THE TSITSA PROJECT

Integrated Restoration and Sustainable Land Management Plan

Working Together Adaptively to Manage and Restore Ecological Infrastructure for Improved Livelihoods and Futures

T35A-E (Phase 1 of TP)

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Executive summary

The Tsitsa Project (TP) aims at carrying out erosion prevention, avoided habitat degradation and general rehabilitation efforts in the Tsitsa catchment (T35), particularly those reducing sediment delivery into proposed dams and associated infrastructure of the Mzimvubu Water Project (MWP). In the long-term TP will strive towards ***avoiding land degradation*** and ***sustainable land management*** across the catchments. TP is a collaborative venture into polycentric governance with the main proponents and sponsors being the Department of Environmental Affairs (DEA), The Department of Science and Technology (DST), the Water Research Commission (WRC) and the Department of Water and Sanitation (DWS).

The project framing is social-biophysical (or social-ecological as it was termed in the formative initiatives) and systemic (holistic) in nature, and centres around local livelihoods especially in the ex-homeland areas of the catchment. Although the MWP and TP began in a top-down manner, efforts are now being made to secure a meaningful, even where possible central, participatory position for local resource users. This report is (at this stage) the first draft, reflecting a process which began as a more biophysically-centred sedimentation and rehabilitation plan but which evolved quickly as the commitment of the team to social-biophysical linkages deepened. In addition, commitment to pragmatic interfacing with the many realities on the ground, such as local power structures and governmental schedules, has in part given the report a nitty-gritty touch. These various evolving emphases will be apparent to the reader, and will grow further in future drafts as TP, hopefully successfully, gains the wider collaborative and trans-disciplinary reach to which it aspires. A central conceptual framework in the founding "Research Investment Strategy" (Fabricius *et al.* 2016) document reminds participants of the social-biophysical and systemic obligations in TP's approach (see diagram in Appendix 1). The reader will thus appreciate that the TP's view is that, without these social and other contextual considerations properly incorporated, any biophysical design or "fix" is very likely to be unsustainable. Another way to put this is to say that we recognise that biophysical, institutional and social considerations have their own "minimum requirements" – below which sustainability will not be possible – and that it is in the particular way the social and the biophysical are related, or can be brought to be so, that often offers the most promise.

Effective stakeholder assessment and engagement was spoken about from the outset of TP, but in reality took over a year to move anywhere beyond some research contact. There have, however, been some routine prescribed interventions such as the EIA for the MWP project and such as the committees formed by DEA-NRM (Project Steering Committees) when their teams operate in an area; and notably, there has been more intensive engagement at one pre-existing local site in the catchment (the Green Village Project or GVP). Engagement is now increasingly being placed more centrally, and this report reflects many of the principles and plans in this regard. A thorough stakeholder assessment of the sub-catchments related to the proposed Ntabelanga Dam (the first proposed dam of the two) was conducted in 2016 (Sisitka *et al.* 2016) and its recommendations form, along with the outcomes of much discussion since, the basis of the stakeholder section in this document.

TP is also evolving in an era when developmental evaluation is starting to be seen alongside conventional M&E efforts. The TP effort does not discount classic M&E, but has an initiative focussing on (initially internal) learning

as a consequence of a developmental (adaptive, emergent) reflection, partly through narrative. In line with current trends there is also an evolving theory of change which draws on the underlying systemic understanding of inter-relationships, particularly the process links between biophysical, institutional and social elements.

The commitment to adaptive and reflexive ways of thinking throughout all TP activities, is encouraged by various Strategic Adaptive Management (SAM) guidelines including the adaptive planning process. The elements of this whole report, for instance, are cross-mapped onto the adaptive planning process which rests primarily on agreed-on values or deeply held beliefs (ideally derived by joint visioning) and whose implementation themes are usually represented by a tree of objectives. Constructive feedbacks between processes are seen as crucial to sustainability, and these are sought and explicated throughout. Representations of this type of thinking are used in this report, but probably need expansion (as seen by a demand for a fuller objectives tree in mid-2017). These collaborative adaptive approaches help realise the elements of the other (called the "implementation framework") in the founder Research Investment Strategy (Fabricius *et al.* 2016) (see figure in Appendix 2).

The governance structures of a programme such as TP need to themselves have the requisite variety to represent the heterogeneity and complexity of the larger task at hand. To this end TP evolved three communities of practice or COPs (initially called working groups) that span to a reasonable extent the breadth of what is taking place (Figure A). These three essentially voluntary groups of enthusiasts meet amongst themselves and increasingly cross-link with the other groups, helping form a more coherent blend. Currently the three COPs are: Governance, Sediment & Restoration, and Livelihoods and Ecosystem Services. There are bi- or tri-annual Science-Management meetings at a broader plenary level. Slightly more formally, there is an evolving "B-team" (or the Praxis Evaluation and Recommendation Panel) of mid-level managers and researchers who grow and keep the science-management links meaningful, a subset of this group specifically charged with ensuring that the recommendations are operationalised in both directions. There are concrete plans for a formal high-level "A-team" (or High Level Promotion of Cooperative Governance Committee) which will represent TP interests' at the most senior level and provide the highest level of buy-in in a vertical governance sense. A final component of the TP Governance is provided by the Praxis Consultation Committee (previously thought of as a potential TP Wisdom Trust). All this is necessary to enable TP to achieve what it is setting out to do.

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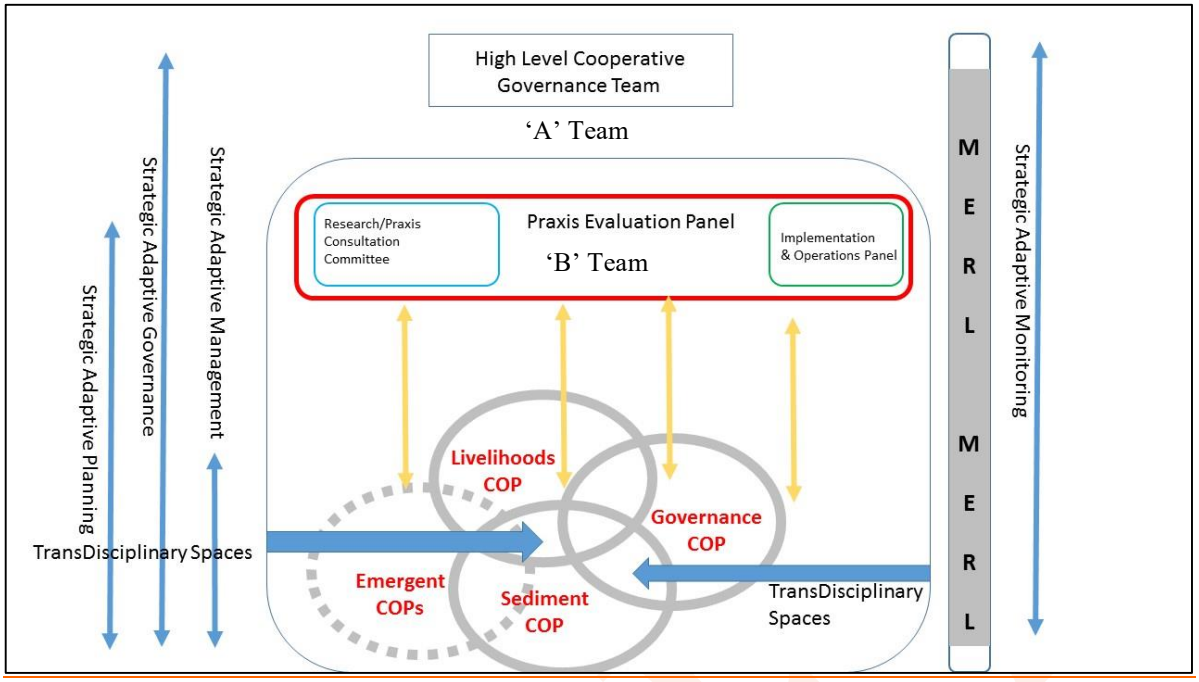

Figure A: Governance arrangements within TP

This report describes in some detail what the catchments look like and how they function, both biophysically and socially, and then (true to the social-biophysical calling) how the key linkages across these domains work. The implementation of TP has required a phased approach, purely due to the size of the catchment and the complexity of the total system. As with the stakeholder analysis (Sisitka *et al.* 2016), this plan focusses purely on the ***five quaternary catchments (T35A-E)*** that impact directly on the proposed Ntabelanga Dam (Figure B). The second stakeholder analysis and the second TP Integrated Adaptive Management and Restoration Plan will focus on the balance of the quaternary catchments in T35 (T35F-M) which materially impact the proposed Lalini Dam and associated infrastructure (see Figure A).

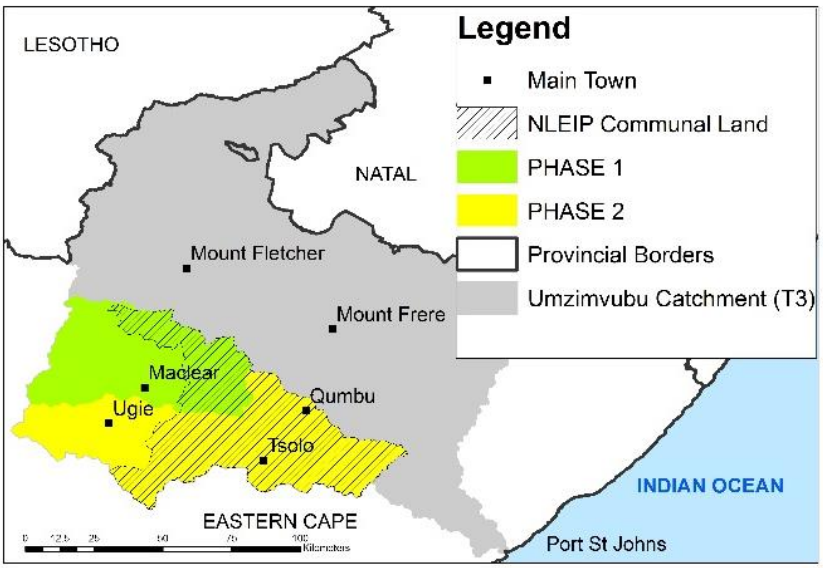

Figure B: Locality map for the TP depicting the two phases (Ntabelanga – Phase 1 and Lalini Phase 2).

The Ntabelanga catchment receives summer rainfall (~600-1 000 mm pa) and is marked by steep topography, with the pronounced Drakensberg Escarpment forming the headwaters of the catchment, followed by a second smaller escarpment in the lower catchment. Soils become more erodible towards the lower parts of the catchment, as is demonstrated by the extensive gully features in the lower catchment. Grassland is dominant throughout with primary grasslands in the upper catchment and degraded secondary grassland in the lower catchment. The upper catchment is wetter and has more crop production. The south-western upper catchment is privately owned with commercial livestock, crop production and forestry, whereas the north-eastern part of the upper catchment and entire lower catchment is communally owned with subsistence livestock and crop production.

Various socio-economic factors contribute to land degradation. Key elements that impacted on the Tsitsa were: the political and administrative separation of the former Transkei homeland from Republic of South Africa (RSA); laws that restricted black ownership of land; the loss of able bodied men who were enrolled to work in the mines, reducing available labour in the rural areas; pass controls which prevented women from living in urban areas with their husbands; limited investment in education, especially at school level. Forced removals from the RSA from 1960s onwards contributed to rapid population growth. Betterment planning, introduced from the 1930s, led to resentment and political resistance. Social grants in the form of pensions also affected people's reliance on the land, often abandoning agricultural land and practices. Since 1994 the focus of direct government support has shifted from white commercial farmers to black farmers, with an emphasis on 'emerging' black commercial farmers. The effectiveness of this support can, however be questioned as new farmers need a huge investment in material and social capital (e.g. business and agricultural skills). The level of support through extension services in communal areas is variable. Poverty remains a reality within the communal area.

Three stakeholder groupings were identified in the catchment: a **high level** that includes district and local municipalities (possibly elements of national and provincial government departments), ward councillors, traditional authorities, chiefs, AmaMpondomise Royal Council, Maclear Fire Protection Association, Maclear Farmers Association, JGDMASAFA, ORTDMAFASA TP and partner reps; an **intermediate level** that includes MFPA or subcommittee, Tribal Councils/Royal Council (or sub-committees) + Ward councillor, agricultural extension officer, TP and partner reps, others; a **local level** that includes farms, village areas, farmers or sub-headmen, resource users/managers, TP and partner reps, community facilitators. Despite the presence of various government departments in the catchment, natural resource related decision making is mainly controlled by individual farmers (with advice and support from their agricultural suppliers) and traditional authorities (chiefs, headmen and sub-headmen). TP will need to engage stakeholders at all these levels in order to effectively influence natural resource management (NRM).

Various social ecological links can be identified that impact on natural resource management in the Tsitsa River catchment. The climate, soil stability and terrain steepness make agricultural activities less successful and reliable. Without technology to overcome these challenges, agriculture is not a reliable source of income. Break-down of local governance systems leads to lack of control over resource use. Land management is often reactive and fuels further degradation. Migrant labour, increased school attendance and new generation less interested in hard physical labour reduces interest in land and NRM. Government grants support families, but much time is still

spent on collecting water and fuel wood instead of engaging with economic activities. Poverty is common and reduces health, education opportunities and resilience to environmental challenges, leaving residents vulnerable. Landownership is communal, thus a disincentive to invest in common-pool natural resources. Livestock are culturally very important, with less focus on productivity. Large numbers on small areas result in under nourished, often old animals that are not worth much on commercial markets. Reliable markets are far away and expensive to get to, thus excludes active farmers from turning livestock into cash. Current levels of degradation make any new agricultural activity unlikely to remain successful without continued support and investment.

Our social-biophysical approach helps understand the environmental, social, economic and governance factors (and importantly the particular linkages between them) which drive the system of interest to the residents and stakeholders. We do not underestimate the severity of challenges facing the region, but increasingly recognise that we can act jointly on the opportunities and hopefully work coherently towards agreed-on goals for a better future. The essence of a strategic adaptive management approach means that we have to have the determination to act firmly in the ways we have jointly decided, learn from the results, and hence also adapt accordingly. This implies that we will navigate our progress altogether, and that we expect at least some setbacks and adjustments. Engendering this culture will be an important contributor to an ultimately better future. We do not promise quick fixes, rather a drive towards a sustained systemic effort which is co-constructed and builds trust based as far as feasible on shared values. In this way ecological goods and services will be improved and support the success of alternative livelihoods and the wellbeing of land users.

