of the catchment. The fear of being "put in the hot seat" was also an issue that came up for DWA raising issues regarding forums of "name and shame".

Many recommendations and inputs for better functioning of the ORF have tabled in discussions. Some of the more interesting include the suggestion that licenced users should be mandated to attend through conditions in licences; the lack of funds will decrease civil society inputs and poorly resources groups need to be subsidised.

Crocodile River Forum (CRF)

Most sectors responded positively to the Crocodile Catchment Management Forum and it appears that of all the lowveld rivers the Crocodile has the most functional catchment forum (CMF). All sectors interviewed are aware of the CMF and the majority are regular participants in meetings. Although some sectors feel that the way that the forum functions can be improved, it is generally seen as a valuable forum with some respondents claiming the it is through the CMF that they learn about water resources management and get to discuss issues of common interest and do collective thinking. There is a feeling that the forum can, and should, focus more on collaborative planning and that it should be more than a platform for 'trouble shooting'. Some felt that logistical issues need attention i.e. invitations need to be sent out timeously; dates and venues need to be arranged and adhered to by the organisers and communication should be more regular. Respondents from the industry sector felt that the Croc Forum is not functioning optimally.

Another problem specific to the CRF is that it is un/underfunded and it is largely run by a volunteer ethic with the result that the level of functioning and outputs are rudimentary. Two sectors mentioned that professional forums (or at least professional chairpersons) would represent a more successful approach.

Despite the forum, communication and relationships between different sectors were noted as weak. Relationships with DWA were singled out as particularly problematic. The industrial sector claims that DWA is unreasonable and uncommunicative: “we need a sympathetic ear in order to move forward”. The lack of responsiveness, feedback and communication is identified as an obstacle to collaboration in the catchment.

Whilst multiple stakeholder platforms as an opportunity for the evolution of a collective action we believe the potential is being lost. As far as sustainability goes, the lack of consensus around future priorities is a threat to achieving sustainability. Even with the well established Crocodile Catchment Forum, the concept of sustainability appears to be currently missing from the agenda. The need to facilitate such discussion warrants serious consideration. The appointment of a lead agent capable of this facilitation is of equal importance. It is hard to see how sustainability will be embedded in the Catchment Management Strategies if stakeholders are not familiar with the concept, its associated tools and its relevance for water resources management. The chairperson of the Forum is a key person in this regard. Working with Forums, their members and chairpersons is potentially a direction that Phase 2 needs to consider.

CHAPTER 10. AN OVERVIEW OF FINDINGS, IMPLICATIONS AND POTENTIAL AREAS FOR FUTURE ACTION

10.1 Introduction

This work has focused on understanding the factors that enable or constrain meeting the commitment to sustainability in the rivers of the lowveld as set out in the National Water Act (NWA; (RSA, 1998). Through the development of profiles for each of the lowveld rivers (the Luvuvhu, Letaba, Olifants, Sabie, Crocodile and Komati), the efforts aimed at **integrated water resources management** (IWRM), by both the regulators and stakeholders in each of the catchments, were examined. As is pointed out below, the broader focus than simply the Reserve reflects the fact that for the Reserve to be met no single set of actions alone (be it classification, setting resource quality objectives or regulation) can ensure long-term sustainability; rather it is the combined and synergistic actions and plans that will collectively bring about change and ultimately deliver the Reserve. This in line with the national policy for IWRM which is to be given effect through the catchment management strategies (Pollard and du Toit, 2008; see Figure 10.2). Importantly although strategies are yet to be developed for most of the water management areas, aspects of IWRM are already underway. Although widely variable in scope and progress, we must find ways to lend support to such transformation towards integrated water resources management.

In this final chapter we summarise the major findings and scope options for further work. It is important to note firstly, that the scoping of themes as the basis for a further phase was undertaken by a larger advisory group at a strategic workshop held from 28-29 May 2009 in Skukuza. Here representatives from the WRC, universities, DWA, SANParks and consultants deliberated the findings, analysed and grouped these according to themes and developed broad-scale recommendations. Those outputs that conform to the funding criteria were then re-worked by AWARD and the WRC into terms of reference for a second phase as per the contractual agreements. Secondly, the idea was to scope out, broadly, a series of key focus areas (developed from the aforementioned themes) to guide research and action rather than to develop a prescriptive set of detailed recommendations that may constrain a second phase. Although the focus was on the rivers of the lowveld, it is believed that many of the issues raised are echoed in other catchments in the country.

10.2 Synthesis of key findings and focus areas for action

10.2.1 Compliance with the Ecological Reserve as a benchmark for future action

None of the eight rivers examined met the Reserve requirements for flow i.e. non-compliance was evident throughout (Pollard et al., 2010). With the exception of the Sabie River this situation has deteriorated over the last decade (Figure 10.1).

Whilst this might present a dismal picture of progressive implementation, it is believed that this will improve in the Inkomati WMA in the near future, certainly in the case of the Crocodile River. Recent developments for a catchment-based water resources management system will (a) incorporate the Ecological Reserve (ER) as well as international obligations and (b) re-align and incorporate sector-specific management targets (see Chapter 9). It is hoped that this will be accompanied with improved regulation and enforcement.

Government needs to lead the way through a cohesive strategic plan that includes frameworks, tools and management systems to operationalise the Reserve. This means embedding the process in catchment-scale plans for IWRM (such as the Catchment Management Strategies). Various approaches such as that described for IWRM for the Crocodile River (this report) or for the operation of dams in the Olifants-Doring (Brown et al., 2010; Pollard et al., 2010) – are being tested country-wide and offer models that can be examined for their applicability elsewhere.

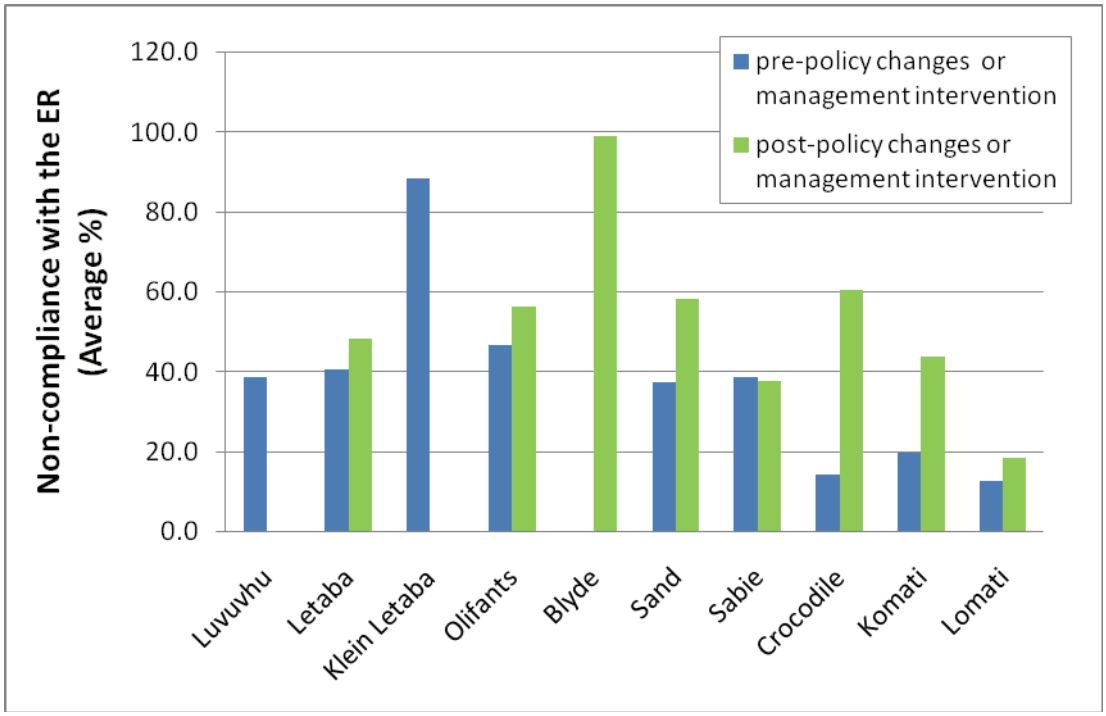

Figure 10.1: A comparison of non-compliance with the Ecological Reserve before and after policy changes or management intervention

Further research

Research requirements regarding Reserve compliance have been dealt with elsewhere (Pollard et al., 2010). Importantly however is that:

- The concepts and frameworks for water quality compliance need to be tested (Pollard et al., 2010) focused on quantity and on low-flows).
- Future Reserve and classification determination processes must consider the practicalities of operationalising the Reserve.
- Research that seeks to elucidate collective benefits of the Reserve at a catchment scale in a way that holds meaning for participants will be an important step.

10.2.2 Operationalising the Reserve based on an integrated, catchment-based approach: supporting IWRM

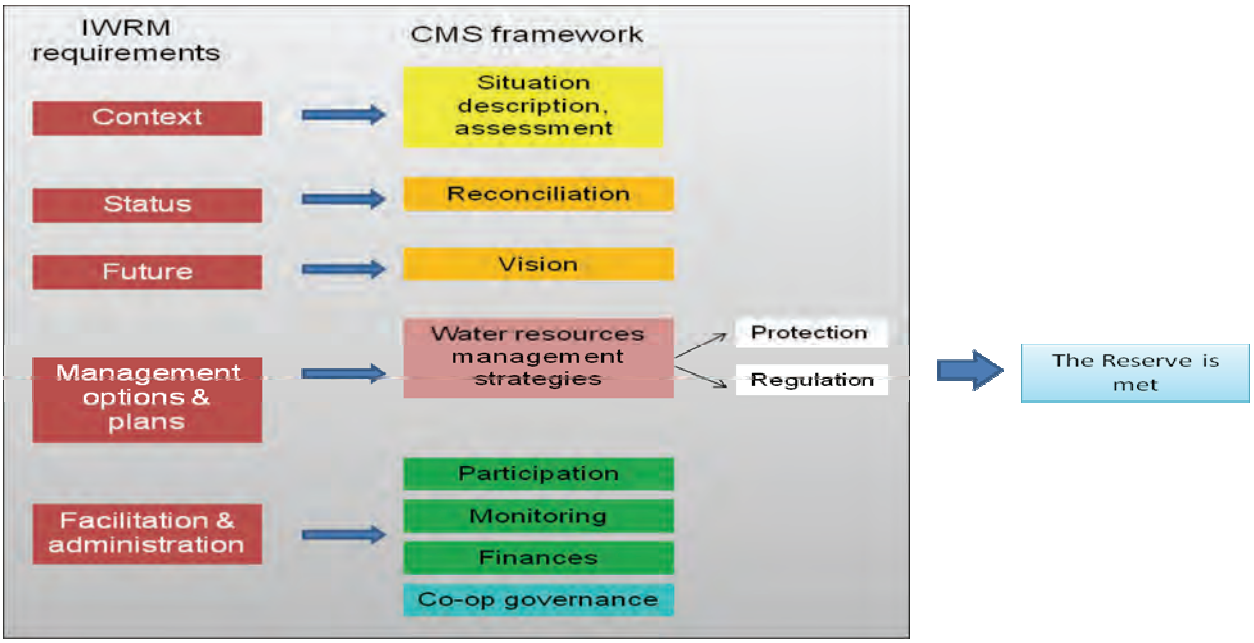

Figure 10.2: Schematic illustrating the relationship between IWRM requirements, the response in South Africa through the catchment management strategy and the outcome- in this case the Ecological Reserve. This indicates that it is combined and synergistic actions and plans that will collectively bring about change

As noted in the opening to this chapter, operationalising the Reserve moves the discourse and practice beyond water protection alone (i.e. Resource Directed Measures). It is predicated on water reform and IWRM as a new and transformative way of managing the nation's water resources. Hence it is the collective contribution and synergies of a number of strategies, plans and practices (as envisaged in the NWA and the NWRS (DWAF, 2004e) that make up IWRM (Figure 10.2).