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List of Acronyms and Abbreviations

ARC	Agricultural Research Council
ARDI	Actors, Resources, Dynamics and Interactions
ASGISA	Accelerated and Shared Growth Initiative for South Africa
CLO	Community Liaison Officer
CMA	Catchment Management Agency
CMF	Catchment Management Forum
CMS	Catchment Management Strategy
CoP	Community of Practice
CSO	Civil Society Organisations
CV	Coefficient of variation
DAFF	Department of Agriculture, Forestry and Fisheries (national)
DEA	Department of Environmental Affairs (national)
DEA.EP-NRM	Department of Environmental Affairs. Environmental Programmes - Chief Directorate Natural Resource Management
DEDEAT	Department of Economic Development, Environmental Affairs and Tourism (provincial)
DEM	Digital elevation model
DMR	Department of Mineral Resources (national)
DRDAR	Department of Rural Development and Agrarian Reform
DRDLR	Department of Rural Development and Land Reform ( )
DSD	Department of Social Development (national)
DST	Department of Science and Technology (national)
DWS	Department of Water and Sanitation (national)
EC	Eastern Cape Province
ECCoGTA	Eastern Cape Cooperative Governance and Traditional Affairs
ECD	Early Childhood Development
ECPTA	Eastern Cape Parks and Tourism Agency
ECRDA	Eastern Cape Rural Development Agency
ECSECC	Eastern Cape Socio-Economic Consultative Council
EGS	Ecosystem Goods and Services
EI	Ecological Infrastructure
EIA	Environmental Impact Assessment
ELM	Elundini Local Municipality
EPWP	Expanded Public Works Programme
GEAR	Growth, Employment and Redistribution

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GIS	Geographic Information System
GVP	Green Village Project
Ha	Hectare
IDP	Integrated Development Plan
IGE	Inter-Generational Equity
JGDM	Joe Gqabi District Municipality
JGDMAFASA	Joe Gqabi District Municipal Africa Farmers Assoc. of South Africa
LED	Local Economic Development
M&E	Monitoring & Evaluation
MAP	mean annual precipitation
Masl	meters above sea level
MEC	Member of Executive Council
MERL	Monitoring, Evaluation, Reflection and Learning
MFA	Maclear Farmers Association
MFPA	Maclear Fire Protection Association
MLM	Mhlonthlo Local Municipality
MOU	Memorandum of Understanding
MRC	Monthly Recurring Charge
MWP	Mzimvubu Water Project
NAFU	National African Farmers Union
NDP	National Development Plan
NGO	Non-governmental organisation
NGP	New Growth Plan
NIP	National Infrastructure Plan
TP	Ntabelanga and Lalini Ecological Infrastructure Project
NRM	natural resource management (activities generally)
NWGRA	National Wool Growers Association
ORTDM	OR Tambo District Municipality
ORTDMAFASA	OR Tambo District Municipal Africa Farmers Assoc. of South Africa
PROTO-CMA	Proto-catchment management agency
RIS	Research Investment Strategy
SAM	Strategic Adaptive Management
SDF	Spatial Development Framework
SELD	Stakeholder Engagement and Livelihood Development
SES	Social-Ecological System
SIP	Strategic Infrastructure Projects
SLM	Sustainable Landuse Management
SMP	Stormwater Management Plan

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TARDI	Tsolo Agricultural and Rural Development Institute
TD	Trans-disciplinarity
ToC	Theory of Change
WfEcosystems	Working-for-Ecosystems
WfW	Working-for-Water
WfWetlands	Working-for-Wetlands
WMA	Water Management Authority
WoF	Working-on-Fire
WTW	Water treatment works
WWTW	Waste water treatment works
WRC	Water Research Commission

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Acknowledgements

We would like to thanks DEA:NRM for providing the funding to develop this adaptive natural resource management and restoration plan. This took significant inputs from various Rhodes and external groups, such as Environmental Science, IWR, Geography, ELRC, GroudTruth, SMC Synergy, Sigwela & Associates and GIB. We are especially grateful for the leadership and mentorship provided by Harry Biggs.

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1. Introduction, guiding proto-vision and preliminary objectives

Harry Biggs

The Tsitsa Project (TP; formerly known as Ntabelanga Lalini[1] Ecological Infrastructure Project) is a response to severe soil erosion and high sediment yield, principally a result of extensive landscape degradation, in the Tsitsa River catchment (quaternary catchments T35A to T35M). The TP project aims to avoid the degradation and promote sustainable management of ecological infrastructure, with a special focus on rangelands, watercourses, wetlands, thicket and indigenous forest so current and future generations of local land users and downstream water users (both current and future) can benefit from the improved ecosystem services. This would also benefit future bulk water infrastructure by reducing the sediment loads in the Tsitsa River. Particularly in the ex-homeland part of the catchment, where erosion is worst and there is widespread poverty. Community buy in is pivotal in improving rangelands and maintaining soil conservation practices for future use. This is reflected in the TP proto-vision[2] (as at July 2015):

"To support* sustainable livelihoods *for local people through* integrated landscape management *that strives for* resilient social-ecological systems *and which* fosters equity in access to ecosystem *services."

In order to work towards this proto-vision, we propose that land management and restoration follows a holistic integrated approach that combines grazing, fire and storm water management (using biological engineering and some hard structures) to improve vegetation cover, slow excessive water movement down and support land-based livelihood options that are sustainable. This supports LDN principles to avoid degradation fist, followed by the reduction in degradation and lastly rehabilitation or reversing of degradation (see Figure AS).

[1] The project was initiated with the spelling 'Laleni', but was recently changed to the correct spelling of 'Lalini'.
[2] We use the word 'proto' as the vision and objectives are research oriented and not co-constructed by land users in the proposed Ntabelanga Dam catchment. The proto-vision and propo-objectives need to be tested and developed with these land users.

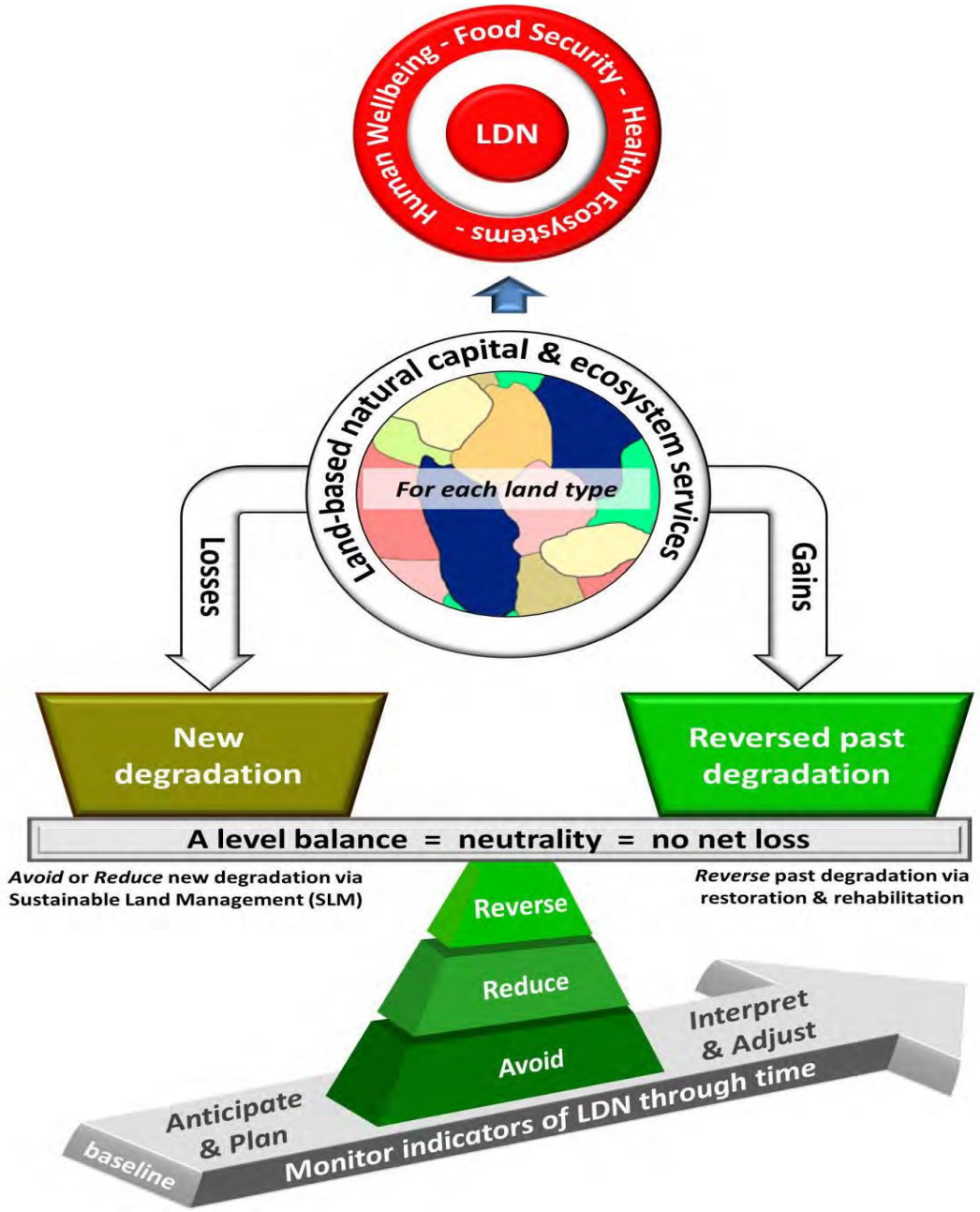

Figure AS: The Land Degradation Neutrality diagram with the focus of prevent and reduce degradation to maintain the current level of ecosystem functioning (copied from UNCCD SCIENCE POLICY BRIEF 02— September 2016).

This should all happen in a way developed together with local catchment residents, or at the very least, with their meaningful agreement. Sadly, developers and implementers seldom achieve this, particularly not in communal rangelands, in spite of for instance EIA requirements specifying public engagement. The purpose of this document is to capture the current understanding of the system, its users (including their social, political and economic inter-relationships, and especially the relationships between all these and the biophysical aspects), possible restoration options, and a spatial and temporal layout of the management and restoration plan. Current limitations and some implementation realities linked to the funders, implementers, logistics and the catchment itself are included.

Because only the first stages of meaningful engagement have taken place (rather more in the area around the smaller area of the "Green Village" project (or GVP) at Sinxaku) the way in which this document will be tackled is to ask experts to write sections in the way they might normally do so, with whatever additional social inputs they know about or feel they can comfortably include. Then we propose, as necessary (we think it normally will be) an explicit next section in each case answering the question "How does the social (including institutional, political and any other related) knowledge influence this section?" which will be written by authors with the assistance of prompts and possibly other persons who can assist in those areas. Ultimately (hopefully starting in a few more months' time when this draft proceeds to version 2, and more knowledge from deeper and wider social engagement is available) there will be another question asking what influence this more definitive knowledge now has. In the end, these three sections:

- professional biophysical/engineering style with some available inclusion of social issues
- influence of taking into account the first round of social assessment currently available
- influence of more definitive knowledge after more thorough community involvement;

may be rewritten for each theme as one unified section, but we can decide later about this.

The whole TP programme takes guidance from a set of ideas generated in the "Research Investment Strategy" or RIS (Fabricius *et al.* 2016), written mainly in 2015 and early 2016 but only published as a brochure in 2017 (Appendix 3). Two central frameworks (one called "TP Conceptual Framework" and one "TP Implementation Framework", see Figure 1-1 and 1-2 or Appendix 1 and 2) in particular became important mediating objects, alongside other commitments to collaborative and systemic adaptive thinking, reflexivity, trans-disciplinarily, recognition of polycentric governance, and (aspirationally) stakeholder-centeredness. These ideas and frameworks will be referred to repeatedly below.

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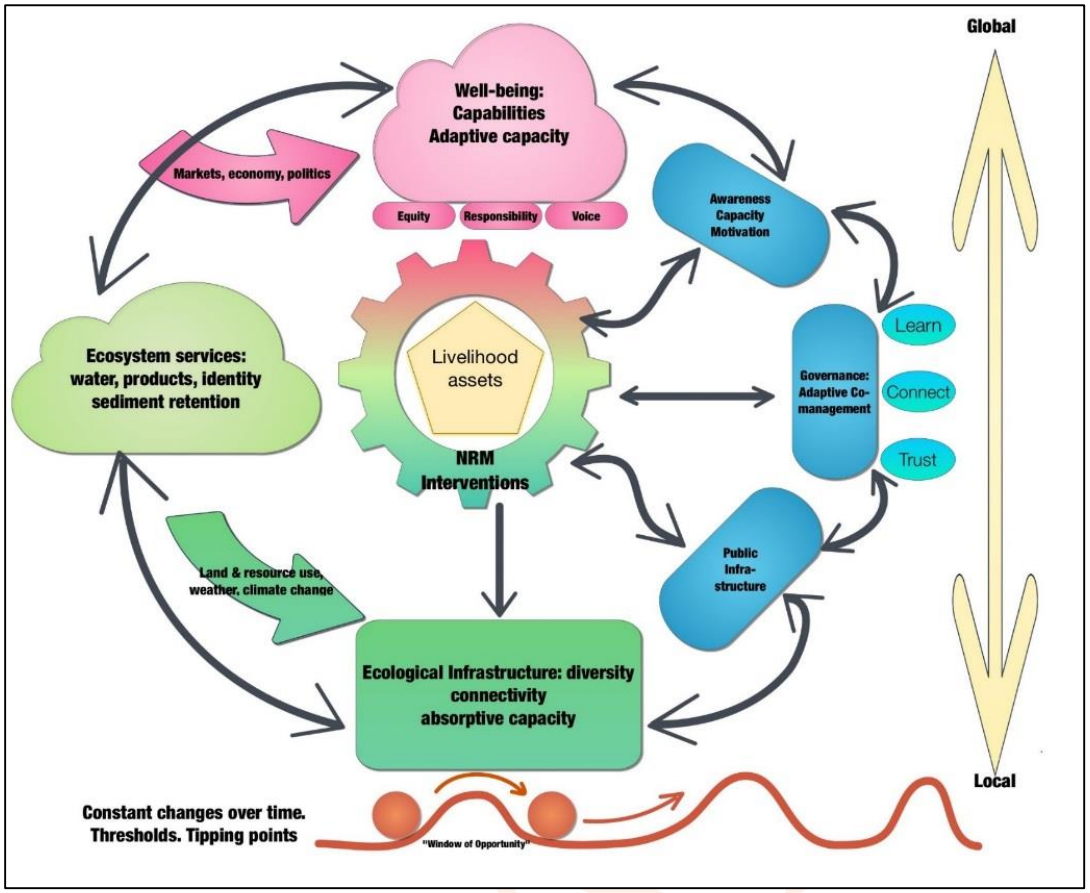

Figure 1-1: The TP central conceptual framework (copied from Fabricius *et al.* 2016).

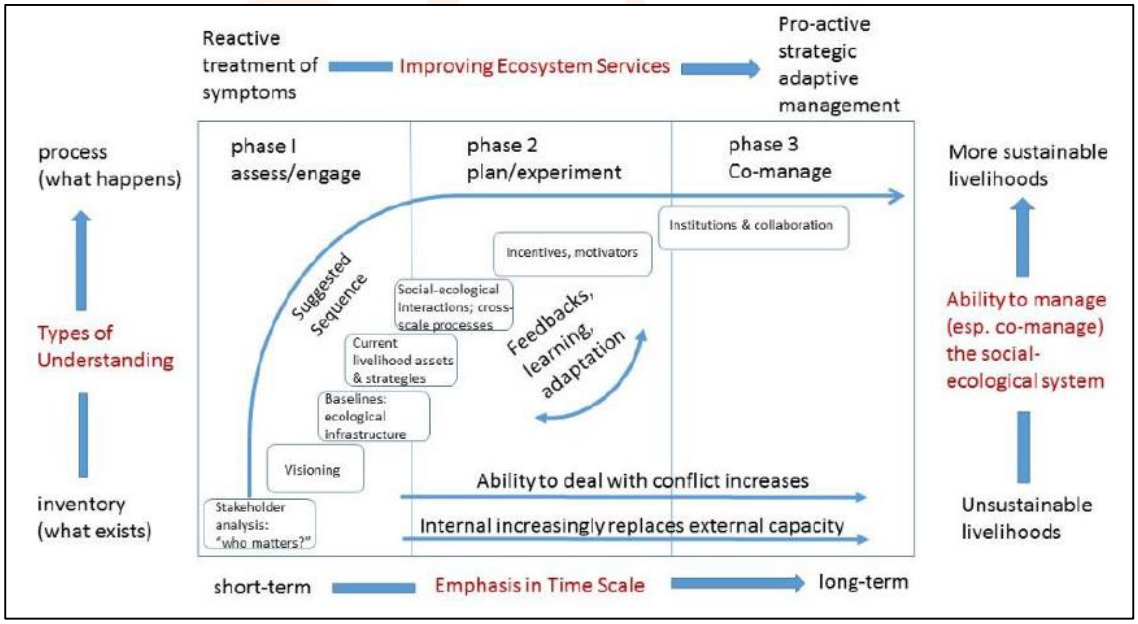

Figure 1-2: TP implementation framework (copied from Fabricius *et al.* 2016).

1.1. Stakeholder engagement

Lawrence Sisitka

The guiding document for the TP - the *Upper Tsitsa Landscape Programme*, also known as the 'party-line' (Appendix 4), includes, under the heading *A Shared Vision for a More Sustainable Future*, the following paragraphs:

This (the TP) *provides an exciting and unusual opportunity to work together towards more sustainable land and water management in this catchment, and in that way improve livelihoods. This way of working sees active relations between all role-players, placing the residents who are the most closely connected to the natural resources at the centre of the future management of the area.*

One main aim is to facilitate the development of a shared vision by residents (and to an appropriate extent, the many other stakeholders), *drawing on their values and aspirations, with other role-players utilising their expertise and resources to realise the future vision of the area, and agree strategies and plans at workable scales to achieve that vision. The idea is that all land-based, water-based and other natural resource-based activities should be guided by the agreed strategies and plans, and contribute to the achievement of the vision.* ***Central to this aim is the need to fully involve the resident users of the natural resources in all stages of planning and implementation. Relevant systems, support and capacity needs to be developed to ensure resource users become the effective managers of the resources.***

The ultimate aim of the stakeholder engagement component of the TP is articulated here very clearly and sets the tone for how the programme and all its partners need to conduct themselves in the Ntabelanga/Lalini area.

Considerable thought has been given by many within the TP partnership as to the principles underlying effective stakeholder engagement, and relating to the many concepts and considerations relevant to the process. Much of this has been recorded in various contributions throughout this document. This provides a wealth of background to the principles of stakeholder engagement, in particular relating to the considerations necessary for effective engagement with the people 'on-the-ground', the users of the land and associated natural resources. It is clear from these various contributions that there is strong consensus regarding the fundamental principles, such as transparency, openness, building trust, developing capacity etc. However, stakeholder engagement in any situation does not involve just any one group of people, or only one level of institutional activity, and cannot be seen in isolation from the cultural, social, political and historical factors shaping the contexts in which people are living and working. Moreover, this includes the social and political institutions and processes established at different levels to make and implement decisions regarding land and natural resource-use and management, and other developmental issues. It is paramount that those engaged in stakeholder engagement (whether within the TP or in other circumstances) need not only to be cognisant of these contextual factors, but need also to work with and within them.

The DEA NRM funded Ntabelanga Stakeholder Analysis – part 1 (Sisitka *et al.* 2016) provides a fairly comprehensive picture (in Section 1 and later sections) of the social/cultural/political context and provides clear guidance on the existing institutional structures and processes in regard to land and natural resource-use and management. In its recommendations, the analysis (in Section 9.2; Sisitka *et al.* 2016) also focusses on what

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could be done to indeed place the land and natural resource users at centre-stage in the TP.

In this Adaptive Management and Restoration plan, the idea will be to draw on the various contributions from others in the programme and elsewhere, and from the Stakeholder Analysis to propose a coherent framework for how the quite radical vision of the TP and the commitment of the partners to genuine stakeholder engagement may be realised.

A further intention will be to, as far as possible, identify the roles and responsibilities of those engaged in the TP with regard to stakeholder engagement. Till recently, received wisdom tended to suggest that such engagement should predominantly be the domain of specialists in social processes, the argument within the TP is that everyone should shoulder some of the responsibility, although supported by specialists. Under the heading: *Collaboration: Working Together* the Upper Tsitsa Landscape Programme document says:

The main difference between this and the many other programmes that have been implemented in similar situations is that it is essentially collaborative. It needs everyone at all levels to work closely together. Indeed, it is not possible to achieve what is needed without real collaboration. Without working together, it is highly likely that all the time and resources being committed by the DEA and others will be wasted, and no real changes will take place in the management of the land and water resources or the livelihoods of residents. All the role-players will need to locate their activities within the agreed strategies and work with others to implement the agreed plans.

*To do this **everyone will have to change their way of thinking and working**. Unless a radical directional change in the way each role-player works both separately and jointly, can be effected in the first few years, there will be little likelihood of achieving either the "together" or for that matter the "sustainable" part meaningfully. This will require complete commitment to the vision and the strategizing, planning and implementation processes by all role-players over a considerable period of time.*

Although the emphasis in the *Upper Tsitsa Landscape Programme* document (Appendix 4) is on collaboration between the TP partners, it is also intended to include real collaboration with the land and natural resource-users and all those involved in decision-making and implementation around such use.

The key driving imperative underpinning the stakeholder engagement component of this plan is that without a clear, pragmatic and coherent framework for full and effective engagement of all relevant stakeholders the best intentions in regard to developing productive working relations with the land and natural resource-users will amount to little in terms of real impact. Such a framework will also provide some direction for the development of the Terms of Reference for the proposed stakeholder engagement specialist to be contracted by DEA NRM.

1.2. Learning and Theory of Change

Harry Biggs

TP has recently taken the bold step of commissioning a PMERL plan, even as it evolves and puts some of the necessary structures in place to help take responsibility for implementing this. PMERL stands for Participatory

Monitoring, Evaluation, Reflection and Learning, expanding on the more conventional notions of monitoring and evaluation on the one hand, and reporting on the other, linking them as systemically as possible to enhance ongoing learning at multiple levels. This change in emphasis has to do with the complex social-biophysical framing, where the conventional linearity and accountability associated with more conventional monitoring and evaluation (M&E) alone, appears insufficient to engender success, in fact on its own may prevent success due to rigidity and to an over-dependence on command-and-control alone. A detailed TP PMERL Draft 1 report has recently been completed (Botha *et al.* 2017). Similar to the TP Stakeholder Analysis and TP Adaptive Management and Restoration Plan, the PMERL implementation plan will focus on phase 1 (T35A-E) – see Figure A in the executive summary.

The TP PMERL plans and visions are slightly modified to stress the need for co-creation, co-learning and hence have a fundamental Participatory prefix PMERL. A second modification is to account for REFLECTION as a vital component of the institutional learning process.

The PMERL has a foundational Theory of Change (ToC), the provisional one in the developing document reproduced below (Figure 1-3).

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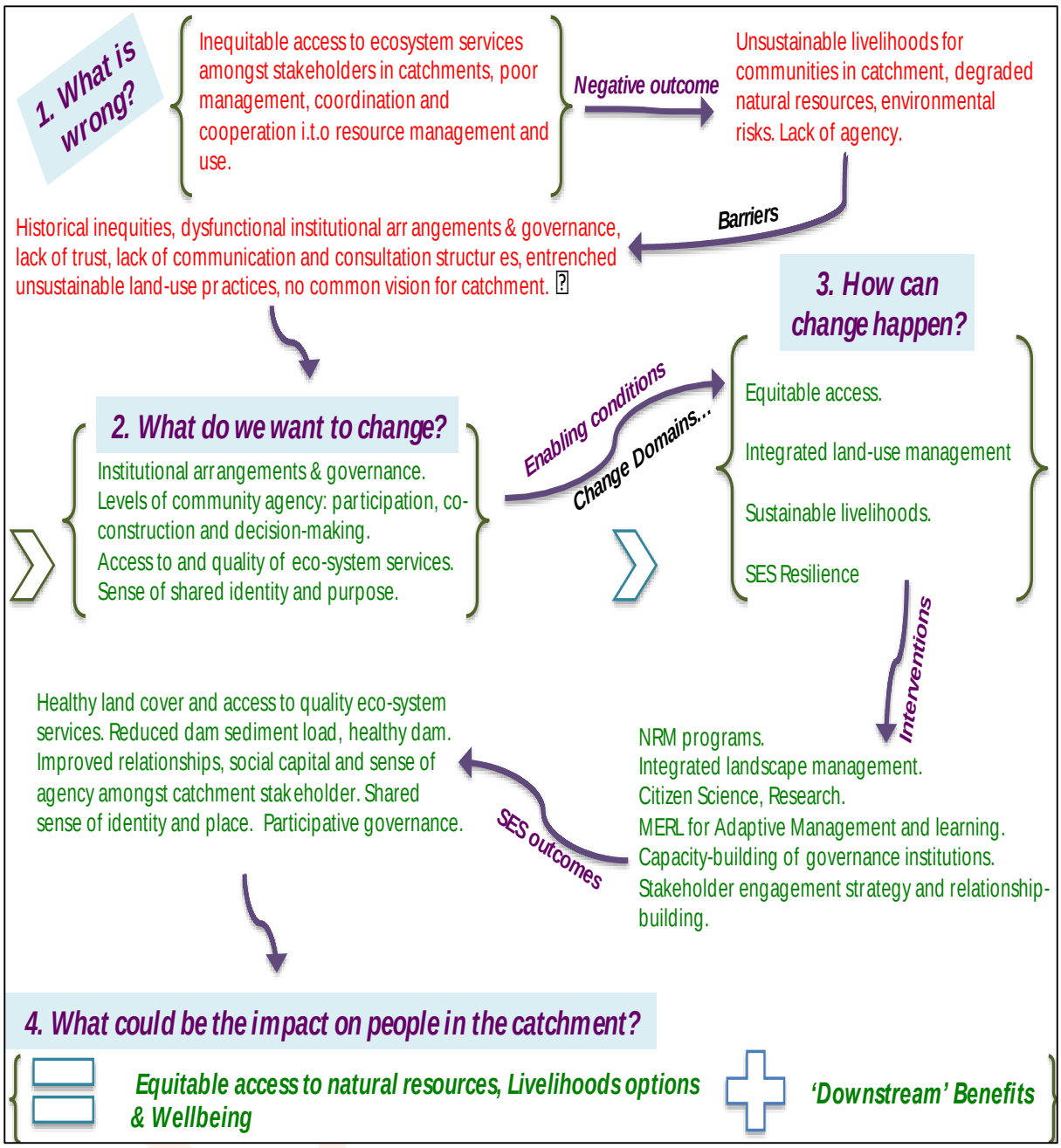

Figure 1-3. The provisional TP Theory of Change (as at May 2017; Botha et al., 2017).

The PMERL report as a whole, discusses on different levels of nested learning (so-called single, double and triple loop learning; see Box 1-1), and who all should be learning at which of the various levels. The report draws up a likely set of objectives (remembering that to date only the 'academic' objectives have been thoroughly developed in TP, though an exercise is planned at and soon after the July TP meeting to develop a wider set, which will confirm, alter and flesh out the broader objectives) and develops a provisional results framework based on these. It talks to regular data collection as per conventional M&E expectations, as well as to experimental and developmental-evaluation style (often more narrative) data collection also via key case studies. It completes the full loop by ensuring that all the above are reflexively used for learning and moving forward.

Box 1-1: Learning types proposed by PMERL (Botha et al., 2017).

Learning Type	**Purpose**	**Evaluation Approach & Methodology**	**Methods**	**Evaluation Questions**
Single-loop	Detect and (possibly) correct deviations from the "rules," i.e. project objectives, targets and indicators. Effectiveness and efficiency.	Results Framework monitors progress towards intended objectives.	Baselines, targets, success indicators	*Are we doing what we said we would do?* Is something happening? What, where and when?
Double-loop	Reflect in real-time on whether "rules" themselves should be changed, not only on whether deviations have occurred. Outcomes and Impact.	Developmental Evaluation tracks change in real-time.	Qualitative case-studies, Change narratives, Appreciative inquiry, etc.	What is changing? *So what?* How is change happening? How do we need to change?
Triple-loop	"Learning how to learn" - reflect on how we think about the "rules," not only on whether the rules should be changed. Question beliefs and assumptions about social-ecological systems, 'How the world works'	Developmental Evaluation. Social learning	Critical reflection amongst managers, Community of Practice, etc.	Are we learning about change? Who else is learning? Are we learning about ourselves? *How can we learn better?*

The fundamental pathways of change in TP are seen to be through **changed behaviour** and actions regarding **land rehabilitation** and **land use sustainability**, particularly in the more biophysically degraded ex-homeland part of the catchment. Implicit in the aforementioned (and also a fundamental pathway of change) is achieving **collaborative and polycentric governance**.

The programme comes from a historic base in DEA-NRM of more conventional (meaning as currently widely practiced in South Africa by the various Expanded Public Works Programmes, or EPWP) rehabilitation programmes. These were structured to provide local employment aimed at land use interventions to improve various ecosystem services, through large state-controlled (more recently privately-organised though still state-mediated) teams. The rationale behind these was to carry out various important physical actions (e.g. removal of alien vegetation, building of erosion-control structures, repairing wetlands, burning of fire-breaks etc.) using local people who benefit from the employment and become more skilled in the process. In so doing, the goal regarding the ecosystem was to improve delivery of various Ecosystem Goods and Services (EGS) such as water, stream flow, the multiple services provided by wetlands, improved grazing, and safer fire patterns. The overall result would be an improvement in what is now known as Ecological Infrastructure (EI) (analogous to the better-known terms physical and financial infrastructure) which in myriad ways underpins human well-being. The immediate social goal is to improve earnings and skills in local communities and hence in the short-term enhance livelihoods. Over time, it became increasingly apparent that the physical rehabilitation actions performed in relative isolation, whilst providing short-term jobs and skills development opportunities, are often not leading to sustainable improvements in EI. Hence, they do not lead to longer- or even intermediate-term improvement of the various EGS which, in turn would lead to enhancement of human benefits - such as improved grazing, safety from floods and fires, foods and materials from wetlands etc. TP has a strong moral commitment towards the concept of Inter-

Generational Equity (IGE) which essentially requires that the landscapes and EGS be restored for the benefit of future generations. This is vital for the Resilience communities will need in the face of future climate change challenges.

TP represents a flagship attempt, in one area and in one fairly typical South African rural context, to embed the above ToC more thoroughly into a wider social-ecological framing. TP's ToC includes the above pathways but in a more systemic and more socially embedded way, with the intended institutionalisation appropriate to longer-term sustainability, even after the inevitable exit of government poverty relief programs. Additional important pathways hence include:

- very deliberate deeper engagement with local communities to produce joint visioning based on the essence of key values and contexts of the various parties. Given the reality of the top-down nature of the origin of the MWP planning (very typical worldwide in such projects) this joint visioning may only be effectively executed following an initial trust-building phase. Since dams and concurrent rehabilitation are regarded as an immediate national imperative, interim arrangements informing and assessing the reactions and desires of communities, supplementing the EIA and other official contact points thus far, are being speedily instituted.
- this more active co-operation will produce a stronger community voice as part of the joint vision and planning, which, if appropriately facilitated in an atmosphere of trust, should lead to wider acceptance ("buy-in") by those communities.
- provided agreement can also be reached on appropriate responses (also compared to other existing practices and attendant norms) and if these responses can be institutionalised effectively in a suitable governance framework, then there exists a pathway to sustainability when DEA NRM influence wanes.
- essentially, the DEA NRM-mediated and the overlapping community-mediated pathways thus have the same longer-term goals but with the community initiatives hopefully outliving the DEA NRM one, and itself adapting to the future beyond that.
- key features of TP therefore include not only national priorities (such as job creation and alien plant clearing) but also very explicit linkage to local human needs, and local knowledge, norms and values, time schedules and economic realities. This is all done in a systemic collaborative context where relationships and linkages are treated as importantly as entities such as towns, areas, companies, pieces of legislation and government agencies.

We believe there should be stronger feedbacks in TP in terms of direct benefits from the MWP to local communities, or that these are at least sufficiently explicated through joint discussion. It could be conceived that there are benefits such as employment during dam construction and supply of piped water, but that the bulk of benefits are perceived as accruing to downstream users. Local residents could conceivably feel (as we experienced in the case of Macubeni Dam which supplies Lady Frere) that they have borne all the costs (such as resettlement and flooding) yet received little or no benefit themselves. If not carefully handled and carried out according to the approach described above, it is even possible that communities will later see the ongoing rehabilitation and its

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maintenance started by DEA-NRM as an ongoing expected cost to them of keeping the dams relatively sediment-free. This "missing or insufficiently strong feedback" (real or perceived as such) would then obviously mean the dams will silt up faster (and other infrastructure's lifespan would be compromised) and that few enduring livelihood benefits will accrue to locals.