A central focus in the transformation of water resources management in South Africa is the adoption of an integrated, catchment-based vision and approach that is based on the principles of sustainability, equity and stakeholder participation. Moreover, the approach needs to be adaptive as

new learning and experience is gained. These elements essentially describe IWRM as conceptualized in South Africa (Pollard and du Toit, 2008). The imperative therefore is to plan for integration and harmonization of planning instruments.

Key findings

Such integrated approaches are not evident in any of the catchments examined, with the exception of the Inkomati WMA where it is emerging through the development of the Inkomati CMS, although the management focus is largely on the Crocodile catchment. Aspects of IWRM are underway at more localized scales and these are discussed.

Of particular concern is that ubiquitous lack of integration between water resources management and supply. Few of the existing water services development plans of local government make reference to – or plan against – water availability. Equally the strategic or operational plans of major sectors make little reference to water resources availability other than to note that it is a constraint. Of growing concern is the lack of integration on the part of mining in the Inkomati and Olifants WMA. Some exceptions to this general pattern are evident in cases such as the Groot Letaba River and some reaches of the Crocodile, Komati and Sabie Rivers where water allocations for agriculture take into account water availability and are well-regulated. In contrast some distinctive cases are illustrative of the lack of integration (Chapters 6 to 8). These include examples such as:

a) Continued inter-basin transfers (planned over a decade ago) despite water resource constraints. For example, the planned IBT will move water from the Olifants (despite it being in water deficit) into the Letaba Catchment (see also Middle-Letaba system in Chapter 6).
b) the fast-tracking of licences Development Facilitation Act (DFA, 67 of 1995, RSA 1995) for rampant housing developments in the Crocodile Catchment despite being highly water-stressed;
c) water management for divergent purposes in the Komati and Middle/ Klein Letaba
d) the escalating needs and impacts of the mining sector in Mpumalanga and
e) expansion of bulk infrastructure by municipalities without consideration of water availability and lawfulness.

Despite legal obligations to do so, not planning within the context of water resource constraints currently carries no consequences. With little consideration of the constraints imposed by the water resource base, this puts the sustainability of water resources of all catchments, and more immediately in the Letaba, Sand, Crocodile and Olifants, into question.

Photo 34: ICMA undergoing training in Catchment Management Strategy development.

This situation is unlikely to change unless there are appropriate platforms and mechanisms for integrated planning together with buy-in, and hence directives, from leadership (for example SALGA (South African Local Government Association), DPLG (Department of Provincial and Local Government) DWA and the CMA.

The overarching recommendation is *to develop support for a systemic, integrated approach to IWRM in each catchment* (as outlined in the guidelines for the catchment management strategies). Additionally:

i. The integration of water resources management and water use/ supply needs to be addressed as a matter of urgency and priority. In particular, water services institutions and mining need to be brought on board and planning processes harmonized.

ii. Where integration occurs it is mainly at a localized scale, such as in the case of irrigation boards or Water User Associations (WUAs). Although the understanding is strong locally, this can be expanded to a catchment-scale perspective. In particular such groups can provide a 'mentoring process' pointing out the benefits and requirements for developing a more integrated approach. The recent actions by Letaba-based local municipality of Giyani to develop a WCDM strategy are commendable and should be encouraged throughout the WMAs.

iii. Given that stakeholders are dissatisfied at 'talking without action', any initiative aimed at integration must have clear outputs and the current policy environment provides for this. For example, the catchment management strategies, WSDPs, Provincial Growth and Development Strategy (PGDS) and sectoral WCDM plans can be improved through a consideration of water availability and water resource management arrangements. Other plans such as provincial

wetland rehabilitation (Working for Wetlands), alien vegetation control (Working for Water) and provincial plans such as the C-plan need also to be brought on board. It is recommended that the current processes be used to ensure integration.

iv. Interviewees perceive (a) few benefits to participation, and also (b) weak enforcement of policy requirements. To address this requires enthusing those in leadership so that they send out clear directives regarding the need to be involved (see below).) Enforcement against non-compliance must be strengthened. Currently for example, there is little cost to municipalities that do not consider water resources in their WSDPs nor to over-use or water quality infringements (see Blue Drop Report, DWAF, 2010).

Further research

Broad areas of research interest include:

- action-research to support integrated approaches and the development of a systems understanding with stakeholders; and
- action-research to support integrating water resources issues into various planning documents such as the WSDPs of local government.

10.2.3 Developing an understanding of the Reserve so as to improve practice

In order to re-orientate stakeholders (including the regulators) towards sustainability and to embed the Reserve in WRM practices, they not only need to understand the concept but also why it is important to them and others in the catchment. Currently however although some awareness of water problems and sustainability exists, it still remains outside of the pre-occupation of users and – in some cases – the regional offices.

Key findings:

The Reserve is poorly understood by most stakeholders in all the WMAs examined, including the DWA regional offices. This is particularly evident in the case of the Luvuvhu/Letaba and Olifants WMAs. The slightly better results for the Inkomati partly reflect the fact that the CMA has been operating for sometime but more importantly, the explicit acknowledgement by the Inkomati CMA (ICMA) of the obligations to meet the requirements of the Reserve (both the basic human needs and ecological components). Further, many of the municipalities had never heard of the Reserve and whilst some sectors were able to describe the Reserve broadly, understanding why it had been included in policy was rudimentary so that it is seen solely as a legal obligation rather than for its broader intent of benefiting society at large. Furthermore,

- in many instances the Reserve is seen to be impeding development and overwhelmingly regarded as benefiting others (mainly the Kruger National Park), such that almost all stakeholders perceive that the benefits of the Reserve accrue to others whilst they carry all the risks.
- Managers expressed frustration in interpreting and hence putting into operation the outputs from a Reserve determination study. In some cases such as the Letaba this has led to defaulting to a single-value flow requirement.

- The concept of sustainability so as to ensure water for people and inter-generational rights was rarely understood as a guiding principle.
- Evidence of practices where sustainability is at the forefront of planning was rare.

All of these factors pose serious constraints to fulfilling the spirit of the transformation to sustainability and equity of water resources through stakeholder participation.

Whilst the "oppositionalisation" of the Reserve against economic viability is worrying, this is not unique to South Africa (see Ison, 2004). By assigning benefits to others (such as the Park), responsibilities can also be assigned elsewhere. Efforts to make the Reserve a collective benefit and responsibility are therefore essential. Without multiple stakeholder platforms at which the *status quo* of the catchment is discussed, together with a sustained programme – not once-off awareness raising campaigns – this is unlikely. Seeking to elucidate collective benefits at a catchment scale in a way that holds meaning for participants will be an important step.

The overarching recommendation is for the development of a collective understanding of water resources protection measures at the catchment level. More specifically, the following recommendations are also made:

i. For sustainability to be embedded in the practices of IWRM, stakeholders must be familiar with the concept, its associated tools and its relevance for water resources management. However, future efforts need to move beyond simplistic awareness-raising campaigns' which are a naïve response to the needs emerging around the implementation of the Reserve. The 'raising' of awareness might familiarise stakeholders with the term but do little to support the development of skills and practices that ultimately lead to *behaviour change*. Globally, social learning approaches (see Ison 2004; Wals 2007; Muro and Jeffrey 2008) are seen as important for developing a collective understanding and reducing resource related conflicts.

ii. In the Luvuvhu, the need to facilitate discussion around sustainability and the nature of the Reserve warrants serious consideration. The appointment of a lead agent capable of this facilitation is essential.

iii. In the Limpopo WMA, the fact that the regional office has a poor understanding of the Reserve, regarding it as a constraint to licencing and the sole responsibility of the national office is problematic and requires urgent attention. A well-developed and sustained programme with the regional office and with the proto-CMA by the RDM directorate, which clearly outlines catchment-based responsibilities, is required. Lessons from the Inkomati CMA can be shared vis-à-vis operationalisation.

iv. It is important to seek the *requisite simplicity* (*sensu* Holling 2001) and consider the practicalities of operationalising the Reserve. Supporting the Reserve through to implementation, means being aware of the difficulties of using sophisticated outputs in practice (see Pollard et al. (2010)). Equally, classification has the potential to become a complicated and fractured process, particularly given the limits that it places on development in a catchment. Such complication does little to garner support; rather it creates opposition and antipathy and people often revert to easier, better-known options (see Pollard and Du Toit, 2009a).

Further research

In terms of research this requires

- exploring innovative ways to understand the Reserve with stakeholders;
- addressing the transboundary (international) nature of environmental Water Requirements;
- understanding the role of collective action and multiple stakeholder platforms in building knowledge and transforming practice.

10.2.4 The importance of leadership and governance for transformation and sustained action

Key findings:

Leadership is key in transformation and yet this is extremely weak or weak in most cases (see also feedbacks, below). There are exceptions to this at localized scales such as in the Groot Letaba and Crocodile. However in the latter case the potential scope of leadership in the Inkomati CMA is severely constrained by the lack of assigned functions. In the case of the Olifants, we suggest that many of the problems being experienced can ultimately be traced to the almost total lack of leadership. Despite localized efforts and research endeavours[38], meaningful change is not possible under the current governance arrangements since there is no single individual tasked with the sole responsibility for transformation in the catchment. This is equally true in the Middle/ Klein Letaba, Sand Rivers.

Also in terms of leadership, ensuring integration (see above) requires support from leadership in other sectors. This is currently very weak.

Given this the overarching recommendation is that *support be given to developing and strengthening leadership as the basis for change.* More specific recommendations are as follows.

i. There is an urgent need to institute *strong leadership and appropriate and effective governance in the Olifants, the Middle/ Klein Letaba, Sand and the Luvuvhu rivers.*

ii. In many of these cases a strong and functional Catchment Management Agency would provide leadership and strategic direction. In the case of the Olifants, this may require fast-tracking the establishment of the Olifants CMA and an integrated plan for the catchment as a whole.

iii. In the case of the Inkomati, the assignment of functions is a priority.

iv. Support must be given to strengthen leadership and action in certain catchments such as the Middle/ Klein Letaba. The confused roles and responsibilities need to be clarified.

[38] For example, the recommendations from the water quality study in the upper Olifants Catchment are unlikely to be acted on in the absence of dedicated leadership within the Department of Water Affairs to take action

v. Given the need for co-operative governance, securing support from key leadership positions in various institutions is essential, namely SALGA, provincial governments, DAFF, DPLG as well as DWA itself. Facilitating such interaction and support must be addressed in Phase II. The WRC has a critical, high-level role to play through the facilitation of high-level discussions in this regard.

Further research is dealt with under feedbacks, below.

10.2.5 Participatory and representative platforms for collective action and learning

Key findings:

Transformation towards a shared, catchment-based vision can only be achieved through a collective understanding and approach (common language and discourse). A number of different platforms do exist throughout the WMAs although less prevalent in the certain catchments like the Middle/ Klein Letaba, Luvuvhu and Sand River catchments. Some of these enjoy the support of multiple sectors (e.g. Crocodile and Olifants River Forums[39]). In many cases however localized platforms often reflect single-sector interests, or focus on specific sections of the river such as in the case of the WUAs or Irrigation Boards. The latter still tend to represent only commercial agriculture.

Networking, negotiation and collaborative planning are elements remarkably well-catered for in the NWA (through CMAs, CMFs, CMCs and WUAs (Chapter 5). Nonetheless, in general collective action towards IWRM is weak and requires attention since as noted above, transformation is unlikely without a common vision and stakeholder participation. Furthermore, integral to collective action is the assumption that diverse stakeholder groups perceive the **same** management problem. Our research suggests that this is not the case and we have documented examples where different sectors within the same WMA see very different priorities for managing the shared water resource. The existing platforms are bedevilled by a sense of **inaction** and criticisms are levelled that nothing ever happens. Thus stakeholder platforms are not the answer on their own; participants need a focus around which they act.

Given the discussions on the importance of collective action as well as leadership, networks and feedbacks (see below), the overall recommendation is that *support be given to strengthen collective action for adaptive capacity for IWRM using existing multiple stakeholder platforms and focusing on action. More specifically the following recommendations pertain:*

i. The first step towards creating the environment for democratic governance and participation in IWRM is to encourage people with contrasting views to work together by supporting the development of a shared understanding that will lead to a future-focused, collective approach rather than polarized protection of vested interests. This has started with the Inkomati CMS.