Naturally all of this happening depends crucially on internal programme design, governance and function. The original core of the programme was a science-management link. In order to function effectively in terms of the intention, this inner core must overlap effectively with the actual work-teams and with society at large (including residents). Considerable discussion around the boundaries of TP suggest that in order for the larger inclusive goals to succeed, all of these domains must somehow be covered. Considering that it might not be feasible, possible or desirable for the inner core to exercise strong direct monitoring for, or "control" over the rest of the larger system (it will have that for itself), the emphasis might best fall on the way in which the inner core might interact with the other domains in a way that:

- helps elicit co-construction around the broader principles (e.g. SES)
- helps come up with appropriate monitoring for the "outer" parts
- helps encourage this to be implemented
- helps with adaptation and learning along the way
- helps with effective and appropriate trans-disciplinary growth and evolution of this larger overall system. But, perhaps without the core carrying the responsibility for all this themselves (though a possibility).

Learning inside the core subsystem is thus itself a key focus, and the "A team" (policy) and "B team" (latter with advisory and operational functions; Figure A) configuration along with the regular meetings and functioning of what is currently called TP, including its three communities of practice, are important structures to consider.

In short, the theory of change internally and regarding this interfacing to the work-teams and rest of society, must mirror the larger ToC as best possible i.e. itself procure, arrange and produce the requisite variety needed to inform, interact with, and influence the larger system (see Box 1-2). The pathways are in broad terms similar to the main ToC (i.e. must be able to map well onto these), although there are specialised sub-ToC's regarding for instance academic performance, governmental procedures, etc.

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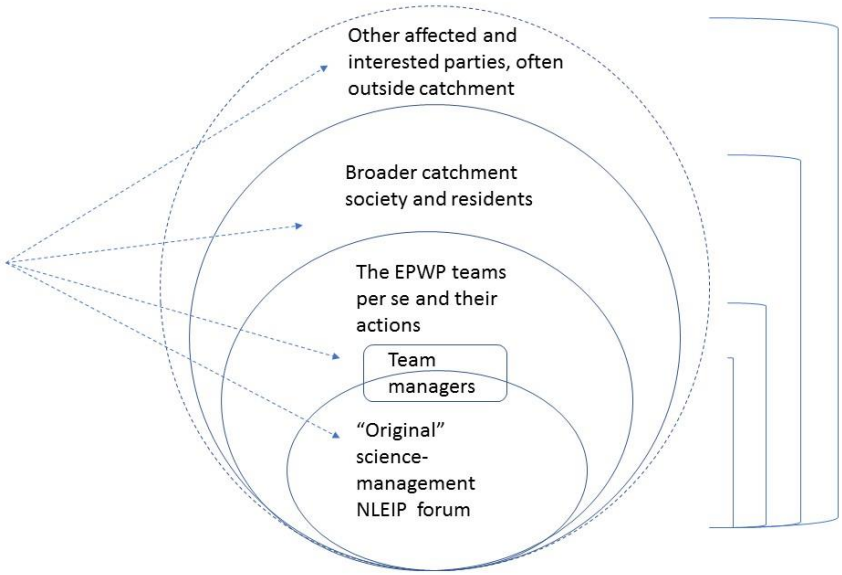
Box 1-2: various circles of influence within TP stakeholder groups (Taken from Botha et al., 2017)



1.3. Preliminary Objectives

We haven't followed the strict process as prescribed under adaptive planning, but such a provisional objectives tree will be available by the time the final report is written. However, a similar tree type structure was derived as part of the RIS, but at that time focussed more on the research than implementation, see Table 1-1 below. It would benefit TP to develop management, institutional and social objectives that include learning about and improvement of each of the themes below.

The following operational guidelines are given in the RIS (Fabricius *et al.* 2016) to reach the objectives:

1. convert research into use – co-create a framework with planners, implementers and land users; feedbacks between different components and processes.
2. promote trans-disciplinarity and multiple knowledge systems while putting knowledge into practise – focus on a common problem.
3. integrate links and feedbacks between system components (resources, resource users, governance and public infrastructure providers); this is critical in promoting self-organisation of the complex SES.
4. incorporate linkages and feedbacks from and to other spatial and temporal scales;
5. be sensitive to non-linear, abrupt change;
6. promote learning and adaptive refinement.

Table 1-1: Research themes and topics for TP (copied from Fabricius *et al.* 2016; see Appendix 3 for more details on each theme

and research topic)

Theme	Research topic
1. Social-ecological system dynamics	***1.1. Driving factors and processes at different scales.*** *1.2 Understanding and predicting the capacity to self-organize and recover from shocks; capacity to learn, adapt and transform* *1.3 Past and future trajectories under different scenarios.* ***1.4 Developing and testing theories of change, incorporating stakeholder goals, drivers and trajectories of change under different scenarios***
2. Land degradation	***2.1 Capacity of ecological infrastructure to retain sediments, water and nutrients*** ***2.2 System's ability to recover to a productive state after shocks and surprise*** ***2.3 Stakeholder beliefs and perceptions of land degradation*** *2.4 Incentives and motivators that would inspire actors to adjust their land management practices.* ***2.5 Impacts of different land use and land management practices (e.g. fire; grazing; cultivation and farming practices, plantation forestry) on ecological infrastructure and sedimentation*** *2.6 Quantification of the value of ecosystem services (including tourism), with and without ecosystem restoration interventions - 'the cost of doing nothing'.*
3. Livelihoods	***3.1 Available livelihood assets*** ***3.2 Current livelihood strategies and their changes over time*** *3.3 Local well-being influenced by economic and political processes at local, national and global levels (including the impacts of non-resident land users and migrants)* *3.4 Pathways into and out of sustainable livelihoods and livelihood strategies* *3.5 Livelihood strategies and assets and their trade-offs with ecological infrastructure management*
4. Institutions, actors and governance	***4.1 Governance processes, interventions, rules and codes of conduct that exist at local, provincial and national levels*** ***4.2 Formal and informal power relations between different institutional actors and its implications for governance*** *4.3 Institutional links and disconnects between decision makers ('public infrastructure providers') and resource users, and their implications for ecological infrastructure and livelihoods* *4.4 Stakeholder perceptions and beliefs about drivers, pressures, state, ecosystem services and responses* ***[see 2.3]*** *4.5* ***Develop and maintain (and concurrently study) an on-the-ground engagement system, with an important part of its emphasis on local communities in the context of NLEIP. This system will be built pragmatically around the existing structures and realpolitik, but also skillfully promote co-construction of necessary change"***
5. Decision support	***5.1 Prioritization of landscapes for ecosystem repair / restoration, priority areas for investment*** *5.2 Assessment of the effects of previous and current interventions for ecosystems and human well-being, and development of the most appropriate and cost effective interventions in different contexts* ***5.3 A monitoring system to implement adaptive management*** ***5.4 A learning and decision making system to implement adaptive management*** ***5.5 Stakeholder analysis and social-ecological inventory*** ***5.6 Time-line and seasonal and events calendar*** ***5.7 Ecological baselines for critical ecological infrastructure*** ***5.8 Liaison and facilitation of collective action between researchers, resource users, implementers and decision makers - building on the primary engagement in 4.5 and using the principles generated by that process***

1.4. Values and ethical considerations

Harry Biggs and Kate Rowntree

Values and ethical considerations are important, and in this project we will at this stage like to provisionally earmark certain values for particular attention (equity, social and environmental justice, sustainability, efficiency, fairness and respect) realizing all the while that the ultimate set we should consider is the set derived by eliciting them from residents and stakeholders. So far we have only elicited values from certain sub-groups (and then even only partly) such as scientists and managers, and from literature that deals with projects involving community landscape work. Eliciting a full range, and

especially those of voices less often heard but possibly ones representing a large portion of intended beneficiaries, is a longer process dependent on trust and akin to and associated with "visioning".

However, the fact that there are so many different values (of the different participants associated within TP) and that these are to some extent at least RESPECTED by others now, means that progress had indeed been made. The manifestations of these values appear in many ways, for instance in styles of discourse and action, ways of thinking and ways of working, and can already be seen between for instance the groups that have so far worked together across what were previously less permeable barriers (such as their different disciplines). These values have been implicitly surfaced and even traded off in getting as far as we have.

The systemic-relational perspective will be used as the overriding framework for balancing these values, and negotiating ways in which they are traded-off in decision making regarding the rehabilitation and natural resource management in the catchment. The social-ecological boundary and context, as well as spatial and temporal context will also guide the balancing of these values.

The following guidelines were taken from the RIS and was based on work by Laird (1998). It was written for researchers, but applies to implementers too.

"When engaging with a community, organization or individual, every implementer and researcher:

1. Should communicate information about their project [in English and isiXhosa] to local stakeholders
2. Must explain the nature and purpose of their proposed research/implementation, including its duration, the geographic area in which research would take place, and research methods, to community leaders and the community at large
3. Obtain permission to conduct research/implementation in an area via appropriate leadership structures [Should as far as possible employ local people as field assistants and local individuals or groups for workshop and field catering]
4. Must explain the foreseeable consequences of the research/implementation for resources, people and stakeholders, including the potential commercial value
5. Should explain the potential non-commercial values, such as academic recognition and advancement for the researcher/implementer [and the community]
6. Should be open about social and/or cultural risks with stakeholders
7. Must regularly inform stakeholders, including other researchers/implementers and local people, about the research/implementation process and findings
8. Should be willing to provide copies of relevant project documents, or summaries thereof, in the local language
9. Must agree on a protocol of acknowledgements, citation, authorship, respecting requests for anonymity
10. Must not engage in bribery or making false promises.
11. Should respect the needs, methods and knowledge systems of other researchers and as far as possible share information with them.

We look forward to expanding on the value set and its dimensionality, authenticity and representivity. When this

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happens, we will be interested in broadly shared values that will help us reach our goals, as well as value conflicts or apparent value conflicts amongst the varied actors.

1.5. General adaptive learning approach of TP

We embrace an adaptive management approach (Figure 1-4; or see Research Investment Strategy Figure 4 page 12, Appendix 3 for more details) where learning and evaluation is part of the process and is used at all levels. This partly structured and partly intuitive iterative process helps make robust decisions in an environment of uncertainty by ongoing system monitoring, explicit or often even by observation along the way. Typical components of adaptive management are: conceptualisation, planning, implementation, analysis, adaptation and learning. But these are interconnected in a way that they can all be inputs or outputs to each other, though it is helpful to also have a more structured version of such **feedback loops and pathways** to help practitioners of adaptive processes with ideas at the different levels/scales. Also, as has been repeatedly stated elsewhere in this report, this is usually a collaborative process with sensible inclusivity.

The South African variant, Strategic Adaptive Management (SAM) is premised on **values** or deeply-held beliefs, usually elicited in joint visioning processes. To some extent (mainly between scientists and managers) this has happened in TP, but wider sharing of values has yet to happen in any explicit way. The relative dominance of value drivers in this version has paid off in ways not readily possible with many often more technocratic versions of adaptive management. Normally the plan outcomes after a joint visioning are represented in SAM via an objectives tree. Again this was not formally done in the strictest sense in TP although there is now some pressure to make it part of the 2017 mid-year science-management meeting. However, a partly analogous process was followed in the earlier TP formative meetings, and a list of project themes developed. It could be argued these represent an objectives tree but over a more limited (mainly research) domain (see Section 1.3.).

Certain other useful heuristics used in combination with SAM processes, such as comparative risk assessment (Gaylard & Ferreira, 2011), see its usage under section 6 of this report) and ARDI (Etienne *et al.* 2011), used in constructing joint "mental models") have been introduced and meaningfully used at various steps in TP and DEA-NRM activities in the last two years. For a unified synopsis of such possible sub-steps, see the IUCN SAM brochure (Kingsford & Biggs 2012).

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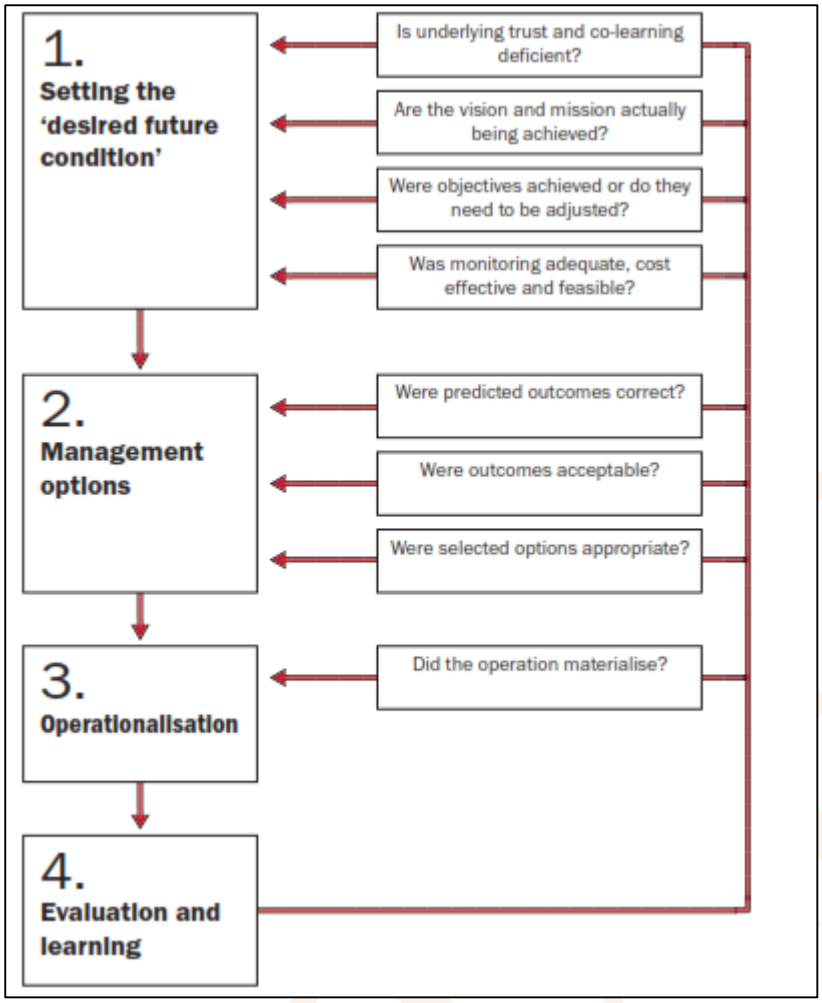

Figure 1-4. Strategic Adaptive Management diagram (after Pollard et al., 2011).

It is important to note that every technique mentioned under this section further helps and strengthens the two main frameworks laid out in TP's formative document. The first "conceptual framework" (Figure 1-1; see Appendix 1) is based mainly on international framings that started with IPBES (Diaz *et al.* 2015) and were consistently social-ecological and systemic in nature (though the scale, level and purpose of the original "mother" diagram was international and more assessment oriented). The second diagram (Figure 1-2; see Appendix 2) takes together more implementation-oriented ideas developed in South Africa around the practical phases in conservation and rehabilitation (or even natural resource management) projects. To demonstrate the meaning of SAM steps in the context of these, the adaptive planning process, for instance, would give an actual way of joint visioning and an actual way of generating an objectives tree against agreed-on values. In the case of the second framework diagram, any systemic diagramming method (ARDI is one mentioned above) used in conjunction with SAM would materially enable participants to move from inventory to process (on the "types of understanding axis); while comparative risk assessment (mentioned above and used in the preamble to part 6 of this report) clearly helps move from reactive to pro-active on the "improving ecosystem services" axis. In these ways we feel that many of the SAM (or SAM-related) suite of tools help the actual person having to facilitate these desirable transformations in NRM projects, to do so in actual practice. In a sense, they thus make possible the execution of

the transitions described in the frameworks.

Another important and again almost entirely compatible (with all the main ideas dealt with till now in this document) set of concepts comes from the notion of "trans-disciplinarity". In the RIS document, this is dealt with on page 14 (see Appendix 6). Participants in TP at many of the levels, are encouraged to use these ideas whenever appropriate, to bring together different "disciplines" but also completely different ways of knowing and the rich experience of both traditional people and/or highly experienced field practitioners. Another helpful formative publication in this field was that of Max-Neef (2005; Appendix 7) who shows diagrammatically how linkages across different illustrative levels make it possible to make useful steps forward in a domain (such as "water conservation and management in society") which is normally seen through multiple "straightjacketed" perspectives.

1.6. General principles for restoration

Although the priority of the TP restoration is to reduce sediment input to the proposed dams, successful restoration must integrate soil and water conservation with enhanced land productivity. This has long term benefits for land users and for consumers of produce. Short-term benefits include employment opportunities arising from the restoration activities. Restoration should therefore be based on the following general principles:

- It is more practical and cost effective to prevent further degradation than restore degraded land (Millennium Ecosystem Assessment, 2005; Cowie et al., 2018)
- Work with communities to co-create their wishes for their landscape
- Provide maximum opportunity for employment of local community members
- Support alternative livelihood development through NRM activities, e.g. plug growers, tree growers, etc.
- Encourage voluntary participation by demonstrating the benefits to households.
- Stabilise erosion sources, including areas of sheet erosion and gully erosion - trap sediment as close as possible to its source
- Use soil and water conservation methods to enhance soil and water retention in the catchment and improve land productivity
- Support equity in access to ecosystem services

1.7. TP Community of Practice visions

TP understandably started off very sediment-focussed, and the first "working group" was indeed a sediment working group which soon widened its focus to incorporate rehabilitation/restoration in general. TP participants soon pointed out that these workgroups appeared to have the qualities described for Communities of Practice (CoP; Wenger, 1998). Wenger define CoPs as groups of people who share a passion about a topic and who want to grow their knowledge by interacting on an ongoing basis. Learning together is a key quality of CoPs. Later two other such CoPs began and these three (there could be more, but given the limited number of people involved in

TP, these three give reasonable coverage, especially since they each need to spend time cross-linking their agendas. Newsletters produced after each TP Science-Management meeting detail activities of each of these and TP in unison. For reasons of brevity, we give only the vision statements of each of the three CoPs below. These also illustrate their interconnectedness and relationship to the overall vision.

Provisional Sediment & Restoration CoP Vision - July 2016:

"*To service the TP proto-vision, in a socially and economically effective way that is compatible with the concept of the Tsitsa catchment as a social-ecological system (SES), with special reference to reducing erosion to more natural levels through restoration efforts and good land use practice across the landscape."*

Livelihoods and Ecosystem Services CoP vision - July 2016:

"*To build a robust and dynamic community of practice that a) fosters learning amongst different actors, b) guides and synthesises integrated research on livelihoods and ecosystem services, and c) distils out key lessons and recommendations for promoting resilient livelihoods within TP*"

Governance CoP vision - July 2016:

"*To understand, prototype and help implement effective polycentric governance"*

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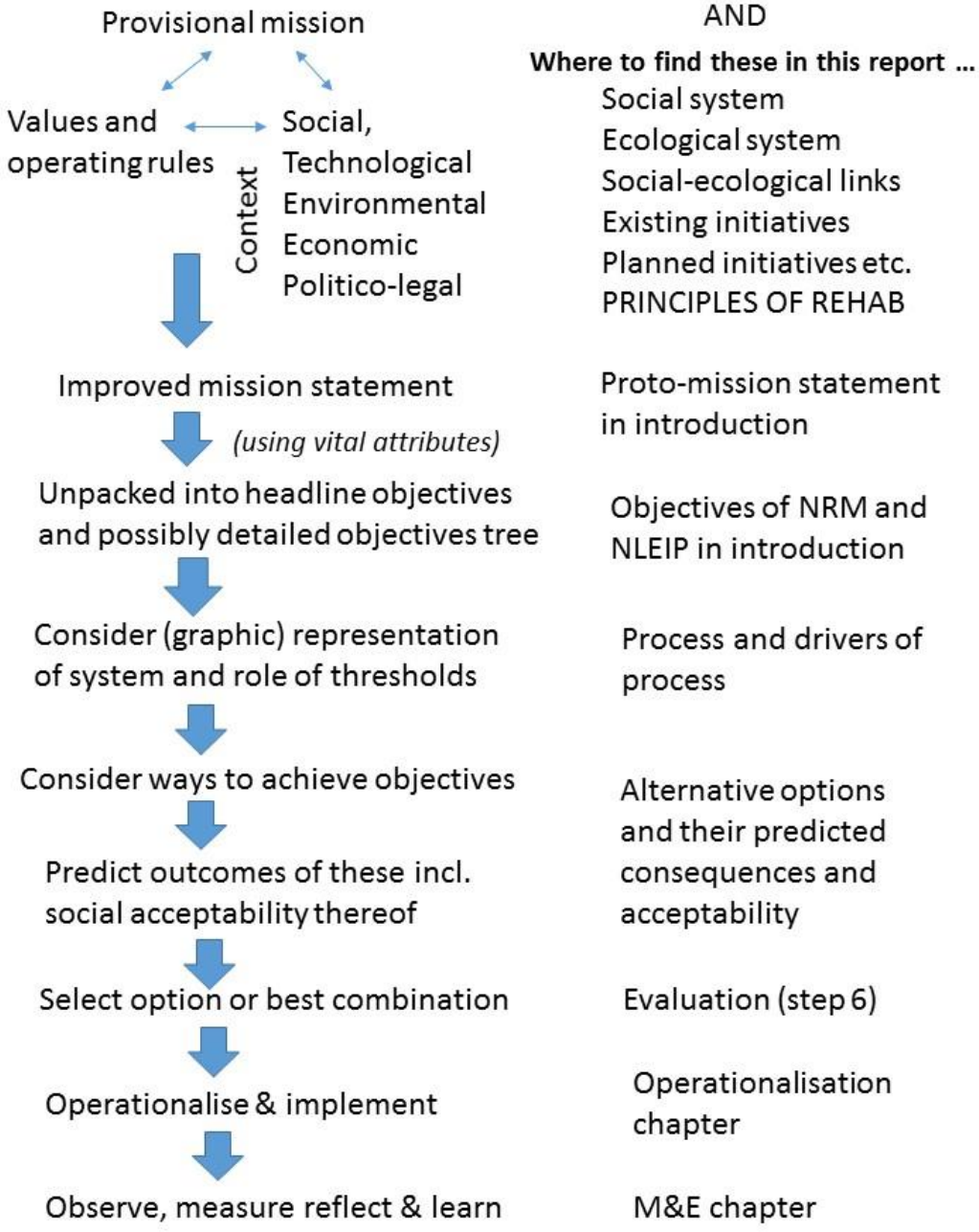
BOX 1-3: Adaptive planning roadmap for this report

The Adaptive Planning process steps, entering into management & evaluation



2. Social-biophysical context

Note: the 'ecological' referred to in SES and the RIS document is changed to 'biophysical' in this title to include the physical components, such as sediment, soil, range lands, rivers, etc., that are integral to TP. The term SES will be left as is and used as intended in the RIS.

The SES approach requires that SES subsystems are integrative and linked in particular places. The emphasis is on the links between social and biophysical (as opposed to social-social and biophysical-biophysical). The system denotes that the interactions are systemic and draws attention to the interactions between the components.
Below is a description of the social and biophysical system, highlighting some of the key interactions between the social and biophysical domains that effect natural resource management. Other planned activities and real world realities for the catchment are briefly-mentioned as these will influence nrm.

2.1. Social system

Below is a description of the political, financial, education and governance structures within the wider Ntabelanga catchment.

2.1.1. Political ecology, policy, grants and education

Kate Rowntree

A basic premise of the political ecology approach to understanding land degradation is that land degradation is the result of external policy decisions that disempower land users and stop them using land sustainably (Blaikie 1985). Drivers of land degradation include biophysical drivers, such as climate, and human drivers, such as policy and socio economic and cultural drivers. Policy drivers consider the impact of policy on land use and land management – policy either can promote protection or exploitation or can create disincentives for people to use land sustainably. Here we will consider some of the South African policies that can be considered as drivers of either degradation or rehabilitation. The discussion will look at policies pre 1994 and developments since.
The Tsitsa catchment comprises two types of rural land holdings, a continuation of the Apartheid structure imposed from 1948 onwards. The communal land is held either on behalf of the National Government by Tribal Authorities or private commercial farms mainly under white ownership. The responsibility of a Tribal Authority varies by area but generally they have the authority to determine matters such as who farms what land, how stock is managed, who is employed on externally funded projects and so on. Survival is a strong motivating factor determining how land is used. Private farmers have autonomy over decision-making but are subject to legal and economic constraints. The profit motive for commercial farmers is usually paramount.

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2.1.1.1. *Pre 1994*

South Africa's Apartheid policy and accompanying legislation was one of many policies globally that restricted entitlement to land and participation in democratic processes of a particular group of people. Enacted in 1948, Apartheid entrenched and extended segregationist policies that had been evolving since the first occupation by white settlers in the eighteenth century. Three significant Acts were the Native Land Act of 1913, the Black Authorities Act of 1951 and the Promotion of Black Self Government Act of 1959. Key elements that impacted on the Tsitsa catchment were the political and administrative separation of the Transkei homeland from Republic of South Africa, laws that restricted black ownership of land, the loss of able-bodied men who were enlisted, solicited, employed to work in the mines, reducing available labour in the rural areas, pass controls which prevented women from living in urban areas with their husbands, limited investment in education, especially at school level. Forced removals from the 1960s onwards contributed to rapid population growth. Betterment planning, introduced from the 1930s, led to resentment and political resistance. Social grants in the form of pensions also reduced people's reliance on the land. Further discussions can be found in Fox 2000, Lester 2000, Simon & Ramutsindela 2000.

Urban labour and Influx controls

Many able-bodied men were enlisted to work in the mines in the Johannesburg area. Influx controls meant that women could not join their husbands as a family unit. This left women to head the households and carry out agricultural tasks. The men would return on occasion to help with ploughing, harvesting and other work. Ploughing was traditionally undertaken using oxen, which required skilled handlers found among the men. Fewer men therefore meant smaller areas would be ploughed.

Forced removals

While able-bodied men were recruited to work on the mines, between 1960 and 1983 over 400 000 isiXhosa were forcibly removed from white areas to the Transkei (Simon & Ramutsindela 2000). This contributed to a significant population increases. Fox (2000) states that Transkei's population increased threefold from 800 000 in 1904 to 1 300 000 in the mid-1950s to 2 600 000 by 1981.

Betterment planning

Betterment planning was introduced in the 1930s but extended in the 1950s and 1960s in response to wide-spread erosion in communal areas (De Wet 1987). The aim was to establish a more sustainable land use pattern through resettlement into nucleated villages and delimitation of land for cultivation and grazing. Although the intention was arguably good, the reality was increased distance from homesteads to lands, decreased control over livestock, a concentration of roads and tracks around the new settlements and dissent from the affected population. Land use planning was not always appropriate for the land in question. In the Sinxaku area, Betterment was accompanied by active destocking, creation of fenced camps and rotational grazing (Heard-Hoare 2015).

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Farmer support

Famer support was provided separately in the RSA and the homelands. By the 1980s white agriculture was afforded protection from foreign competition through import controls, there were direct and indirect subsidies such as grants for soil conservation and the low cost of irrigation water and there were regulated marketing systems for all products through the Agricultural Marketing Act of 1968 (Fox 2000), Act 59 of 1968 (Government Gazette 1968). These privileges were not extended to the homelands where there was a poor level of farmer outreach and infrastructure serves and inadequate market access. The Transkei Government ran a limited extension service and farmer education was provided through the Tsolo Agricultural College, founded in 1904.

Fox (2000) describes the declining productivity of Transkei communal lands. In 1910 maize production stood at 80 000, in 1930 at 180 000 but by the late 1980s at only 120 000. He ascribes this to poor and erodible soils, reduced fallow periods, low fertilizer use, the absence of men to do heavy work and loss of plough teams (oxen). Cultivation moved from fields to kitchen gardens which could be managed more easily by female headed households, they were easily fenced, could have inputs of kitchen waste and kraal manure. Reduced yields overall were offset by remittances, pensions and social welfare payments. Van Zyl *et al.* (1996) estimated that two thirds of rural household income came from the urban sector by way of pensions and remittances.

Social welfare grants

Social welfare grants in the form of pensions for whites were first introduced in 1954. This was later extended to black South Africans and those in the homelands. Rural pensions were increased in 1965 to match their urban counterparts (Kakembo & Rowntree 2003). While providing much needed financial assistance to families, it also reduced their reliance on the land for food. In a region with variable rainfall, declining soil fertility and a high risk of crop failure there is less incentive to grow crops if one can survive on alternative funding sources.

Education

Low investment in education, policies that prevented black children from engaging with maths and science and enforcement of Afrikaans as the language of learning led to a disempowered, resentful, illiterate and innumerate population. Mission schools provided a better 'European style' education than government schools with their stress on Christian values. Gibbs (2014) relates how many black professionals were educated through mission schools in the first half of the twentieth century. However, after 1950 the Apartheid state held back funds from mission schools for not conforming to the Bantu Education Act. At the same time, secondary schooling was greatly expanded but under-resourced, especially in remote rural areas. Young men who would have been engaged as herders of livestock were now brought into an ineffective school system (Gibbs 2014).

2.1.1.2. *Post 1994*

There have been a number of changes since the change of government in 1994, not all of them having positive impacts.

Land ownership and land tenure

Land ownership patterns remains very much the same, with the former Transkei being under communal ownership under the authority of Tribal chiefs, the former RSA being under commercial farms, mostly white ownership. Despite the land reform policies instigated in the late 1990s (South Africa 1995, 1997) there has been little or no change to land holdings in the Tsitsa catchment. However, there is continued pressure for land redistribution, a threat to white farmers who face an uncertain future and will be more reluctant to invest for the long term. According to Kepe & Hall (2017), the most recent government policy on land reform (Department of Rural Development and Land Reform 2013) is leading to state purchase of farms to be provided on leasehold, with an increasing emphasis on business-orientated ventures rather than support for the rural poor.

Economic policies

A major change in South Africa post 1994 is the globalisation of the agricultural market, the external influence of institutions such as the International Monetary Fund (IMF), the World Bank and General Agreement on Tariffs and Trade (GATT) and the move in South Africa towards a neo-liberal growth policy. The short-lived Reconstruction and Development Programme (RDP) was replaced in 1996 by GEAR (Growth, Employment and Redistribution), in turn replaced in 2005 by ASGISA (the Accelerated and Shared Growth Initiative for South Africa). A shift in policy direction came with the New Growth Plan (NGP) in 2010 and the National Development Plan (NDP)-2030 in 2013 (Ncube *et al.* 2012). The NGP was to be more development orientated, focussing on decreasing unemployment through job drivers. There would be renewed investment in infrastructure, skills development, the green economy, among others (Ncube *et al.* 2012).

Agricultural policies

As early as the late 1980s, Fox (2000) states that there had been a liberalization of the agricultural sector, with removal of subsidies, tax concessions and price support mechanisms. Agricultural marketing boards were abolished. As international markets opened up, commercial famers have been encouraged to grow export crops, with a move towards monocultures. These are often crops that provide poor ground cover and promote erosion. The Maclear-Ugie region boasts one of the largest potato growers in South Africa. Such crops are also encouraged by the rise of consumerism and a change in diet, with an increased consumption of fast food (chips) and crisps. Simon & Ramutsindela (2000), comment that in the late 1990s the USA 'discovered' Africa as a market for investment, opening up South Africa to American goods and culture. The increased national population also has increased the need for food production. A further factor affecting farming is the increased labour costs arising from government policy. This leads to increased mechanisation and soil compaction by farm machinery, a significant cause of land degradation.