[39] The Olifants-Luvuvhu-Letaba- Inkomati Forum (OLLI) is an ambitious attempt to bring together multiple stakeholders across the lowveld with a key focus on water stress

ii. The current multiple stakeholder platforms (MSPs) should be used and strengthened and action should be the focus.

iii. A number of opportunities exist for action in relation to visioning, water allocation and resource classification, particularly through the development the Catchment Management Strategies and the development of sectoral plans (e.g. WSDP).

iv. However, as Muro and Jeffrey (2008) note, one needs to be realistic about MSP processes and not assume that such platforms all function in the same way or that they are a blueprint for success. Time taken to explain new structures and their intended functions is essential for transformation.

v. A key ingredient of transformation is 'learning' – learning that confronts the diverse understandings and meanings of the different sectors. To this end theorists have proposed the idea of social learning (Ison et al., 2004; Wals, 2007) and this needs to be explored in future work.

Further research

The main research focus is on deepening understanding of learning as a key ingredient of transformation (learning that confronts the diverse understandings and meanings of the different sectors). Other research areas include:

- Documenting through action-research the progress towards a shared vision and collective action.
- Understanding the central role of functional feedbacks is an essential part of the collective dialogue (see below).

10.2.6 Support for self-organisation and robust multi-scale feedbacks in integrated, adaptive action and management

Key findings:

Functional, responsive multi-scale feedbacks are essential for management in complex systems like catchments since they provide the basis for learning, reflection and response to an ever evolving context. However, the existence of these is variable from non-existent to emergent. The types of feedbacks we are seeking to grow and support are emerging in certain cases such as the Groot Letaba, Crocodile and Komati Rivers although even these need to be strengthened and linked into wider systems (see Sections 6.8 and 8.8 and Figure 6.5). In both cases, leadership (see above) and the ability to self-organise appear to be central. In other cases such as the Olifants, Middle/Klein Letaba and the Sand Rivers leadership and the ability to self-organise is weak or almost non-existent (see Figure 9.2 (Klein Letaba) and Box 9.2 (Sand)). Yet again in other cases such as the Sabie River, despite good efforts to self-organise (around water quality), the feedbacks are limited to a scale which cannot bring about change and leadership at a wider scale is weak. This is illustrated in the figure below.

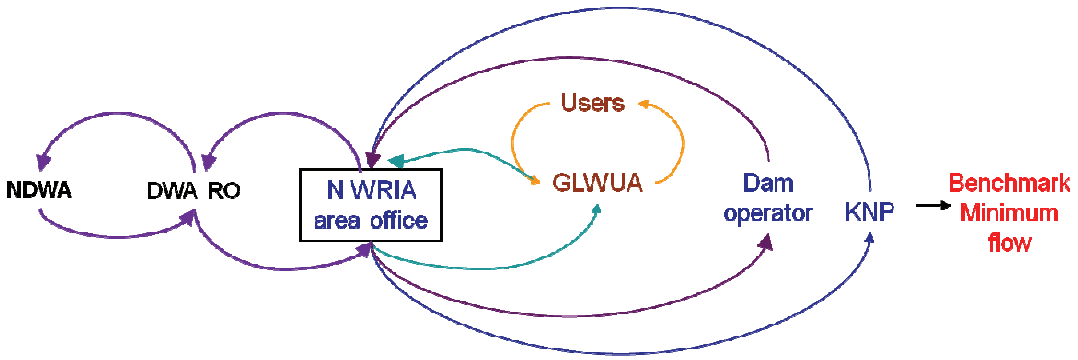

Figure 10.3: Schematic of an envisaged future state of IWRM showing functional multi-scale, feedback loops using the Letaba Catchment as an example.
NWRIA = National Water Resources Infrastructure Agency, KNP = Kruger National Park, GLWUA = Groot Letaba Water User Association

Given this the overarching recommendation is that *support be given to developing and strengthening leadership and coherent, robust and functional feedbacks that provide the basis for action and learning.* More specific recommendations are as follows.

i. In many of these cases a strong and functional plan for the catchment as a whole (i.e. a CMS), together with dedicated leadership would provide strategic direction so that feedbacks at a more localised scale are supported through linkages at a wider scale (Figure 10.3). In some cases such as the Olifants urgent attention is required.

ii. Building on the work presented herein, current feedback systems that are part of WRM should be examined for their functionality and effectiveness and a programme developed to support improvements. Moreover, where feedbacks are working, these can be used as learning for other systems that are developing.

iii. Monitoring and regulation are central aspects of successful feedback loops. These must be developed and strengthened. Examples exist in all catchments that can be built on such as the monitoring and regulation undertaken by WUAs and irrigation boards and in certain industrial enterprises. At a broader scale, the Inkomati CMA is developing a monitoring system linked to decision-making that also offers useful lessons.

iv. If we accept that learning has a vital role to play in ensuring that feedback loops have an impact on self-regulation and self-organization then it becomes a critical process in the support of establishing resilient, sustainable systems (see earlier).

v. The delegation to appropriately-skilled and resourced groups can be considered in support of feedback loops.

Further research

Research will greater enhance this process as follows:

- A scholarly body of work based on initial findings in this work can be undertaken to examine and support the development of functional feedbacks and the role of leadership. It should seek to collaborate with practitioners (action-research) as this would prove invaluable as the basis for building adaptive capacity.
- Research and development of tenable, practical monitoring tools and indicators. Again this should be based on learning from what is currently working.
- Tracking how learning is taking place through various stakeholder platforms such as the Inkomati CMA – especially at the collective level with stakeholders – will offers useful lessons.

10.2.7 The importance of having a lawful and regulated system

The Reserve cannot be achieved without a compliant or lawful catchment-based system. This means that not only is water use authorized and regulated within the context of water resources availability and licence conditions but that the cumulative impacts of use are monitored against the Reserve requirements at a systems level. It is therefore imperative that

1. adequate skills and resources are available for compliance monitoring and enforcement (CME) and;
2. all major stakeholders are drawn into the responsibilities for monitoring, reporting and rectification of transgressions. In this regard, self regulation is an essential building block of feedbacks and regulation.

Key findings:

There are cases of unlawful use and administrate lags that hinder CME[40i]. All of the sub-catchments are bedevilled by major issues with regard to municipalities whose expansion and lack of effluent control is problematic. The upper Komati and Crocodile CMA and the Olifants are experiencing major problems with the expansion on mining- much of it unauthorized (see Chapters 7 and 8).

Whilst cases of unlawful use are evident, equally concerning is the dearth of legal and regulatory skills and support. That the "regulator cannot regulate" was raised in every catchment of the lowveld – even by the regulator themselves who noted the lack of legal back-up, fear of antagonism and insufficient experience (see Chapter 9). The fragmented or inadequate legal back-up to regions by the national legal division at DWA is a growing problem. Other pertinent issues included:

1. The incomplete registration database (WARMS) hampering CME.
2. Unclear roles and responsibilities regarding CME between DWA national and regional offices, and the CMA.
3. The lack of monitoring systems (including technical hardware such as meters) for unlicensed use or for conditions for use was raised on a number of occasions.
4. Many noted the almost total vacuum with respect to legal support many staff described themselves as having a "lack of teeth".

[40] One of the first steps necessary for a 'compliant IWRM system' is that of *validation and verification* without which a whole range of steps cannot proceed.

5. The lack of incentives to comply with legislative requirements, particularly in the case of local government. Currently the regulator has limitations for legal recourse as it is working with another government structure (Intergovernmental Relations Framework Act (RSA, 2005) although this appears to be changing.
6. Tardy procedures related to the licencing approval process mean users go ahead with water use unlawfully out of frustration.
7. DWA officials contested that they "could not take decisions" and that business plans took a long time to be approved by National DWA.

Overall, monitoring and regulation is inadequate and lacks coherency. In all the catchment with weak feedbacks mentioned in the previous section, regulation competency requires urgent attention.

The overarching recommendation is that *monitoring and enforcement must be strengthened as a matter of urgency and legal support given to the development of legal literacy amongst key role-players and in the water sector.* Further specific focus areas emerging from the research are as follows.

i. The Reserve, as part of the 'sustainability apparatus', is accorded considerable status in law but despite its well-developed conceptual grounding, implementation is in its legal infancy in South Africa. To improve this we must build legal literacy through (a) research-based approaches, (b) attracting and retaining people into the field and (c) support for the uptake of a diverse and complex legal discourse and practices into the water sector.

ii. Given that some staff working for the regulator described themselves as having a "lack of teeth", a more focused and structured effort that supports the newly-established CME directorate is required on the part of DWA. Attention to adequate legal back-up for the regions is critical.

iii. An essential component of any adaptive process is an active, viable and functional set of monitoring system. Monitoring – be it to track goals, the status of the resource or compliance – in a complex environment such as WRM must be part of an integrated, collaborative planning process. Currently monitoring is exceptionally weak and requires urgent attention.

iv. Where regulation is problematic, responsibilities may be delegated to water management institutions such as Water User Associations and Water Service Providers. DWA should continue to provide an enabling environment for self-regulation. The water bailiff system managed by the GLWUA provides a good example of how self-regulatory systems can be developed and implemented.

v. A major issue for addressing unlawful use in all catchments requires concerted focus on municipalities. The need to address the disparities of the past of woefully inadequate access to water for the majority has meant that the water services sector sees this objective as foremost. Whilst this is in keeping with national policy it is the uncoordinated manner in which it is being undertaken that is problematic. Where local government is involved in a transgression, co-operative governance is essential (see leadership discussion).

vi. Incentives for compliance should be explored. Some large users claimed that there was little incentive to comply leading some users to "continue with unlawful use until they are caught".

vii. The conflict of legal intent warrants serious investigation. Questions relating to the practices and procedure associated with the use of the DFA by the Mpumalanga Development Tribunal to "suspend" the regulatory requirements and procedures set out under NEMA and the NWA. Likewise mining rights are being issued without regard to water use licences of NEMA requirements.

viii. The establishment of collaborative relationships with law faculties to develop research expertise and enhance experience in WRM amongst new lawyers entering the market is needed.

Further research

There is a wide scope for research to support the development of legal literacy and competency:

- A review of legal support apparatus within the Department (DWA) is necessary.
- Legal research will provide the foundation for identifying and analyzing problems around compliance and enforcement (Humby, 2010), and pave the way for analyzing case studies and building regulatory competence. This should build understanding of:
  - case studies where laws designed to protect water resources and other aspects of the environment have failed;
  - factors that constrain and/or enable the ability of regulators to monitor compliance and enforcement against law related to water resource protection through a series of structured interviews and subsequent analysis;
  - factors that constrain and/or enable the ability of regulators to timely authorize water use through a series of structured interviews and subsequent analysis
- Develop a series of legal case studies to identify and address unlawful uses that are causing significant impacts to the sustainability of the water resource.

10.2.8 Lags in the implementation of the Reserve and emergence of sustainability discourse

As with any transformative policy, it will take and has taken time to implement the new water management system, which requires the implementation of new institutions, broad based participation, and complex regulatory tools (Pollard and du Toit, 2008). Lags are thus a natural consequence of changes in policy, law and the administrative procedure. The best-intentioned policies are meaningless, however, if the time it takes to "implement" them is too long. The key, therefore, is to unpack the issue of lags and subject it to a test of reasonability. Programs and areas of WRM that can be subjected to scrutiny include: plans and strategies, classification, authorization and licensing, verification, Reserve, resource quality objectives, pollution control, institution establishment (such as CMA), monitoring, and enforcement.

Findings:

Meeting the Reserve is subject to progressive implementation and in some cases steps are being put in place. Clear indicators are evident in the Groot Letaba and Crocodile rivers for example, but acute delays or inaction in the case of other rivers such as the Luvuvhu, Olifants and Sand point to excessively long and unacceptable lags. This is a new are of research in South Africa with the WRC

funding an initial exploration of 'lags'. This project should provide useful insights into the issue of lags and how to deal with unreasonable delays.