Since 1994, the focus of direct government support has shifted from white commercial farmers to black farmers, with an emphasis on 'emerging' black commercial farmers. The effectiveness of this support can, however be questioned as new farmers need a huge investment in material and social capital, including for instance, appropriate agricultural and business skills development. The level of support through extension services in communal areas is variable. Organisations such as the National Wool Growers Association (NWGA) and Grain

SA, although largely supporting established commercial farming, are said to be actively promoting wool and grain respectively among black communal farmers in the Maclear area. Grain SA opened up new office in Maclear in August 2014 to support black farmers growing grain. They promote the expansion of maize, soya beans and sorghum, in part for biofuels.

While this support is to be welcomed, it is also important that such organisations consider how the negative aspects of wool (sheep grazing) and grain (monocultures, poor crop husbandry) can be minimised.

Freedom of movement

A significant but unexpected change, is that because women are now allowed to join their husbands in urban centres, the men no longer need to return to the villages on an annual or biannual basis. This means that there are fewer people to plough and do heavy tasks. This has reduced the areas cultivated.

Education

Schools are still under-resourced but there is an attitude shift towards the need for education. One outcome of freer movement is that more learners are joining their families in larger urban centres for high school education. This improves their skills level but also their mobility so educated youth will tend to leave the area.

Local governance and democracy

With the move to democracy there has been a perceived break down of local governance systems leading to increased theft of fences and livestock. Theft is a major disincentive to farming both in the communal and commercial areas.

2.1.2. Natural resource governance. Who has the power?

Current and possible future arrangements of natural resource management is describes in the two following sections.

2.1.2.1. *Current arrangements of natural resource management*

Lawrence Sisitka

Formal governance processes in South Africa, as defined in the Constitution, operate at essentially three (3) levels: national, provincial and district/local. In the former homeland areas, such as the majority of the Ntabelanga/Lalini catchments, a further layer of formal governance, that of the tribal (or traditional) authorities, operates. This additional layer is considered by some commentators to be contrary to the constitutional dispensation. At the very local level, more informal governance structures and institutions can be found, in local associations and committees of various kinds.

Below is a brief overview of the government departments, municipalities and civil society organizations and their activities in the catchment that influence land use to some extent. Also listed is a description of decision making at the 'on the ground' level.

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National Government Departments and related organisations

The following National Departments play a role in governance (see Stakeholder Analysis for more details; Appendix 5):

- Department of Water and Sanitation (DWS) - dam construction, water resource management and proto-CMA
- Department of Environmental Affairs (DEA) – environmental programmes, legal authorisation, compliance and enforcement
- Department of Science and Technology (DST) – supporting research and catchment management
- Department of Mineral Resources (DMR) – borrow pits, quarries, fracking and sand mining
- Department of Agriculture Forestry and Fisheries (DAFF) – agriculture and forestry, land care
- Agricultural Research Council (ARC) – grassland research
- Department of Rural Development and Land Reform - establishment of Agri-Parks and Farmer Production Support Units, and development of Rural Development Plans for each district municipality
- Water Research Commission (WRC) – developing a 'Green Village'
- Working on Fire (WoF) – fire control activities

Provincial Government Departments and related organisations

- Department of Economic Development Environmental Affairs and Tourism (DEDEAT) – local economic development and Mhlonto Nature Reserve lower down the Tsitsa river
- Department of Rural Development and Agrarian Reform (DRDAR) – agricultural extension services to small-scale and emerging farmers and identifying suitable areas for irrigation
- Department of Social Development (DSD) - Village Development Committees upgrading of
- the access road, the establishment of and Early Childhood Development (ECD) centre, installation of rainwater tanks and a poultry project
- Office of the Premier - Mzimvubu Water Project
- Eastern Cape Socio-Economic Consultative Council (ECSECC) - Project Management Office for the Mzimvubu Water Project
- EC Cooperative Governance and Traditional Affairs (ECCoGTA) - development of municipal Integrated Development Plans (IDP) and Spatial Development Frameworks (SDF); adequate representation of communities and traditional authorities in such processes
- Eastern Cape Rural Development Agency (ECRDA) - agency of the Provincial DRDAR and also work closely with DRDLR
- Tsolo Agricultural and Rural Development Institute (TARDI) – works closely with the agricultural extension services and provides training in animal health.
- Accelerated and Shared Growth Initiative for South Africa – Eastern Cape (ASGISA-EC) helps provincial government accelerating growth and development in the eastern part of the Eastern Cape.

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Projects within the Mzimvubu catchment include: agriculture and agro-processing; forestry; water resource development; hydro power and alternate energy; tourism development; sustainable human settlement.

Elected authorities

The sub-catchment falls within two district and two local municipalities:

• Joe Gqabi DM (Barkly East) and Elundini LM (Maclear)
• OR Tambo DM (Mthatha) and Mhlontlo LM (Tsolo and Qumbu)

The vast majority of the Ntabelanga sub-catchment falls within the Joe Gqabi/Elundini area, with just the northern portion of T35E falling under the OR Tambo/Mhlontlo area. The boundary between these municipalities is the Tsitsa River itself (including the dam if it is constructed). Both DMs and LMs have mandated responsibilities for development planning, including the production of Integrated Development Plans (IDP) and Spatial Development Frameworks (SDF).

There is ongoing tension between the elected (municipal) and traditional authority in terms of land use decision-making (see more on this in the TP Stakeholder Analysis report (Sisitka *et al.* 2016), Appendix 5). Currently it is indeed the chiefs and their traditional councils, and, in the Mhlontlo LM area, the Mpondomise Royal Council, who are responsible for determining land allocations and uses within the former Transkei portion of the sub-catchment.

Civil Society Organisations

CSOs and NGOs have been active in the area for a very long time, primarily in the development sector and in the form of mutual-support organisations, such as farmers' associations. In comparison with the government sector CSOs have no decision-making powers and can only provide advice and support in relation to land-uses and management and development processes more generally. More on their areas of influence and involvement in the TP Stakeholder Analysis (Appendix 5; Sisitka *et al.* 2016).

Private/commercial area

In the private/commercial farming and forestry sector, land is privately or municipally owned. Land and natural resource use and management decisions are taken to a large extent, by individual farmers, with advice and support from their agricultural suppliers. Land use decisions have to comply with all relevant legislation. PG Bison, with a land-holding of over 70,000 hectares in the area is managed entirely as a commercial forestry, timber and cattle concern and makes its decisions based on commercial considerations within the constraints of the appropriate legislation. This area, in the Ntabelanga catchment, is covered by the Elundini LM Wards 1, 4 and 17, although there seems little recourse to, or reliance on, by the farmers, either the local or district municipalities. There is a Maclear Farmers Association (MFA) including almost all commercial farmers in the area and the Maclear Fire Protection Association (MFPA) of which all commercial farmers and PG Bison are members. This latter organisation is where farmers actively co-operate to reduce the risk of fire damage and receives support from

WoF.

Former homeland 'communal' area.

Land is state owned and administered through traditional authorities. This has considerable implications in terms of the authority of the state to take decisions regarding the use of this land without full consultation with and approval of the traditional authorities, particularly the tribal councils and the amaMpondomise Royal Council (see 1.3.2 in Appendix 5 for more information), and the land users themselves. Here the state does not need to purchase or lease the land in question, as it would in the case of privately owned land. However, the land does need to be formally released from its current designation as communal land, with the Department of Rural Development and Land Reform (DRDLR) being responsible for this.

The area of land within the former Transkei boundaries is administered through a number of chiefs (either of the Mpondomise or Mfengu, Basuto or Batlokoa Nations – see above), who each oversee a number of headmen who themselves represent individual villages or small clusters of neighbouring villages. Villages not represented directly by a headman have sub-headmen. Decisions regarding land-use and management are taken jointly by the chiefs and headmen in the traditional councils, but the chiefs are the ultimate decision makers at this level, with the headmen not having the authority to unilaterally make such decisions.

The critical fora in the former homeland area are the tribal (or traditional) councils, which usually meet every month, and often involve, in addition to the chiefs, headmen and sub-headmen, the relevant ward councillors and agricultural extension officers. While there is considerable contention regarding the roles and constitutional relevance of the traditional authorities, the reality is that it is these councils which determine most if not all land use activities within the boundaries of the particular authority. Some villages may still support Village Committees, who liaise closely with their sub-headmen and/or headmen in matters of importance to the villagers, including matters related to land and natural resource use and management.

2.1.2.2. Possible future natural resource management: an emerging forum for water and natural resource management

Tally Palmer and Margaret Wolff

This section is provisional and needs further updates by the authors to dovetail with the proposed TP Stakeholder Engagement model as CMF will not link to all proposed levels.

The landscapes on which rain falls, flows, seeps and filters into wetlands, streams and rivers, and collects in underground aquifers have the biophysical boundaries of quaternary catchment T35 A-E. The river is the Tsitsa River and its tributaries. The Tsitsa River is itself a tributary of the Mzimvubu River primary catchment (the easternmost River in Water Management Area, WMA, 7).

Water use and management falls within two district municipalities that overlap with T35A-E (Figure 2-1). Joe Gqabi District Municipality, which includes Elundini Local Municipality (ELM); and OR Tambo District Municipality, which has Mhlontlo LM. The municipalities will source water from dams, and have water treatment

works (WTW) and waste water treatment works (WWTW) to treat water and waste, and systems of pipes to carry drinking water to people and waste water to the treatment works.

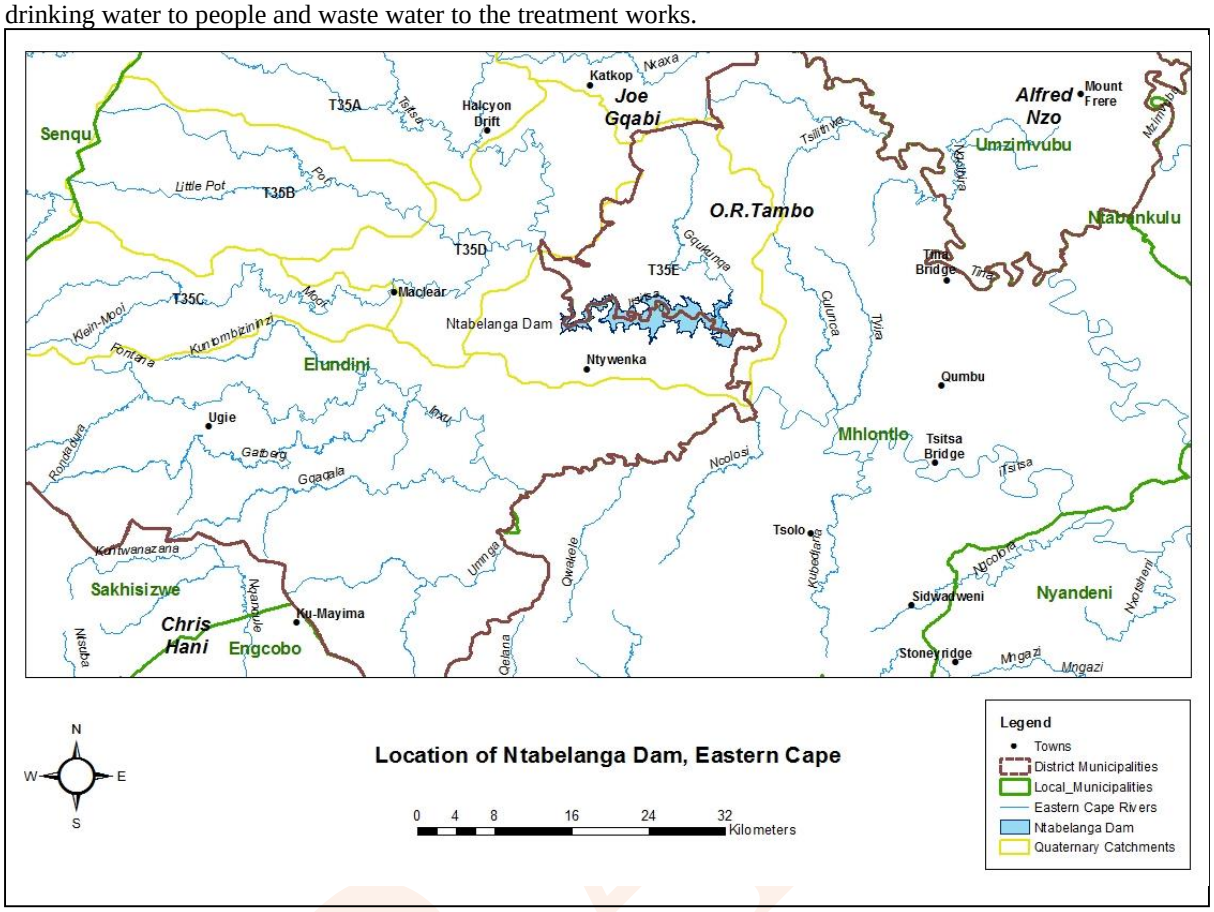

Figure 2-1. Map showing the location of the proposed Ntabelanga Dam – district (brown) and local (green) municipality borders and the quaternary catchments T35A-E (yellow).

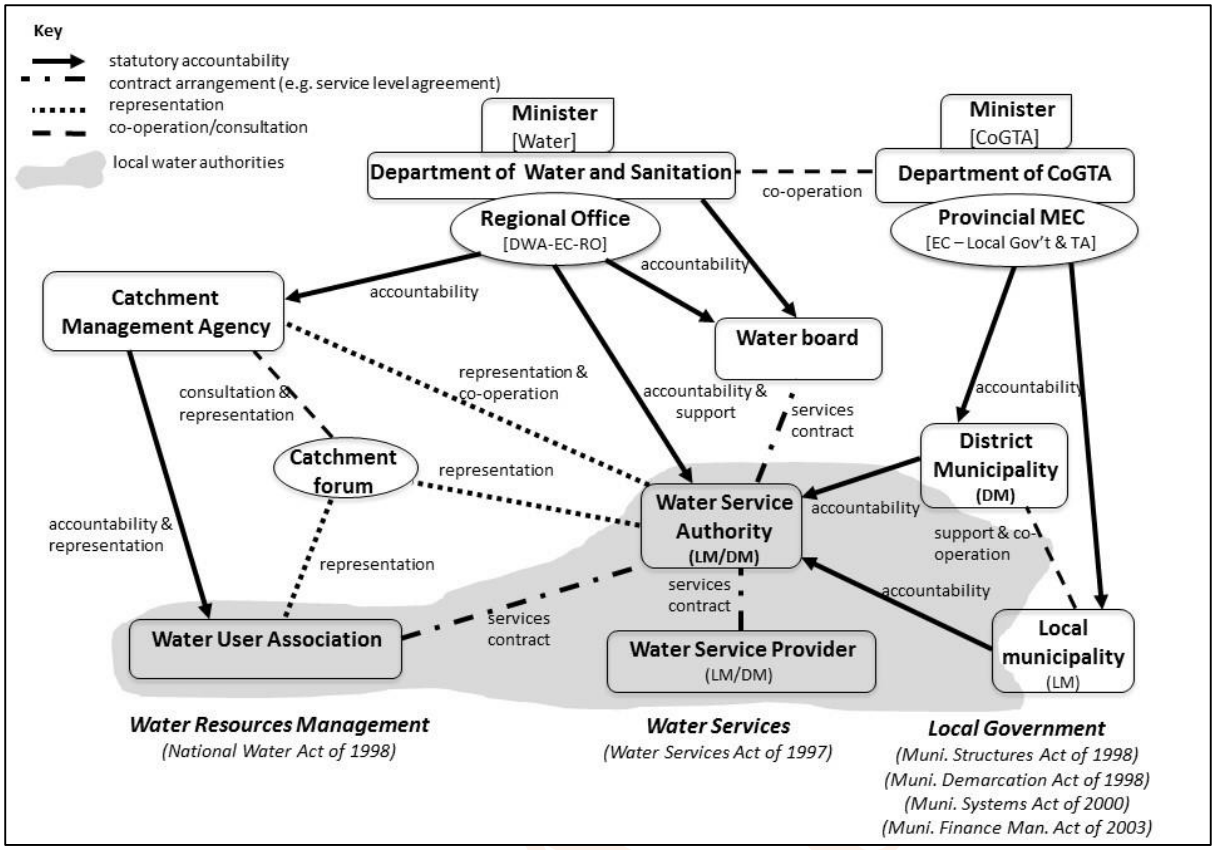

Figure 2-2: Primary institutional arrangements, with the established institutions in square brackets. The Department of Water and Sanitation (DWS); CoGTA = the Department of Cooperative Governance and Traditional Affairs; EC = Eastern Cape; MEC = Member of the (provincial) Executive Council.

Significantly, at the LOCAL individual person scale the NWA provides for a participatory institution linked to water governance: the Catchment Management Forum (CMF) (Palmer *et al.* in press).

The TP governance **research** is focussed on tracking and facilitating the emergence of a CMF through which people living in quaternary catchment T35A-E can network and collaboratively contribute to catchment governance. CMFs have very close links to CMAs.

Land management is still mostly project driven. In South Africa, the only investment in institutional structure at a local level, on a landscape, is a Catchment Management Forum (CMF) - and CMFs happen to belong in water governance and are linked to Catchment Management Agencies. Within the DEA the habit is nrm but there is not an institutional fabric down to local level. The DEA NRM have provincial offices which act in the same way as a CMA in scale. The DEA NRM should use CMFs because of the link between water as a synthetic resource in a landscape with a natural biophysical boundary of a catchment.

It makes little difference if we call it natural resource management or water resource management or catchment management because we are talking about the interaction. Here very clearly, we are talking about a complex social ecological system where people live on landscapes with land and water.

There seems to be little point in replicating institutional development so our recommendation would be for CMFs to work for water, sanitation and environment. Water was designated at a national level which is not the same for environment BUT water intrinsically includes environment through the catchment. The catchment is the way in

which water and land is linked in landscape.

2.2. Biophysical system and general land management

Bennie van der Waal, Jay Le Roux, Kate Rowntree, George van Zyl, Ralph Clark

Below is an overview of the biophysical landscape template and the current land management practises.

2.2.1. Topography

The catchment is located in the mountainous foothills of the southern Drakensberg, also known as the Great Escarpment geomorphic province (Partridge et al., 2010). Elevation ranges from approximately 950 m at the catchment outlet in the southeast to approximately 3 000 m in the Drakensberg Mountains (Figure 2-3). The catchment has a drainage area of approximately 2 000 km^2 and is drained mainly by the Tsitsa River with a flow length of approximately 200 km from north to south. The Tsitsa River takes its source from the Drakensberg and is fed by mainly three rivers namely, the Mooi, Pot, Tsitsana and upper Tsista Rivers. After a flow length of approximately 200 km, the Tsitsa River flows into the Tina River, which flows into to Mzimvubu River less than five km downstream from above-mentioned confluence. Longitudinal connectivity of the main rivers mentioned above is not influenced by large dams, but 455 small dams occur in their tributaries along the axial valleys and related hill slopes (for T35A-E). Approximately 3 410 wetlands occur in T35A-E, ranging between relatively small (≤ 8 ha) isolated hillside seep wetlands to large (> 1 000 ha) valley bottom wetlands in the upper catchment area (Huchzermeyer and Schlegel, 2017).

Landforms are complex, ranging from very steep (40%) mountain slopes of the Drakensberg to gently undulating foot-slopes (2%) and nearly level valley floors. The Drakensberg runs northeast to southwest with long narrow spurs extending from the escarpment, creating many ridges and plateaus separated by steep valleys (De Decker, 1981; Rutherford et al., 2006).

Limited sediment storage space exists due to the steep slopes and confined nature of the valleys. Narrow valley fills exist along sections of river in T35A-E. In general, the rivers of the eastern seaboard are incised and in a phase of degradation, cutting down into previously deposited valley sediments or bedrock (Dardis et al., 1988).

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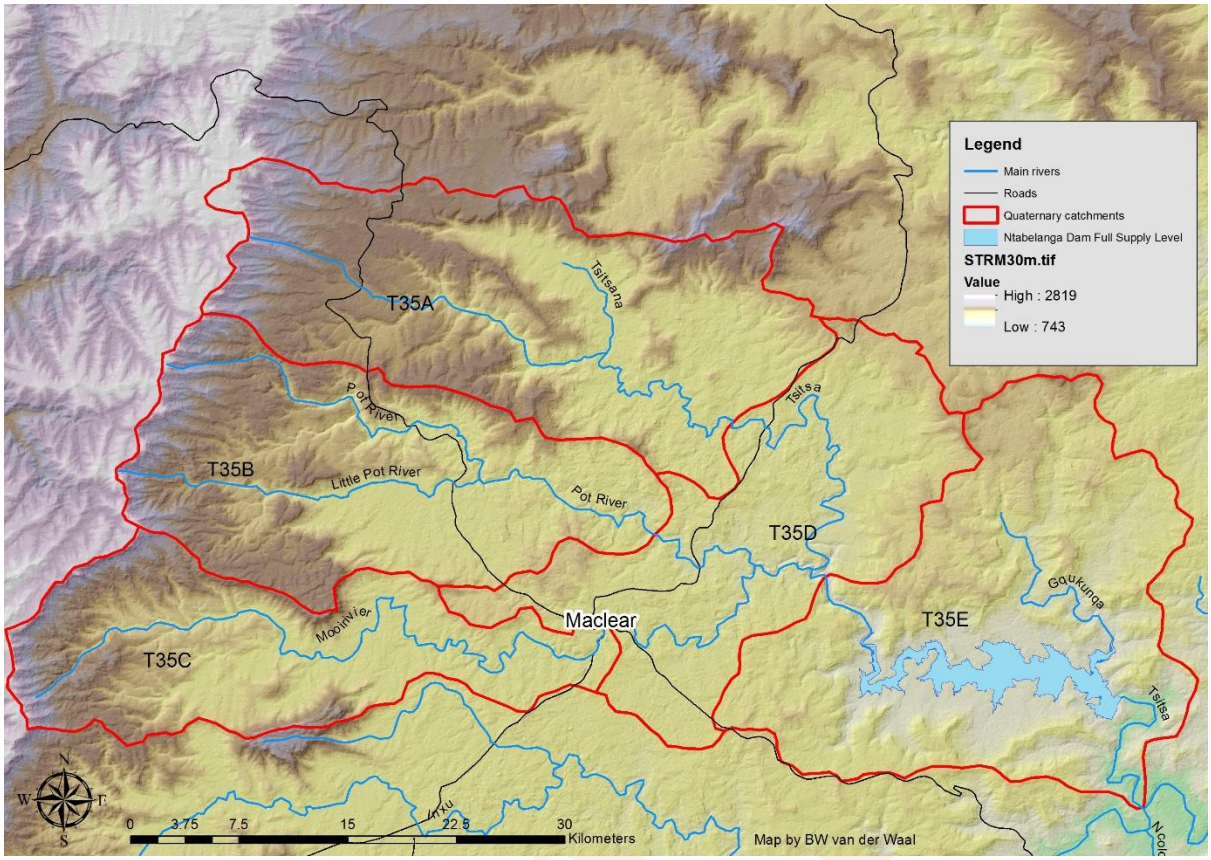

Figure 2-3: Elevation map of T35A-E.

2.2.2. Climate

Precipitation peaks in summer, in the form of high intensity thunderstorms (Nel, 2008), with snow during winter on the higher ground (Rutherford et al., 2006). Rainfall varies from 600 - 1 000 mm per year and increases with elevation (Rutherford et al., 2006), up to 2 100 masl above which rainfall and rainfall intensity decreases (Nel et al., 2010). Evaporation peaks in summer (December to February) and can be as high as 1 628 mm per year (Rutherford et al., 2006). Although evaporation exceeds rainfall, the area has a mean annual runoff of 187 - 289 mm per year (WR2005; Middleton and Bailey, 2011). River flow is perennial and peaks in summer. Mean monthly temperatures range between 6.6 and 20.3 ◦ C, with monthly means of daily minima and maxima, respectively - 4.5 and 10.7 ◦C in winter (July) and 17.1 and 29.8◦ C in summer (January) (Climatology Staff, 2012).

2.2.3. Geology

The upper parts of the catchment are underlain by basic/mafic lavas (Drakensberg Formation), whereas the lower portion is underlain by intercalated arenaceous and argillaceous strata (Figure 2-4). The lower sedimentary sequence consist of the Clarens, Elliot, Molteno and Tarkastad Formations, all except the Clarens Formation consisting of layers of sandstone and mudstone. The Clarens Formation consists of sandstone. Intrusions of Karoo

pyroclastic rocks or dolerite dykes can be found throughout the catchment, mostly in lines indicating previous fissures in the base material.

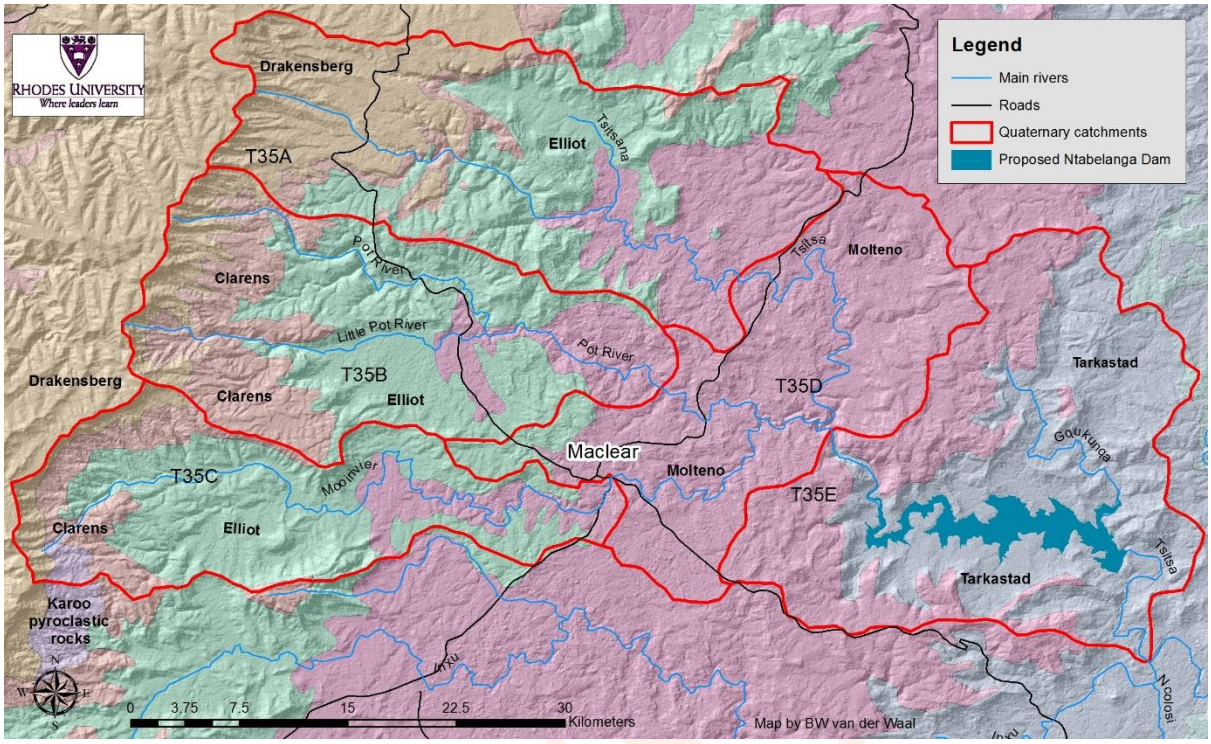

Figure 2-4: Geology of T35A-E given in different colours with Formation names on the various shadings.

2.2.4. Soils and soil erodibility

Soils in the catchment vary significantly but the most prominent soil forms include poorly drained and shallow to moderately deep loams usually with minimal development on hard or weathering rock (e.g. Mispah and Glenrosa Soil Forms) (Land Type Survey Staff, 2012). Moderately-deep to deep-sandy loams with good permeability and relative stability (e.g. Hutton Soil Form) are less prominent. Soils from the Tarkastad, Molteno Elliot Formations in the central part of the catchment are associated with duplex soils with a non-reddish colour, and are highly erodible with widespread gully erosion evident. The most prominent feature of these soils is the marked increase in clay content from the topsoil to subsoil horizon, with an abrupt transition between the topsoil and the subsoil with respect to texture, structure and consistence (Samadi *et al.*, 2005). As a result, these soils inhibit root growth and limit infiltration, which leads to increased runoff and erosion. Since intrinsic permeability is limited, water does not move readily into the subsurface matrix. A permeable horizon overlies a less permeable one, causing water to infiltrate and saturate the top layer where it moves in a predominantly lateral direction as subsurface flow, which leads to tunnel erosion (Beckedahl, 1998). In addition, duplex soils in the central part of the catchment are dispersive and easily lose aggregation because of high sodium absorption. A large central section of the catchment is affected by dense and deep gully networks. Gullies vary in shape (V- to U-shaped) and size; from 0.5 m to 15 m deep and 0.5 m to 100 m wide.

Erodibility

An erosion risk map (Figure 2-5), that combines rainfall erosivity, topography, soil erodibility and landcover shows that the lower parts of the catchment are highly susceptible to erosion (Le Roux et al., 2008; Msadala et al., 2010). This high erosion risk is caused by the duplex soils that form on the mudstones (Le Roux and Sumner, 2012).

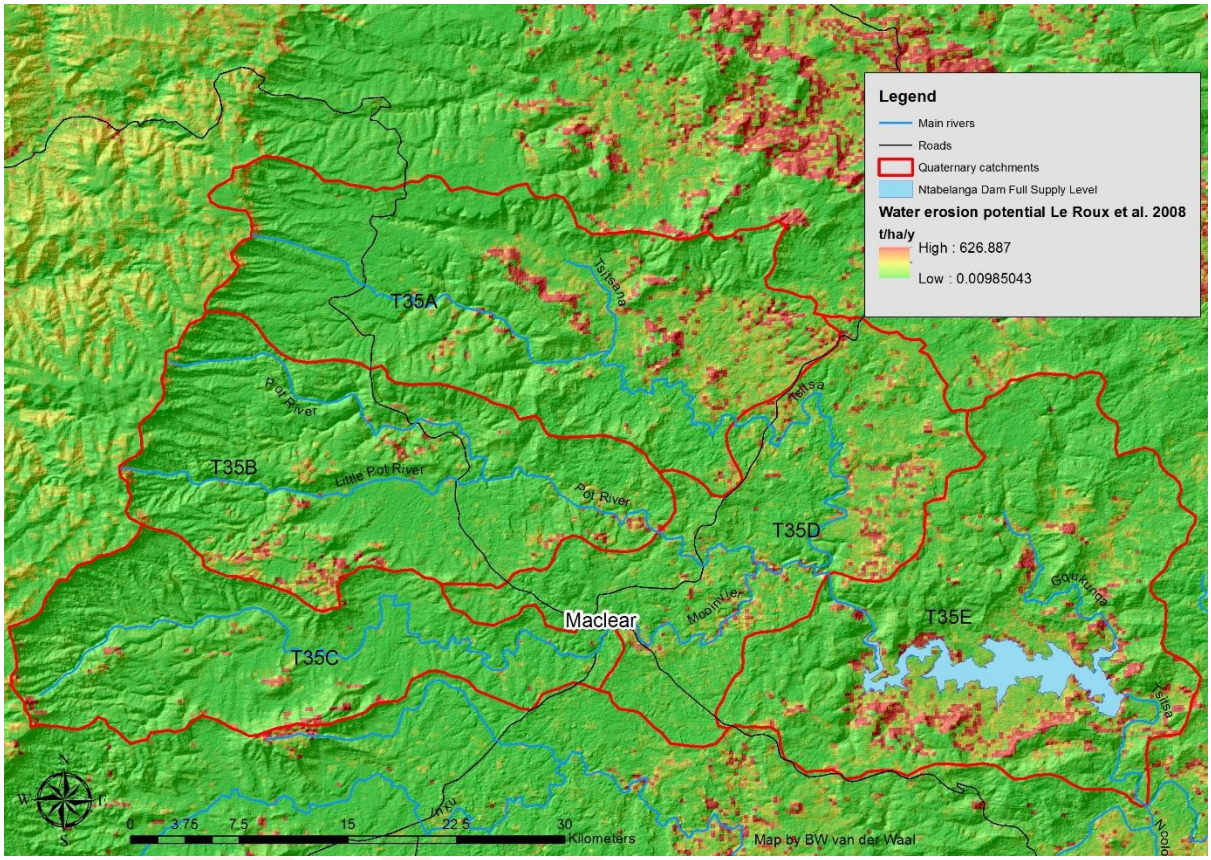

Figure 2-5: Water erosion potential (in tons of soil per ha per annum) by Le Roux *et al.* (2008).