The recommended strategic action in respect of this theme is contingent on what the outcomes of a research consultancy currently underway but is likely to entail a focus on clear benchmarks and indicators for lags.

10.3 Concluding remarks

South Africa has embarked on a transformatory water reform process which aims – through IWRM and stakeholder participation – to give effect to the NWA commitments to sustainability and equity. In this work we have focused principally on progress towards sustainability through the progressive realisation of the Ecological Reserve. As is to be expected with policy changes and the entrained transformation of organisational practices to meet these principles, progress is highly variable. Some aspects are moving ahead whilst others are only doing so slowly. Such a major change process cannot happen unsupported however, and part of the role of this work has been to ask where can change be supported effectively?

Part of this process means stepping back and asking: where do we want to be? Essentially the legislation provides answers to this question since it establishes certain imperatives, namely that priority be given to sustainability and equity. These priorities set the agenda for all planning and action with stakeholders – be this within, or between government agencies and water users. This requires us to think beyond the conceptual and into the realm of governance, management and practice. It also means doing things differently, so that authorising water use or setting monitoring priorities, for example, is now done against the imperatives of sustainability and equity. Nonetheless ***securing the Reserve in reality relies on the collective contribution and synergies of a number of strategies, plans and practices*** (as envisaged in the NWA and NWRS) that make up IWRM (see figure 10.2). Thus we need to be thinking into support for the wider milieu of IWRM if we are to work towards sustainability (and achieving the Reserve amongst other things).

Cases where system resilience is strengthening – especially through collective action – can offer lessons and frameworks for weaker situations. If a people-centred approach that is guided by sustainability is to be sought, then we also need to find new ways of understanding, collaboratively, the benefits associated with water resources protection measures (such as the Reserve and classification). Such thinking needs to extend across boundaries – be they upstream-downstream, sectoral or international. This is because we need to find ways of sharing our scarce freshwater resources collectively. Since catchments are complex physical and socio-economic environments, they are not always predictable. This means building the resilience of the system to adapt to change in a complex and not-always-predictable environment, so that it is responsive, has strong feedbacks and is able to incorporate new learnings. This requires strong leadership and appropriate and tenable governance systems. In many ways IWRM is predicated on collective action but importantly, collective action that is reflexive and adaptable so as to incorporate learning (copes and responds). This research points towards a situation where, if appropriately handled, catchments can become units for sustainable water resource management that are both robust and responsive.

LIST OF REFERENCES

AGTERKAMP JW (2009) Allocating contested water: A case study on the (non-) compliance with Environmental Water Allocations in the Sand sub-catchment, South Africa. Wageningen University, Wageningen, M.Sc.

ALCHIAN AA and DEMSETZ H (1973) The Property Right Paradigm. The Journal of Economic History. The Tasks of Economic History 33 (1) 16-27.

ALLISON HE and HOBBS RJ (2004) Resilience, Adaptive capacity, and the "Lock -in Trap" of the Western Australian Agricultural Region. Ecology and Society 9 (1) 3.

ANDERIES JM, WALKER BH and KINZIG. AP (2006) Fifteen weddings and a funeral: case studies and resilience-based management. . Ecology and Society 11(1):21. [online] URL: http://www.ecologyandsociety.org/vol11/iss1/art21/.

APPLE MW (2007) Ideological Success, Educational Failure? On the Politics of No Child Left Behind. Journal of Teacher Education 58 (2) 108-116.

ARGYRIS C and SCHÖN D (1978) Organizational Learning: A Theory of Action Perspective. Jossey-Bass, San Francisco.

BAKER T (2007) Groot Letaba River Water Development Project (GLeWaP). EIA (Tzaneen Dam). Exec summary only.

BAMMER G (2005) Integration and Implementation Sciences: Building a New Specialization. Ecology and Society 10 (2) 6.

BERKES F, COLDING J and FOLKE C (2003) Navigating Social-Ecological Systems. Cambridge University Press,

BIGGS H and TOIT DR (2008) Preliminary exploration of two approaches to documenting elements of the mental models of stakeholders in the Crocodile Catchment. Water Research Commission Pretoria.

BIGGS HC and ROGERS KH (2003) The Kruger National Park: Experiences of savannah heterogeneity. In: Toit JTD, Rogers KH and Biggs HC (eds), The Kruger National Park: Experiences of savannah heterogeneity, P. 59-80., Elsevier press,

BROWN CA, BERG EVD, SPARKS A and MAGOBA RN (2010) Options for meeting the ecological Reserve for a raised Clanwilliam Dam. Water SA 36 (4 July 2010)

BRUNER J (1983) In search of mind: essays in autobiography. Harvard University Press., Cambridge, MA.

BURNS M, AUDOUIN M and WEAVER A (2006) Advancing sustainability science in South Africa. South African Journal of Science 102 p379-384.

CAPRA F (1996) The Web of Life: A new synthesis of mind and matter. Harper Collins, London.

CAPRA F (2007) Social learning towards a sustainable world. In: Wals AEJ (ed) Social learning towards a sustainable world, Wageningen Academic Publishers. Netherlands,

City of Johannesburg Metropolitan Municipality vs. Gauteng Development Tribunal and Others, [2010] ZACC 11 (CC). See Chapters V and VI of the Development Facilitation Act 67 of 1995.

CILLIERS P (1998) Complexity and postmodernism: Understanding complex system. Routledge, London, New York.

COOPERRIDER D & DUTTON J (2001) No Limits to Cooperation. Cleveland, OH Weatherhead School of Management

CONSTANZA R, R. D'ARGE, R. DE GROOT, S. FARBERK, M. GRASSO, B. HANNON, K. LIMBURG, S. NAEEM, R.V. O'NEILL, J. PARUELO, R.G. RASKIN, P. SUTTONKK and BELT. MVD (1997) The value of the world's ecosystem services and natural capital. . NATURE 387 253-260.

DEWEY J (1933) Heath. In: Heath., Boston: D. C.

DICK B (2000) Grounded theory revisited. Occasional pieces in action research methodology. http://www.scu.edu.au/schools/gcm/ar/arm/op027.html (03/09/2006).

DLAMINI VG and COUSINS T (2009) Case Study on Bushbuckridge Water Service Delivery Challenges in The Context of Integrated Water Resource Management (IWRM) and Sustainable Water and Sanitation Services (WATSAN): Turning Advocacy into Action in the South African Water Sector. Association for water and Rural Development (AWARD).

DOLL WE, JR. (1993) A Post-Modern Perspective on Curriculum. Teachers College Press, New York.

DU TOIT D (2005) Preparing people for integrated catchment management: A proposed learning alliance for the implementation of a new legal framework for water management in South Africa. 'Reflexive learning in context'. Association for Water and Rural Development (AWARD).

DWAF (1994) Report on the proposed Sabie river Government Water Scheme (First Phase: Injaka Dam and Bosbokrand transfer pipeline). White Paper WP D-94. DWAF, Pretoria.

DWAF (1996) Sabie Sand Instream Flow Requirements. Starter document Aan de Vliet. 18-22 August 1996. . Department of Water Affairs and Forestry.

DWAF (1997) White paper on a National Water Policy for South Africa. Department of Water Affairs and Forestry. 37.

DWAF (2003a) Development of internal strategic perspective Inkomati water management area (WMA 5). Department of Water Affairs and Forestry.

DWAF (2003b) Luvuvhu and Letaba Water Management Area Overview of Water Resources Availability and Utilisation. Prepared by BKS on behalf of the
Directorate: National Water Resources Planning. DWAF Report No. PWMA02/000/0203.

DWAF (2003c) Volume 1: Water conservation and water demand management – a planning framework for Catchment Management Agencies. DRAFT. Department of Water Affairs and Forestry.

DWAF (2003d) Water Management Institutions: Overview, Department of Water Affairs and Forestry (DWAF), Pretoria.

DWAF (2004a) Guidelines for Stakeholder Participation in Integrated Water Resources Management in Water Management Areas. Integrated Water Resource Management Strategies, Guidelines and Pilot Implementation in Three Water Management Areas, South Africa.

DWAF (2004b) Internal Strategic Perspective. Inkomati WMA. Department of Water Affairs and Forestry.

DWAF (2004c) Internal strategic perspective. Luvuvhu / Letaba WMA. Department of Water Affairs and Forestry.

DWAF (2004d) Internal Strategic Perspective. Olifants River WMA. Department of Water Affairs and Forestry.

DWAF (2004e) National Water Resources Strategy. First Edition. Department of Water Affairs and Forestry.

DWAF (2004f) The Olifants WMA – Overview of Water Resources Availability and Utilisation. (P WMA04/000/00/0203). Department of Water Affairs and Forestry.

DWAF (2007a) Guidelines for the development of Catchment Management Strategies. . Department of Water Affairs and Forestry (DWAF), The Association for Water and Rural Development (AWARD), Zinkwazi Consulting, Water for Africa. 135.

DWAF (2007b) Guidelines for the Development of Catchment Management Strategies: Towards equity, efficiency and sustainability in water resources management. Department of Water Affairs and Forestry.

DWAF (2009) Assessment of Water Availability in the Inkomati Water Management Area by Means of Water Resource Related Models. (Project Number W8147/02). DWAF

DWAF (2010) Blue Drop Report. South African Drinking Water Quality Management Performance.

EASTERBY-SMITH M and ARAUJO L (1999) Organizational Learning and the Learning Organization: Developments in Theory and Practice. In: Easterby-Smith M, Araujo L and Burgoyne J (eds), Organizational Learning and the Learning Organization: Developments in Theory and Practice, 1-22, Sage Publications, London.

ENGESTROM Y (1999) Activity theory and individual and social transformation. IN: Engestrom, Y, R. Miettinen & R. Punamaki (eds) (1999). Perspectives on activity theory: Cambridge University press

FAO (2004) Drought impact mitigation and prevention in the Limpopo River Basin: A situation analysis. Land and Water Discussion Paper 4. FAO.

FOLKE C (2003) Freshwater for resilience: a shift in thinking. Phil. Trans. R. Soc. London 358 2027-2036.

FOLKE C, BERKES F and COLDING J (1998) Pages 414-436 in . Linking social and ecological systems. In: Berkes F and Folke C (eds), Pages 414-436 in . Linking social and ecological systems, 414-436, Cambridge University Press, London, UK.

FOLKE C, CARPENTER S, ELMQVIST T, GUNDERSON L, HOLLING CS, WALKER B, BENGTSSON J, BERKES F, COLDING J, DANELL K, FALKENMARK M, GORDON L, KASPERSON R, KAUTSKY N, KINZIG A, LEVIN S, MÄLER K-G, F.MOBERG, OHLSSON L, OLSSON P, OSTROM E, REID W, ROCKSTRÖM J, SAVENIJE H and SVEDIN U (2002) Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations. Scientific Background Paper on Resilience for the process of The World Summit on Sustainable Development on behalf of The Environmental Advisory Council to the Swedish Government.

FORRESTER JW (1992) System Dynamics and Learner-Centred-Learning in Kindergarten Through 12th Grade Education. . Massachusetts Institute of Technology. [Online] URL: ftp://sysdyn.mit.edu/ftp/sdep/Roadmaps/RM1/D–4337.pdf.

GLASER B G (1978) Theoretical Sensitivity: Advances in the methodology of Grounded Theory. Sociology Press

GLASER, B G & STRAUSS, ANSELM L, (1967) The Discovery of Grounded Theory: Strategies for Qualitative Research, Chicago, Aldine Publishing Company

GORGENS A, PEGRAM G, UYS M, GROBICKI A, LOOTS L, TANNER A and BENGU R (1998) Guidelines for Catchment Management to Achieve Integrated Water Resources Management in South Africa. (KV 108/98). Water Research Commission (WRC).

GRAY B (1985) Conditions Facilitating Interorganizational Collaboration Human Relations 38 911-936.

GUNDERSON L (2001) Holling CS (ed) Washington DC.

GUNDERSON LH and HOLLING CS (eds) (2002) Panarchy: Understanding transformations in human and natural systems, Island Press, Washington DC.

GWP (2003) Dialogue on Effective Water Governance: Learning from the Dialogues. 3rd World Water Forum, Kyoto, Japan 36.

HABERMAS J (1971) Knowledge and Human Interests. Beacon Press, Boston.

HABERMAS J (1981) Modernity versus postmodernity. New German Critique 22 (Winter)

HAIG BD (1995) Grounded theory as scientific method. Philosophy in Education. http://www.ed.uiuc.edu/eps/pes-yearbook/95docs/haig/html (04/04/2006).

HALES NK (1990) The cosmic web. Ithaca. Cornell University Press

HEROLD CE and GORGENS A (1991) Vaal Dam salinity assessment with particular reference to atmospheric deposition. Department of Water Affairs, Hydrology Research Institute.

HOLLAND JH (1992) Adaptation in natural and artificial systems: An introductory analysis with applications to biology, control, and artificial intelligence. MIT Press.

HOLLING CS (2001) Understanding the complexity of economic, ecological and social systems. Ecosystems 4 390-405.

HUMBY T (2010) Out of balance – Defects of design and implementation. Centre for Applied Legal Studies, University of Witswatersrand Faculty of Law.

ICMA (2010) Learning Strategy Framework for the Inkomati Catchment Management Agency.

ISON R, STEYAERT P, ROGGERO PP, B. HUBERT B and JIGGINS J (2004) Social Learning for the Integrated Management and Sustainable Use of Water at Catchment Scale. Final Report, SLIM August 2004 (accessed at http://slim.open.ac.uk).

JENTOFT S, MCCAY BJ and WILSON DC (1998) Social theory and fisheries co-management. Marine Policy 22 (4) 423-436.

JESSOP B (2003) The governance of complexity and the complexity of governance: Preliminary remarks on some problems and limits of economic guidance. Department of Sociology, Lancaster University.

KING J and BROWN C (2006) Environmental Flows: Striking the Balance between Development and Resource Protection. Ecology and Society 11(2): 26. [online] URL: http://www.ecologyandsociety.org/vol11/iss2/art26/

KOLB DA (1984) Experiential learning: experience as the source of learning and development. Prentice Hall, Englewood Cliffs, NJ: Prentice Hall.

KOTTER JP (1996) Leading change. Harvard Business School Press, Boston.

LAVE J and WENGER E (1991) Situated Learning. Legitimate peripheral participation. Cambridge: University of Cambridge Press,

LEVIN SA (1999) Fragile dominion: Complexity and the commons. Massachusetts Helix Books, Cambridge.

LUBCHENCO J (1998) Entering the century of the environment: A new social contract for science. Science 279 491-497.

MCDOUGALL C & BRAUN A (2003) Navigating Complexity, Diversity and Dynamism: Reflections on Research for Natural Resource Management. *In:* Pound, B., S. Snapp, C. McDougall and A. Braun (eds). Managing Natural Resources for Sustainable Livelihoods: Uniting Science and Participation. Earthscan Publications, London

MCKAY H (1996) The philosophy and practice of Integrated Catchment Management: Implications for Water Resource Management in South Africa. Discussion Document. Water Law Review Process. WRC Report No TT 81/96. Department of Water Affairs and Forestry (DWAF), Water Research Commission. 140.

MEINZEN-DICK R and NKONYA L (2005) Understanding legal pluralism in water rights: lessons from Africa and Asia. International workshop on 'African water laws: Plural legislative frameworks for rural water management in Africa', Johannesburg, South Africa.

MEINZEN-DICK R and PRADHAN R (2002) Legal Pluralism and Dynamic Property Rights. CAPRI Working Paper 22. CGIAR System-Wide Program on Collective Action and Property Rights, IFPRI, Washington, DC. www.capri.cgiar.org/pdf/capriwp22.pdf.

MOON J (1999) Reflection in learning & professional development: Theory and Practice. Kogan Page London.

MUNRO B (1995) Water for Sustainable Development in Africa. Discussion paper (Expert Group Meeting on the Implications of Agenda 21 for Integrated Water management in Africa). 28.

MURO M and JEFFREY P (2008) A critical review of the theory and application of social learning in participatory natural resource management processes. Journal of Environmental Planning and Management 51 (3) 325-344.

MURPHREE MW (2004) Communal approaches to natural resource management in Africa: From whence to where? (Keynote Address). Breslauer Symposium on Natural Resource Issues in Africa, Center for African Studies, University of California, Berkeley.

OSTROM E (2000) Private and common property rights. Workshop in Political Theory and Policy Analysis, and Center for the Study of Institutions, Population, and Environmental Change, Indiana University. http://encyclo.findlaw.com/2000book.pdf. 332-352.

PEJAN R (2004) The right to water: The road to justiciability. The George Washington international law review 36 (5) 1181-1210.

PEJAN R, NORBERG A, TOIT DD and POLLARD S (2007) The development of a framework for understanding human rights-based approaches and integrating them into water resources management in South Africa. Water Research Commission (WRC). 119.

PENNING DE VRIES FWT, ACQUAY H, MOLDEN D, SCHERR SJ, VALENTIN C and COFIE O (2002) Integrated Land and Water Management for Food and Environmental Security. Comprehensive Assessment Research Paper 1. Comprehensive Assessment Secretariat, Global Environment Facility, International Water Management Institute (IWMI). 70.

POLLARD S and AGTERKAMP JW (in prep-a) Constraints to meeting the Reserve in the Sand River Catchment.

POLLARD S and AGTERKAMP JW (in prep-b) Managing in complex systems: Understanding the multiple drivers and their interactions that underlie sustainable and equitable water resources in the Sand River Catchment.

POLLARD S and DU TOIT D (2006) Recognizing heterogeneity and variability as key characteristics of savannah systems: The use of Strategic Adaptive Management as an approach to river management within the Kruger National Park, South Africa. Report for UNEP/GEF Project No. GF/2713-03-4679, Ecosystems, Protected Areas and People Project.

POLLARD S and DU TOIT D (2009a) Drawing Environmental Water Allocations into the World of Realpolitik: Emerging Experiences on Achieving Compliance with Policy in the Lowveld Rivers, South Africa. Implementing Environmental Flow Allocations, Port Elizabeth, South Africa.

POLLARD S and DU TOIT D (in prep) The importance of feedback loops in ensuring catchment resilience: An examination of six catchments in South Africa

POLLARD SR, BIGGS H and DU TOIT D (2008) Towards a Socio-Ecological Systems View of the Sand River Catchment, South Africa: An exploratory Resilience Analysis. . Report to the Water Research Commission. Project K8/591. Pretoria.

POLLARD SR and COUSINS T (2008) Towards integrating community-based governance of water resources with the statutory frameworks for Integrated Water Resources Management:: A review of community–based governance of freshwater resources in four southern African countries to inform governance arrangements of communal wetlands. WRC Report TT.328/08. Water Research Commission. WRC Report TT.328/08. 105.

POLLARD SR and DU TOIT D (2004) The Save the Sand Project: a case study. Both Ends.

POLLARD SR and DU TOIT D (2005) Achieving Integrated Water Resource Management: the mismatch in boundaries between water resources management and water supply. African Water Laws: Plural Legislative Frameworks for Rural Water Management in Africa, Johannesburg, South Africa.

POLLARD SR and DU TOIT D (2008) Integrated Water Resources Management in complex systems: How the catchment management strategies seek to achieve sustainability and equity in water resources in South Africa. Water SA Special Edition IWRM 34 (6) Available on website http://www.wrc.org.za.

POLLARD SR and DU TOIT D (2009b) Drawing Environmental Water Allocations into the World of Realpolitik: Emerging Experiences on Achieving Compliance with Policy in the Lowveld Rivers, South Africa. Implementing Environmental Flow Allocations, Port Elizabeth, South Africa.

POLLARD SR and DU TOIT D (2009c) The Sabie-Sand Catchment: Contextual profile on factors that constrain or enable compliance with environmental flows. Shared River Programme. DRAFT Report. Project K5/1711.

POLLARD SR, MALLORY S, RIDDELL E and SAWUNYAMA T (2010) Compliance with the Reserve: How do the Lowveld Rivers measure up? Towards improving the assessment and implementation of the ecological Reserve. (K8/881/2). Report prepared for the WRC: Reserve assessment of lowveld rivers (Del. 1). Unpubl.

PROOST J and LEEUWIS C (2007) Learning alliances: scaling up innovations in water sanitation and hygiene. In: Learning alliances: scaling up innovations in water sanitation and hygiene, IRC, Delft, The Netherlands.

RSA (1995) The Development Facilitation Act, Act 67 of 1995. Cape Town.

RSA (1996) Constitution of the Republic of South Africa Act, Act 108 of 1996. Cape Town.

RSA (1997) Water Service Act. Act No. 108 of 1997. 69, Republic of South Africa, Cape Town.

RSA (1998) National Water Act, Act 36 of 1998. Republic of South Africa, Cape Town.

RSA (2000) Local government: Municipal Systems Act. Act No. 32 of 2000. Cape Town.

RSA (2005) Intergovernmental Relations Framework Act 2005.

SCHLAGER E & OSTROM E (1992) Property-Rights Regimes and Natural Resources: A Conceptual Analysis Land Economics, Vol. 68, No. 3. pp. 249-262

SCHÖN D (1987) Educating the Reflective Practitioner. Jossey-Bass, San Francisco.

SCHÖN D (1983) The Reflective Practitioner: How Professionals Think in Action (Arena). Basic Books, Inc,

SELLICK C and BONTHUYS B (2003) Sabie River Catchment: Operating Rules and Decision Support Models for Management of the Surface Water Resources. User Manual: Daily Ecological Reserve Estimate Model. Department of Water Affairs and Forestry, National Water Resources Planning.

SELLICK E, BONTHUYS B, BENADE N, VEELEN MV, HUGHES D, LOUW D and BIRKHEAD A (2002) Sabie River Catchment. Operating Rules and Decision Support Models for Management of the Surface Water Resources. Main Report: volume 1 of 2. First Draft June 2002
Report No: P.X300/00/3802. Department of Water Affairs and Forestry. 140.

SENGE PM (1980) A System Dynamics Approach to Investment Function Formulation and Testing. Socioeconomic Planning Sciences 14 269-280.

SMAKHTIN V, REVENGA C and DÖLL P (2004) Taking into Account Environmental Water Requirements in Global-scale Water Resources Assessments. Comprehensive Assessment Research Report 2. Comprehensive Assessment Secretariat.

STEINS NA and EDWARDS VM (1998) Platforms for collective action in multiple-use CPRs. Crossing Boundaries, the 7th Annual conference of the International Association for the Study of Common Property, Vancouver Canada.

STRAUSS, A & CORBIN J (1990) Basics of Qualitative Research: Grounded Theory, Procedures and Techniques. Newbury Park, Ca. Sage Publications

TENGO M and HAMMER M (2003) Navigating Social-Ecological Systems. In: Berkes F, Colding J and Folke C (eds), Navigating Social-Ecological Systems, 132-162, Cambridge University Press,

TPTC (2002) Tripartite Interim Agreement between the Republic of Mozambique and the Republic of South Africa and the Kingdom Of Swaziland for Co-Operation on the Protection and Sustainable Utilisation of the Water Resources of the Incomati and Maputo Watercourses. IncoMaputo. 62.

TSANG EWK (1997) Organizational Learning and the Learning Organization: A Dichotomy Between Descriptive and Prescriptive Research. Human Relations 50 (1) 73-89.

VON BERTALANFFY L (1972) The History and Status of General Systems Theory. The Academy of Management Journal 15(4) 407-426. URL: http://www.jstor.org/stable/255139.

VYGOTSKY LS (1987) L.S. Vygotsky, collected work. In: Rieber R and Carton A (eds), L.S. Vygotsky, collected work, Trans N Minick. Plenum., New York.

WALKER B, HOLLING CS, S.R. CARPENTER and KINZIG A (2004) Resilience, adaptability and transformality in social ecological systems. Ecology and Society 99 (2) 5.

WALKER B and SALT D (2006) Resilience thinking: Sustaining ecosystems and people in a changing world. Island Press, Washington DC.

WALS AEJ (ed) (2007) Social learning towards a sustainable world. Wageningen Academic Publishers. Netherlands,

WALS AEJ and JICKLING B (2002) Sustainability in higher education from doublethink and newspeak to critical thinking and meaningful learning. Higher education policy 15 121-131.

WARNER J (ed) (2007) Multi-stakeholder platforms for integrated water management, Ashgate publishing,

WARNER J and VERHALLEN A (eds) (2005) Multi-stakeholder Platforms for Integrated Catchment Management: Towards a comparative typology, Wolf Legal Publishers, Nijmegen.

APPENDICES

APPENDIX 2.1
Projects in the three WMAs relating to water resources

Area	Thematic focus	Project/ doc name	Organisation	Start	Finish
All	ER	Operationalising the Ecological Reserve PowerPoint			
All	Legislation	National Water Resources Strategy	DWAF	Sept 2004	
All	Management planning	Testing water demand management scenarios in a water-stressed basin in South Africa: application of the WEAP model	IWMI		2003
All	Management planning	An Integrated approach towards Compliance Monitoring and Enforcement in a Water Resources environment	SARPA Conference 2006		2006
All	Management planning	Mining, Minerals and Sustainable Development Project, South Africa	CSIR, MRC, and Geology Department University of Zimbabwe		Aug 2001
All	Management planning	A Hydropolitical History of South Africa's International River Basins	African Water Issues Research Unit (AWIRU)		Oct 2002
All	Management planning	Water Supply Infrastructure Modelling, Local Government Water Information Project (LOGO WIP)	AWARD		05 Dec 2008
All	Management planning	Regulatory Governance in Developing Countries			
All	Management planning	Water for Sustainable Growth and Development	DWAF	16 Sept 2008	
All	Management planning	Catchment2Coast: Making the Link Between Coastal Resource Variability and River Inputs	CSIR	July/August 2003	
All	Water availability	Rainfall Variability and Drought in Sub-Saharan Africa since 1960	FAO Agrometeorology		1996
All	Water quality and availability	Invasive alien trees and water resources in South Africa: case studies of the costs and benefits of management	CSIR, Division of Water, Environment, and Forestry Technology		2000 (published Jan 2002)
All	Water requirements, Management planning	Overcoming constraints to the implementation of water demand management in southern Africa	University of Swaziland, TSE Water Services, University of Zambia, Zimconsult, Ministry of Agriculture, Water and Rural Development (Namibia), University of Dar es Salaam		2003
All	Water quality	State of the Nation Report: An overview of the current status of water quality and eutrophication in South African rivers and reservoirs.	DWAF: Water Resources Inf Mgt.		Mar 2008

INCOMATI and/or MAPUTO BASIN					
Incomati Mozambique	ER	Research into modelling of the impacts of river catchment developments on the sustainability of coastal resources, which support urban and rural economies: the case study of Maputo Bay	CSIR and WI Delft Hydraulics	01 Oct 2002	31 Dec 2005
Komati Swaziland	ER	Komati Basin Water Authority. Historical Account of the Main Events and Water Resource Development and Water Use Agreements Affecting the Komati River Basin	Komati Basin Water Authority (South Africa)	16 Jan 2008	
Incomati	Management planning	Sharing the Incomati Waters: Cooperation and Competition in the Balance	UNESCO-IHE and Universidade Eduardo Mondlane		Jun 2003
Incomati, Komati	Management planning	Decision support systems for managing the water resources of the Komati River Basin	Dlamini, E.M., Komati Basin Water Authority		Sep 2007
Incomati	Management planning	Incomati Basin (Mozambique, Swaziland, South Africa): Negotiating a water sharing agreement. Main characteristics of the basin	UNESCO		
Incomati and Maputo Basins	Management planning	Tripartite Interim Agreement between the Republic of Mozambique and the Republic of South Africa and the Kingdom of Swaziland for Co-Operation on the Protection and Sustainable Utilisation of the Water Resources of the Incomati and Maputo Watercourses	Agreement	29 Aug 2002	
INKOMATI WMA					
Komati	Ecology	Komati Catchment Ecological Water Requirements Study	DWAF, AfriDev Consultants		2005
Inkomati	Ecology	Inkomati for IWAAS Study Ecological Requirements Report Summary	WRC		2009
Inkomati (Sabie-Sand)	Ecology	Inkomati for IWAAS Study Ecological Sabie Sand EWR Rule	WRC		2009
Crocodile	Ecology, Management planning	Adaptive assessment and management of riverine ecosystems: the Crocodile/Elands River case study	WRC, Roux *et al.*		
Crocodile	EIA	Environmental Impact Assessment (EIA) for the Proposed Expansion of the Sappi Ngodwana Mill Near Nelspruit	Golder Associates for Africa		22 Feb 2008
Komati	ER	SWAZI VAC Livelihood Based Vulnerability Monitoring Report	SWAZI VAC		May 2004
Sabie-Sand	ER	A Case Study on the (Non) Compliance with Environmental Water Allocations in the Sand Sub-catchment, South Africa	Irrigation and Water Engineering Group		Aug 2009
Crocodile	ER	Crocodile (East) Dam Development Reconnaissance Study	DWAF	7 Nov 2007	
Sand	Ground water	Sand river Catchment Groundwater Evaluation Hydrogeological Report for the Villages in Sand River Catchment Bushbuckridge Municipality Mpumalanga Province	WSM LESHIKA Consulting		Nov 2008
Inkomati	Management planning	An Assessment of Small-Scale Users' Inclusion in Large-scale Water User Associations of South Africa	IWMI		2004

Komati	Management planning	Transforming River Basin Management in South Africa, Lessons from the Lower Komati River	International Water Resources Association		June 2005
Crocodile	Management planning	A Real Time Operating Decision Support System for the Crocodile East River System			
Sabie-Sand	Management planning	Assessment of eutrophication and chemical pollution in surface waters of the Upper Olifants River system: Implications for aquatic ecosystem health and the health of human users of water .	IWR Water Resources	Due Jan 1, 2010	
Komati (Swaziland)	Management planning, Climate Change	Managing water under climate change for peace and prosperity in Swaziland	Department of Geography at University of Swaziland, Water Resources Branch		2005
Komati	Management planning, Water availability	Equitable water allocation in a heavily committed international catchment area: the case of the Komati Catchment	Department of Water Affairs, Swaziland, and UNESCO/IHE Institute for Water Education		
Komati	Water allocation	Equitable water allocation in a heavily committed international catchment area: the case of the Komati Catchment	Nkomo, S. and van der Zaag, P.		2004
Incomati Basin	Water allocation	Fractional water allocation and reservoir capacity sharing concepts: An adaptation for the Komati Basin	Komati Basin Water Authority (South Africa), Ministry of Natural Resources and Energy (Swaziland)		2007
Inkomati	Water availability	Inkomati Water Availability Assessment Study-Report Numbers			2009
Inkomati	Water availability	Assessment of Water Availability in the Inkomati Water Management Area by Means of Water Resource Related Models. DWAF Project Number W8147/02.	DWA		
Incomati Basin	Water availability	Remote Sensing and GIS for Reservoir Water Assessment in the Incomati Basin	Eduardo Mondlane University, Unesco-IHE		
Inkomati	Water availability and Water requirements	Inkomati Water Management Area: Overview of Water Resources Availability and Utilisation, NWRS	DWAF	May 2002	Sept 2003
Komati (Swaziland)	Water availability, Climate Change	Water Resource Availability in Three Catchments of Swaziland under Expected Climate Change	Department of Geography at University of Swaziland, Water Resources Branch		2006
Komati (South Africa and Swaziland)	Water quality	A Review of a Water Quality Information Management System for a Water Management Authority in South Africa and Swaziland	Ninham Shand Consulting Services, University of Stellenbosch, Komati Basin Water Authority		2005
Crocodile	Water requirements	Analysis of Water Use in the Krokodil River System	van der Zel, DW		1976

Inkomati	Water requirements	Inkomati WAAS Water Requirements Draft Final	WRC		2009
Inkomati	Water situation assessment	Inkomati Water Management Area Water Resources Situation Assessment	DWAF, Directorate: Water Resources Planning	Sept 2001	Feb 2003
Inkomati	Water situation assessment	Inkomati Water Management Area ISP	DWAF Directorate: National Water Resource Planning		March 2004
LUVUVHU AND LETABA WMA					
Letaba	EIA	Groot Letaba Water Development Project (GLeWaP) Final Scoping Report, Environmental Impact Assessment	DWA		Dec 2007
Letaba	ER	Letaba Catchment Reserve Determination Study- Ecospecs and Monitoring Report	DWAF, Directorate: Resource Directed Measures		Feb 2006
Letaba	ER	Letaba Catchment Reserve Determination Study- Main Report	DWAF, Directorate: Resource Directed Measures		Feb 2006
Luvuvhu	ER	Economic Analysis of Forestry and Commercial Agriculture in the Luvuvhu Catchment, Report on Activities in South Africa for DFID Forestry Research Programme Project R7937: Catchment Management and Poverty	Centre for Ecology and Hydrology		
Luvuvhu	Land cover	Mapping land cover change of the Luvuvhu catchment, South Africa for environmental modelling	University of Wyoming, KNP		2009
Luvuvhu	Livelihoods	Linking the hydrological cycle and rural livelihoods: a case study in the Luvuvhu catchment, South Africa	Center for Land Use and Water Resources Research, School of Bioresources Engineering and Environmental Hydrology, and Department of Agriculture, Food and Rural Development		2004
Luvuvhu	Management planning	Water resources planning and modelling tools for the assessment of land use change in the Luvuvhu Catchment, South Africa	University of KwaZulu-Natal, University of Newcastle		2004
Letaba	Management planning	Determining operating rules for the Letaba river system in South Africa using three models	W R Nyabeze and Associates, Water for Africa, Clear Pure Water, DWAF		2007
Luvuvhu and Letaba	Situation assessment	State of the Rivers Report Letaba and Luvuvhu River Systems – 2001	WRC		2001
Letaba	Situation assessment	State of Rivers – Letaba	River Health Program		

Letaba	Water availability	A fuzzy inference system for modelling stream flow: Case of Letaba River, South Africa	University of the Witwatersrand		2009
Letaba	Water availability, Surface water, Ground water	Developing a Surface Water – Groundwater Interaction Model for Letaba River System in South Africa	University of the Witwatersrand		
Letaba	Water availability	The February 2000 floods on the Letaba River, South Africa: an examination of magnitude and frequency	Heritage, G. L. , B. P. Moon, A.R. G. Large		2000
Shingwedzi	Water quality	Water quality impacts on instream biota of the Shingwedzi River, South Africa	University of Venda, University of Johannesburg	2007	2008
OLIFANTS WMA					
Olifants	Ecology	Fish assemblage patterns as a tool to aid conservation in the Olifants River catchment (East), South Africa	US Environmental Protection Agency; University of Witwatersrand; Monash University (South African Campus)		2009
Olifants	Ecology	Contrasting genetic patterns and population histories in three threatened redfin species (*Cyprinidae*) from the Olifants River system, western South Africa	Department of Zoology, University of Stellenbosch		Jan 2004
Olifants	Ecology	State of the Aquatic Ecosystems in the Olifants Final Report	Department for International Development United Kingdom and DWAF		Jan 2007
Olifants	Ecology	Demise of the Nile crocodile (*Crocodylus niloticus*) as a keystone species for aquatic ecosystem conservation in South Africa: the case of the Olifants River	Ashton, PJ, CSIR		Jun 2010
Olifants	EIA	Olifants-Sand-Mogalakwena Transfer Scheme: Prognosis of the Relevant Environmental Impacts associated with the proposed alternatives.	DWAF, Ninham Shand		1993
Olifants (Blyde)	EIA	Lower Blyde irrigation network, Environmental Impact assessment, Pretoria.	CSIR		1997
Olifants (Lower)	EIA	Environmental Impact Assessment for the proposed Ethanol Plant Hoedspruit development on the following alternative sites; the Farm Portsmouth 286 KT or Richmond 241 KT, Limpopo Province	Africa Geo-Environmental Services (Ages)	2008	
Olifants	ER	Olifants River Ecological Water Requirements Assessment: Lower Olifants Comprehensive Ecological Reserve (Water Quantity)	DWAF, Directorate: Water Resources Planning	Dec 2000	Aug 2001
Olifants (Steelpoort)	Ground water	Middle Steelpoort Catchment, groundwater management plan	DWAF		1995
Olifants (Steelpoort)	Ground water	Groundwater and Mining in the Bushveld Complex	Water Geosciences Consulting; Anglo Platinum Limited		2009

Olifants	Ground water	Conceptual Overview of the Olifants River Basin's Groundwater, South Africa	International Water Management Institute (IWMI) and African Water Issues Research Unit (AWIRU)	Jan 2000	
Olifants	Management planning	Olifants River Catchment: Report on international system analysis	DWAF, Wates and Wagner		1990
Olifants	Management planning	Water resources planning of the Olifants river basin – Study of development potential and management of the water resources	DWAF, Theron, Prinsloo, Grimsehl and Pullen		1991
Olifants	Management planning	Olifants basin study: Water resources planning of the Olifants river basin, Study of development potential and management of the water resources.	DWAF		1991
Olifants	Management planning	Proposal for the establishment of a Catchment Management	DWAF		1993
Olifants	Management planning	Olifants-Sand Transfer Scheme: Prefeasibility study	DWAF, Ninham Shand		1993
Olifants (Steelpoort)	Management planning	Hydro-Institutional Mapping in the Steelpoort River Basin, South Africa	IWMI	1998	2001
Olifants (Blyde) and Komati (Sand)	Management planning	Integrated water resources management for the Blyde and Sand River catchment complex.			2002
Olifants and Inkomati	Management planning	The Development of a Comprehensive Water Conservation and Water Demand Management Strategy and Business Plan for the Olifants and Inkomati WMAs: water Use Sectors.	DWAF, Directorate: Water Use Efficiency		Oct 2006
Olifants	Management planning	Hydrology and Water Resources Development in the Olifants River Catchment	International Water Management Institute (IWMI)	2004	
Olifants	Management planning	Increasing the Productivity of Water at Basin Scale in the Olifants River Basin, South Africa	IWMI, ARC-Institute of Agricultural Engineering		
Olifants (Upper)	Management planning	Water resources planning detailed study	National Water Resources Planning Sect of Johann van Rooyen.		
Letaba and Olifants (Lower)	Management planning	Mopani District Municipality Draft Local Economic Development Strategy	Mopani District Municipality	Sept 2005	
Olifants	Management planning	Olifants River Irrigation Schemes	IWMI		
Olifants	Management planning	Olifants River Water Resources Development Project (ORWRDP)	DWAF	Oct 2005	
Olifants	Management planning	Reconciliation strategy development	Johan van Rooyen		
Olifants (Blyde)	Management planning	Water Affairs in the Lower Blyde River The Role of DWAF in Local Water Management	IWMI	April 2004	
Olifants and Letaba	Management planning	Environmental Management Framework for the Olifants and Letaba Rivers Catchment Area: Draft Report			

Olifants(Lower), Letaba and Vaalharts	Management planning	The Transformation of Irrigation Boards into Water User Associations in South Africa Case Studies of the Lower Olifants, Great Letaba and Vaalharts Water User Associations	IWMI	2004	
Olifants	Management Planning, Climate Change	Incorporating climate change into water resources planning for the town of Polokwane, South Africa	Aurecon, University of Colorado at Boulder, University of Cape Town, WSM Lesheika, DWAF, BC Gildenhys and Associates, Stratus Consulting		2010
Olifants, Sabie-Sand, Luvuvhu-Letaba	Management planning, Water payments	The feasibility of developing payments catchment protection services and improved livelihoods South Africa			Jun 2005
Olifants	Management planning, Water quality	Management of Environmental Impacts from Coal Mining in the Upper Olifants River Catchment as a Function of Age and Scale	CSIR Natural Resources and the Environment		Sept 2008
Olifants	Municipal	All town study			
Olifants	Situation assessment	Olifants River Basin in Southern Africa-Presentation	Help- UNESCO	June 2002	
Olifants	Situation assessment	Olifants River Research Project	Olifants River Forum, CSIR	May/June 2010	
Olifants (Lower)	Social	An analysis of the livelihoods of communities of the upper Selati catchment, South Africa	International Institute for Environment and Development (IIED), CSIR		Sep-05
Olifants	Tourism, water quality	Impact on ecotourism by water pollution in the Olifants River catchment, South Africa	Oberholster, PJ, CSIR, SIL News		2009
Olifants	Water availability	Water resource planning of the Olifants River basin – Basin study report annexure 29 : Kruger national park. Hydrological data assessment	DWAF, Theron, Prinsloo,Grimsehl and Pullen		1991
Olifants	Water availability	Application of the Instream Flow Incremental Methodology to Southern African Rivers: Protecting Endemic Fish of the Olifants River	The Center for Field Biology, Freshwater Research Unit, Cape Chief Directorate of Nature and Environmental Conservation		1991
Olifants	Water availability	The Impact of Land Cover and Land Use on Hydrological Response in the Olifants Catchment	School of Civil and Environmental Engineering, University of Witwatersrand		26 Aug 2005
Olifants	Water quality	Irrigation Water Quality requirements of the farmers on the Loskop Irrigation Scheme in the upper Olifants.	DWAF, Loxton, Venn and Associates		1990
Olifants	Water quality	Olifants River Catchment: Water quality management Interim report on water quality resource analysis	DWAF, Wates and Wagner		1990

Olifants	Water quality	Water resource planning of Olifants River Catchment :Study of the development potential and management of the Water Resources: Water Quality Report module 6.1	DWAF, Theron, Prinsloo, Grimsehl and Pullen		1990
Olifants	Water quality	Water resource planning of the Olifants River basin – Basin study report annexure 19 : Water quality	DWAF, Theron, Prinsloo,Grimsehl and Pullen		1990
Olifants	Water quality	PCB's and chlorinated hydrocarbon pesticide residues in water, fish and sediment from the Olifants river catchment	DWAF, D. F. Grobler		1991
Olifants	Water quality	A Preliminary Investigation of the Concentration of Selected Metals in the Tissues and Organs of the Tigerfish (Hydrocynus vittatus) from the Olifants River, Kruger National Park, South Africa	Research Unit for Aquatic and Terrestrial Ecosystems, Department of Zoology, Rand Afrikaans University		1992
Olifants	Water quality	The Development of an Aquatic Toxicity Index as a Tool in the Operational Management of Water Quality in the Olifants River (Kruger National Park)	Research Unit for Aquatic and Terrestrial Ecosystems, Department of Zoology, Rand Afrikaans University		1992
Olifants	Water quality	Olifants-Sand Transfer Scheme: Feasibility Study – Reservoir Water Quality Simulation: Rooipoort	DWAF, Ninham Shand		1994
Olifants (Middle and Lower)	Water quality	A note on the occurrence of metals in the Olifants River, Eastern Transvaal, South Africa	DWAF	1990	1994
Olifants (Upper)	Water quality	Metal concentrations in *Clarias gariepinus* and *Labeo umbratus* from the Olifants and Klein Olifants River, Mpumalanga, South Africa: Zinc, copper, manganese, lead, chromium, nickel, aluminium and iron	Rand Water		Oct-02
Olifants (Upper, Loskop Dam)	Water quality	A Water Resource Quality Study of Loskop Dam and the Upper Catchment of the Olifants River, Mpumalanga	Environmental Management, University of the Free State		Aug 2007
Olifants (Upper)	Water quality	Collection, treatment and re-use of mine water in the Olifants River Catchment	Anglo Coal; CSIR; Wates, Meiring and Barnard.		Jan/Feb 2001
Olifants	Water quality, Ecological	Responses of phytoplankton upon exposure to a mixture of acid mine drainage and high levels of nutrient pollution in Lake Loskop, South Africa	P.J. Oberholster, J.G. Myburgh, P.J. Ashton, and A.-M. Botha		Aug 2009
Olifants	Water quality, Ecological	Assessment of eutrophication and chemical pollution in surface waters of the Upper Olifants River system: Implications for aquatic ecosystem health and the health of human users of water .	P.J. Oberholster	2010	On going
Olifants	Water quality, Ecological	River Corridor Project.	Kruger to Canyons (K2C)	2010	On going

Olifants	Water requirements	Olifants River Catchment: Study of the development potential and management of the water resources. Water Requirements Report Module 4.1 Estimated water requirements for irrigation, afforestation and stock watering	DWAF, Theron, Prinsloo, Grimsehl and Pullen		1990
Olifants	Water requirements	Olifants River Catchment: Study of the development potential and management of the water resources. Water Requirements Report Module 4.2 Estimated water requirements for domestic, industrial, mining and power generation	DWAF, Theron, Prinsloo, Grimsehl and Pullen		1990
Olifants	Water use	An investigation into water use at the Arabie-Olifants irrigation scheme.	IWMI		2000
Olifants (Upper)	Wetlands	Upper Olifants River Catchment (UORC) Wetland Management Framework	DWAF		

APPENDIX 3.1:
Dams in the Luvuvhu/Letaba WMA

Table A: Dams in the Luvuvhu/Letaba WMA

Secondary catchment	Dam
Luvuvhu	Nandoni Dam, Funduzi Dam, Albasini Dam, Vondo Dam
Letaba	Middle Letaba Dam, Lornadawn Dam, Hans Merensky Dam, Tzaneen Dam, Ebenezer Dam, Nsami Dam

APPENDIX 3.2:
Dams and major water resources in the Olifants WMA

Table B: Major water resources and dams in the Olifants WMA

Sub area	Major tributaries	Major Dams	Smaller dams	Transfers
Upper Olifants	Bronkhorstspruit; Wilge and Klein Olifants rivers.	Witbank Dam , Middelburg Dam, Bronkhorstspruit Dam, Loskop Dam	Trichardtsfontein Dam, Rietspruit Dam, Doornpoort Dam, Premier Mine Dam (Wilge River), Klipspruit Dam	In: Usuthu (Vaal); Inkomati; Upper Vaal Out: BHT – Croc west
Middle Olifants	Including the Elands, Tongwane and Mohlapitse rivers.	Rust de Winter Dam, Rhenosterkop Dam, Flag Boshelo Dam (previously Arabie dam),	Smaller dams include Rooikraal Dam, Chuniespoort Dam, Lepellane Dam, Lola Montes Dam, Lower Gompies Dam, Makotswane Dam, Mogoto Dam, Molepo Dam, Nkadimeng Dam, Piet Gouws Dam, Upper Gompies Dam, Nkumpi1 Dam, Nkumpi 2 Dam, Grootrietvly 210JS Dam	In: Loskop; Ebenezer (Letaba) Out: Olifant-Sand (Polokwane); Olifant-Sand (Capricorn; Greater Sekhukune) Flag Boshielo to Mokopane

Steelpoort	Steelpoort Waterval and Spekboom rivers	Belfast Dam, Buffelskloof Dam, De Hoop Dam, Der Brochen Dam		
Blyde	Including the Ohrigstad and Blyde rivers	Blyderivierspoort Dam, Ohrigstad Dam		
Lower Olifants	With the Makhutswi, Ga-Selati, Klaserie, Timbavati rivers.	Phalaborwa barrage	Kaserie Dam, Palabora Dam, Jan Wassenaar Dam (Klaserie river), Tours Dam	In: Letaba; Luvuvhu Out: New Letaba/Luvuvhu

APPENDIX 3.3:
Dams in the Inkomati WMA

Table C: Dams in the Inkomati WMA

Secondary catchment	Major Dams	Smaller dams
Sabie-Sand	Injaka Dam,	Corumana Dam, Zoeknog dam, Maritsane, Da Gama, Orinoco, Casteel, Edinburgh, Mahlope
Crocodile	Kwena Dam, Ngodwana,	Witklip, Primkop, Klipkoppie/ Longmere, Lake Fundudzi, Mundts Concession, Friedenheim, My Own, Spago, Vergenoeg, Pappas Quarry, Barberton
Komati	Nooitgedacht, Vygeboom	Sand River, Maguga, Mweti Weir, Seekoeigat Weir, Coopersdal Weir, Furley's Drift Weir, Simonvlei Weir, Elsana Weir, Ronel Weir, Sibange Weir, Masibekela Weir, Mbambiso, Swartvlei, Biltong, Langpiet, Turfbult, Shiyalongubo
Lomati	Lomati, Driekoppies	

APPENDIX 5.1
Select legislation, policy, guidelines and documents relevant to Integrated Water Resource Management

Note: Some departmental names have changed subsequent to promulgation of legislation

A. Legislation

Constitution-related Legislation

Constitution of the Republic of South Africa [No. 108 of 1996]

Intergovernmental Relations Framework Act [No. 13 of 2005]

Promotion of Administrative Justice Act [No 3 of 2000]

Promotion of Access to Information Act [No. 2 of 2000]

Promotion of National Unity and Reconciliation Act [No. 34 of 1995]

Water-related Legislation

Department of Water Affairs and Forestry

National Water Act [No. 36 of 1998]

Water Services Act [No. 108 of 1997]

Environment-related Legislation

Department Environment and Tourism

National Environment Management: Air Quality Act [No. 39 of 2004]

National Environmental Management: Protected Areas Amendment Act [No. 31 of 2004]

National Environmental Management: Biodiversity Act [No. 10 of 2004]

National Environmental Management: Protected Areas Act [No. 57 of 2003]

Environment Conservation Amendment Act [No 50 of 2003]

National Parks Amendment Act [No. 54 of 2001]

South African Weather Service Act [No. 8 of 2001]

National Environmental Management Act [No 107 of 1998]

Environment Conservation Act Extension Act [No. 100 of 1996]

Environment Conservation Act [No. 73 of 1989]

Department of Water Affairs and Forestry

National Forest and Fire Laws Amendment Act [No. 12 of 2001]

National Veld and Forest Act [No. 101 of 1998]

National Forests Act [No. 84 of 1998]

Land-related Legislation

Department of Land Affairs

Communal Land Rights Act [No. 11 of 2004]

Transformation of Certain Rural Areas Act [No. 94 of 1998]

Extension of Security of Tenure Act [No. 62 of 1997]

Land Survey Act [No. 8 of 1997]

Interim Protection of Informal Land Rights Act [No. 31 of 1996]

Communal Property Associations Act [No. 28 of 1996]

Land Reform (Labour Tenants) Act [No. 3 of 1996]

Development Facilitation Act [No. 67 of 1995]

Land Administration Act [No. 2 of 1995]

Restitution of Land Rights Act [No. 22 of 1994]

Public administration-related legislation

Department of Finance

Finance Act [No. 26 of 2004]

Public Finance Management Act [No 1 of 1999]

Department of Provincial and Local Government

Disaster Management Act [No. 57 of 2002]

Department of Trade and Industry

Broad-Based Black Economic Empowerment Act [No. 53 of 2003]

Governance-related Legislation

Department of Provincial and Local Government

Re-determination of the Boundaries of Cross-boundary Municipalities Act [No. 6 of 2005]

Traditional Leadership and Governance Framework Act [No. 41 of 2003]

Local Government: Municipal Systems Act [No. 32 of 2000]

Local Government: Cross-boundary Municipalities Act [No. 29 of 2000]

Local Government: Municipal Structures Act [No 117 of 1998]

Local Government: Municipal Demarcation Act [No. 27 of 1998]

National Council of Provinces Act [No. 17 of 1997]

Council of Traditional Leaders Act [No. 31 of 1994]

Sector-specific Legislation

Department of Agriculture

Agricultural Laws Rationalisation Act [No. 72 of 1998]

Subdivision of Agricultural Land Act Repeal Act [No. 64 of 1998]

Conservation of Agricultural Resources Act [No. 43 of 1983]

Department of Minerals and Energy

Mineral and Petroleum Resources Development Act [No. 28 of 2002]

B. Policy

White Papers

Department of Agriculture

Agriculture White Paper, 1995

Department of Environmental Affairs and Tourism

Integrated Pollution and Waste Management White Paper, March 2000

Environmental Management Policy White Paper, 15 May 1998

Environmental Management Policy White Paper, 28 July 1997

Conservation and sustainable use of South Africa's biological diversity White Paper, May 1997

Department of Land Affairs

South African Land Policy White Paper, June 1997 – Department of Land Affairs

Department of Minerals and Energy

Promotion of Renewable Energy and Clean Energy Development White Paper: Part One: Promotion of Renewable Energy, 23 August 2002

Energy Policy White Paper, December 1998

Minerals and Mining Policy White Paper, October 1998

Department of Provincial and Local Government

Traditional Leadership and Governance Draft White Paper – 29 October 2002

Spatial Planning and Land Use Management White Paper, July 2001

Disaster Management White Paper, 15 January 1999

Local Government White Paper, 9 March 1998 – Department of Provincial and Local Government

Department of Water Affairs and Forestry

Water Services Draft White Paper, October 2002

National Water Policy White Paper, April 1997 – Department of Water Affairs and Forestry

National Sanitation Policy White Paper, October 1996 – Department of Water Affairs and Forestry

Sustainable Forest Development in South Africa White Paper, March 1996 –

Water Supply and Sanitation White Paper, November 1994

Other Documents

Department of Agriculture

Department of Agriculture Strategic Plan 2003-2006, March 2003

Land redistribution for agricultural development, June 2001

Formulation of the Regulations on the Combating of Declared Weeds Invader Plants, November 1999

LandCare programme implementation framework: Discussion document, February 1999

Department of Environmental Affairs and Tourism

Consolidated Environmental Implementation and Management Plan 2000, June 2000

Water Conservation and Demand Management Strategy for the Forest Sector: Draft, May 2000

Water Conservation and Water Demand Management Strategy for the Water Services Sector: Draft, 15 March 2000

Water Conservation Strategy for the Industry, Mining and Power Generation User Sector: Draft, 11 February 2000

Groundwater quality management in South Africa policy and strategy, 2000

Department of Land Affairs

Opportunities and obstacles to women's land access in South Africa (Land reform gender policy framework), February 2002

Department of Water Affairs and Forestry

Department of Water Affairs and Forestry Strategic plan 2003/4-2005/6, 25 March 2003

Using water for recreational purposes policy, March 2002

Water conservation and demand management national strategic framework: Draft, May 1999

Managing the water quality effects of settlements: The national strategy, April 1999

Government of South Africa

The New Partnership for Africa's Development (NEPAD), October 2001 – Department of Foreign Affairs

Integrated Sustainable Rural Poverty and Inequality in South Africa: Final Report, 13 May 1998

Growth, Employment and Redistribution: A Macroeconomic Strategy for South Africa (GEAR), 1996
Development Strategy, 17 November 2000

APPENDIX 5.2
Instruments for integration and co-operation

The table below contains a list of strategies, plans, frameworks and projects that have relevance to IWRM. The list cannot be considered comprehensive, especially with regard to international frameworks. However, these instruments provide the focus for co-operation and integration. Note that the instruments operate at different levels: national, provincial and local (after Pollard and Du Toit, 2004).

SADC protocols

The SADC protocols provide regional guidelines for the use of shared water resources.

The National Water Resource Strategy (NWRS)

The NWRS, called for in the NWA, guides institutions in the implementation of the National Water Policy. In terms of co-operative functions, the NWRS sets out interrelationships between institutions involved in water resources management and other water-related activities.

Catchment Management Strategies (CMS)

The CMS must be in line with the NWRS of the DWAF. The CMS is based on participatory and integrated processes that should reflect the plans and visions of water users located in a particular WMA.

The Integrated Rural Development Strategy (IRDS)

The ISRDS is a national plan of government to implement development plans that are integrated and sustainable for rural areas. The aim of the IRDS is to work cooperatively with all sectors to provide services and support development of rural areas by providing services and supporting economic growth. The Integrated Rural Development Strategy, whilst not dealing with water *per se*, talks to issues of sustainable rural livelihoods.

Provincial Growth and Development Strategies (PGDS)

PGDS are aimed at guiding provincial growth and development. These plans are important in that

they place significant demands on water resources and will therefore need to be aligned with the CMS and take into account the processes of IWRM.

Integrated Development Plans (IDP)

An IDP is the main 'strategic planning' tool for planning and development within a municipality. It must link, integrate and co-ordinate plans and be compatible with national and provincial development plans.

Water Services Development Plans (WSDPs)

Every Water Services Authority (usually a district municipality but sometimes a metropolitan or local municipality) is required by the Water Services Act to develop a Water Services Development Plan as part of the IDP. The WSDP must be consistent with the broader goals of IWRM and be informed by the CMS. The plan must also reflect an implementation programme for a five-year period.

Integrated Water Resource Management Plan (IWRMP)

the Constitution and national environmental and local government legislation lays the foundation for Local Authorities to consider IWRM although there is not yet any specific legal requirement for the preparation of an IWRMP.

Integrated Waste Management Plans

To integrate, improve and optimise waste management in order to maximise efficiency by providing an adequate service to residents and businesses and, minimise the associated environmental impacts and financial costs.

Spatial Development Frameworks (SDFs)

The Municipal Systems Act calls for spatial development frameworks to be part of municipalities' IDP's. The SDF must associate development priorities with different geographic areas of the municipality. The SDF, CMS and WSDP need to be harmonised in terms of water allocation and provision.

Land Use Management Systems (LUMS)

In terms of the Municipal Systems Act (2000) and the Local Government Municipal Demarcation Act (1998), land under Traditional Leadership has been incorporated into municipal boundaries. The MSA and the Land Use Management Bill requires that a single Land Use Management System (LUMS) be developed for the entire area. Land use management is closely interlinked with resource management and harmonization is needed between relevant resource management strategies/plans such as the CMS, EMPs and WSDPs.

Provincial Environmental Management Plan and/or Environmental Implementation Plans (EIMPs)

The NEMA calls for both National and Provincial Environmental Management Plans – sometimes called Environmental Implementation Plans. These plans ensure provincial activities to be in line with sound environmental planning.

Local Government Environmental Management Plans (EMP)

Local Government need to prepare EMPs as part of the IDP planning process. These plans guide Local Government activities to be in line with sound environmental planning.

Redistribution for Agricultural Development policy (LRAD)

LRAD policy is designed to provide a framework for grants to previously disadvantaged South Africans to access land specifically for agricultural purposes or to improve current land uses. Links between spatial planning and resource allocation are critical especially were water needs to be 'freed up' to support new and emerging farmers (see links to Water Allocation Reform).

Strategic Plan for South African Agriculture (2001) Department of Agriculture

This strategic plan proposes a number of interventions to increase the participation of small-scale, communal and subsistence farmers in the formal agriculture sector and make it more profitable, and to ensure that agricultural developments are not implemented at the cost of degrading natural resources.

Working for Water (WfW)

Working for Water is a multi-departmental programme to clear invasive alien plants. It also aims to create jobs and combat poverty, particularly in rural areas. Since the activities of the WfW project impact on water resources, biological diversity, agricultural production, secondary industry, and

employment it is important that they co-ordinate with a wide range of role-players.

LandCare

The National LandCare Programme (NLP), run by the Department of Agriculture and Land Affairs, provides capacity building and awareness raising aimed at ecosystem rehabilitation and restoration. The vision of the Department's NLP is to have communities and individuals adopt an ecologically sustainable approach to the management of South Africa's environment and natural resources, while improving their quality of life.