2.2.5. Vegetation

Grassland dominates the vegetation and varies between Lesotho Highland Basalt Grassland, Southern Drakensberg Highland Grassland, East Griqualand Grassland, Drakensberg Foothill Moist Grassland, Eastern valley bushveld, Mthatha Moist Grassland, Eastern Temperate Freshwater Wetlands and small pockets of Southern Mistbelt Forest in ravines (Figure 2-6; Mucina and Rutherford, 2006). Natural vegetation is largely influenced by aspect, catena, slope, geology, soil type, altitude, as well as fire occurrence.

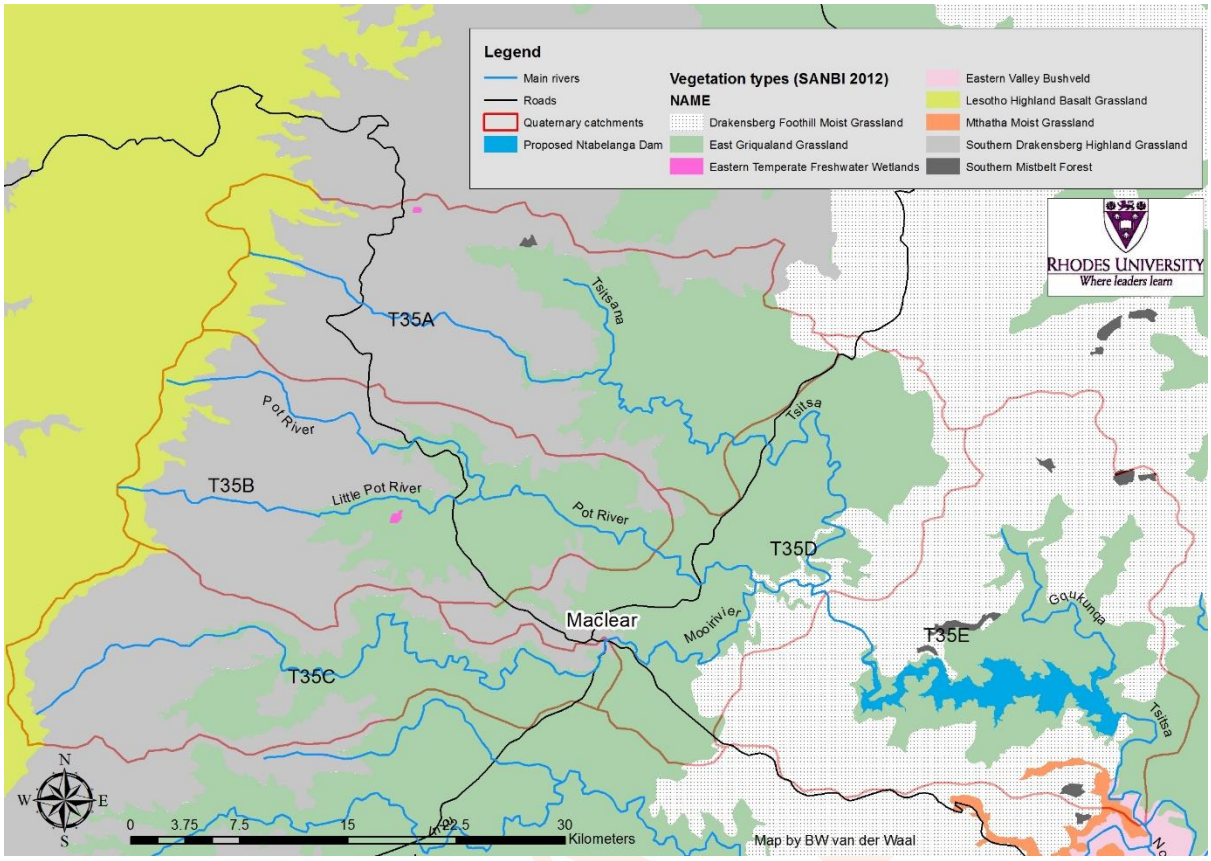

Figure 2-6: Vegetation types of T35A-E area as per SANBI (2012) classification.

These vegetation types and associated environmental characteristics are given below:

- The Lesotho Highland Basalt Grassland can be described as short grassveld with patches of shrubland (*Passerina montana, Chrysocoma ciliata, etc.* - related to disturbance) at 1 900-2 900 mamsl on plateaus and high ridges of mountains, often separated by valleys (Mucina et al., 2006). This vegetation type is underlain by basalt and sandstone and soils are basalt derived with almost equal parts of coarse sand, fine sand, silt, clay and organic material (Mucina et al., 2006). The organic material is a result of slow decaying grass roots, retaining a lot of precipitation, releasing water slowly in the form of seeps (Mucina et al., 2006). The main land type is Ea. The mean annual rainfall is 928 mm of rain a year with mean monthly minimum and maximum temperatures range between -10.5 and 31.4 ºC, with frost occurring throughout winter and in summer along higher parts (Mucina et al., 2006). Snow fall is common in winter. The grassland type is highly grazed, especially during warmer months. Erosion is common due to high grazing intensity and a lack of suitable rotation regimes (Mucina et al., 2006).
- Southern Drakensberg Highland Grassland is found on steep slopes underlain by the Clarens and Elliot Formations, where dense tussock grassland dominates with a dwarf shrubby component on exposed rocky areas (Mucina et al., 2006). *Leucosidea sericea* is common on wet slopes. Soils are deep and fine-grained, typical of the Fa, Fb and Ea land types (Mucina et al., 2006). Mean yearly rainfall is 780 mm (CV of 16-31%) with a cool temperate climate (mean temperature of 13 ºC) and has 30 – 90 days of frost per year (increasing with altitude)(Mucina et al., 2006). Snow is common in winter and erosion rates are

relatively low (Mucina et al., 2006).

- East Griqualand Grassland is found at 920-1 740 mamsl on hilly country, with grassland being dominant and with patches of bush clumps (Mucina et al., 2006). Associated soils are derived from mudstones and sandstones of the Clarens, Elliot and Molteno Formations (Mucina et al., 2006). Soils are on average 500–800 mm deep, well drained with a high clay content (15-55%) (Mucina et al., 2006). Hutton, Clovelly, Oatsdale soils form on sedimentary parent material and Shortlands on dolerite (Mucina et al., 2006). Fa and Ac are common land types with a low to moderate erosion extent (Mucina et al., 2006). Mean annual temperature is 14.7 ºC, with frost occurring roughly 30 days a year(Mucina et al., 2006).
- Drakensberg Foothill Moist Grassland is found on Drakensberg piedmont (foothills) at altitude of 880-1 860 mamsl (Mucina et al., 2006). This vegetation type is characterised by forb-rich grassland dominated by short bunch grasses (Mucina et al., 2006). It is found on mudstones and sandstones of the Tarkastad and Molteno Formations and intrusive dolerites. On the sedimentary parent materials soils are well drained, >800 mm deep, with a clay content ranging from 15-55% (Mucina et al., 2006). Soil forms such as Hutton, Clovelly, Griffin, and Oatsdale are common (Mucina et al., 2006). On the volcanic parent material Balmoral, Shortlands and Vimy soil forms are found (Mucina et al., 2006). Ac and Fa land types are common with low to moderate erosion rates (Mucina et al., 2006). Mean annual rainfall varies around 890 mm with a mean annual temperature of 14.6 ºC and 26 frost days (Mucina et al., 2006).
- Southern Mistbelt Forest occurs in fire protected habitats on south and south-east facing slopes from 850-1 600 mamsl (Mucina and Geldenhuys, 2006). The forest is species rich, tall (up to 20m) and multi - layered (tree, shrub and herbs). Uncontrolled harvesting and frequent burning of surrounding grasslands threaten these forests (Mucina and Geldenhuys, 2006).
- Mthatha Moist Grassland is found at 600–1 080 mamsl and is characterised by undulating plains and hills with species-poor, sour, and wiry grassland (Mucina et al., 2006). This vegetation type is mostly found on mudstones of the Tarkastad and Adelaide subgroups where highly leached soils are typical of the Fa land type (Mucina et al., 2006). The mean annual rainfall varies between 600-900 mm (CV of 25-30%) and 2-14 days frost per year (Mucina et al., 2006). Erosion is a serious problem with high erosion levels (Mucina et al., 2006).
- Eastern Valley Bushveld occurs in deeply incised valleys at 100-1 000 mamsl where semi-deciduous savanna woodlands is found in amongst thickets (Rutherford et al., 2006). This vegetation type is found on mudstones and subordinate sandstones of the Adelaide and Tarkastad Formations and some Ecca group shales where the Fa land type is dominant (Rutherford et al., 2006). Annual rainfall varies between 550-1 000 mm and frost occurs infrequently in winter (Rutherford et al., 2006).
- Eastern Temperate Freshwater Wetlands are typically bodies with stagnant water such as vleis on flat landscapes or in shallow depressions found in a wide range of climatic zones (Mucina and Geldenhuys, 2006). Vegetation ranges from aquatic to hygrophilous plants (Mucina and Geldenhuys, 2006). They are found at altitudes ranging from 750-2 000 mamsl on impermeable soils on sedimentary parent materials or where resistant dolerite dykes dam runoff. The wetland areas are only wet or inundated during summer and early winter (Mucina and Geldenhuys, 2006). Livestock drinking from the waterbodies and intensive

grazing are major threats to these systems (Mucina and Geldenhuys, 2006).

2.2.6. Land cover and land use

Land cover distribution and percentage cover per land cover type are given in Figure 2-7 and Table 2-1. Grassland is the dominant (71%) land cover type, followed by plantations, cultivated fields, indigenous bush/forest, urban village, etc. (Table 2-1).

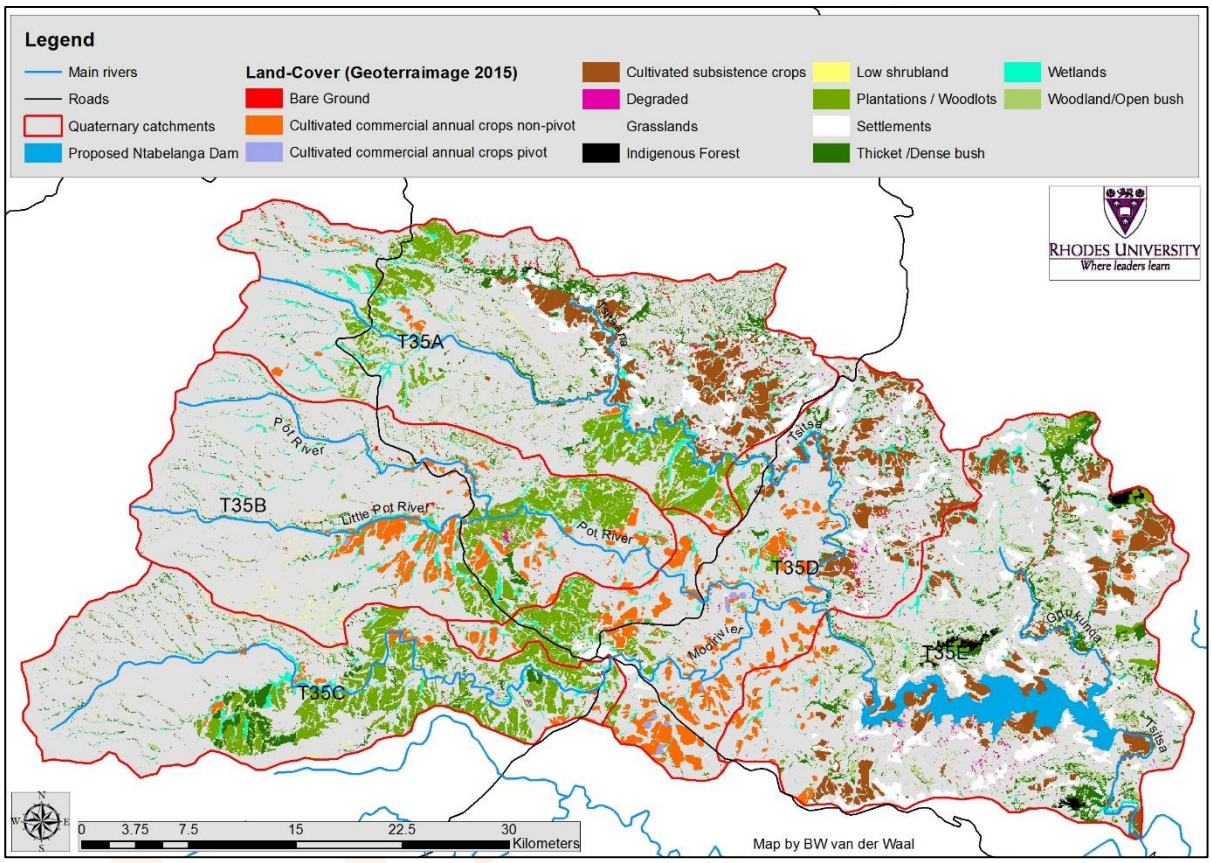

Figure 2-7: Land-cover type distribution for T35A-E (Geoterraimage, 2015).

Table 2-1: Land-cover type percentages for 2013-2014 (Geoterraimage, 2015).

Land cover	**% of catchment**
Indigenous Forest	0.2
Thicket /Dense bush	4.1
Woodland/Open bush	2.3
Low shrubland	0.3
Plantations / Woodlots	6.9
Cultivated commercial annual crops non-pivot	3.5
Cultivated commercial annual crops pivot	0.1
Cultivated subsistence crops	5.4
Settlements	3.3

Wetlands	2.3
Grasslands	71.1
Bare Ground	0.3
Degraded	0.2

2.2.7. Agricultural practices

Agricultural practice in the lower communal part of the catchment is mostly subsistence-based, located around households and/or within fenced areas. Soil is mostly ploughed with oxen or hired tractor or done by hand. Maize is possibly the most popular and extensive crop, with vegetables and fruit trees forming a smaller component of the worked area. These fields are not irrigated and manure and fertilizers are often added when available. Larger fields are ploughed with tractors and not irrigated and are frequently fenced to limit animal damage.

Commercial farmers in the upper catchment plant extensive areas with maize, potatoes and beans. All work is done mechanically and overhead/centre pivot irrigation is used where terrain and water access allows. Fertilizer is applied frequently and fields are fenced off.

2.2.8. Grazing management

Representing a microcosm of land-care in South Africa, there are currently two primary grazing management systems in place in the Catchment: one more sustainable and one unsustainable (Bembridge 1990). Westaway (2012) takes this further to imply that there are two forms of governance in South Africa: one that is western/first world, and one that is traditional/third world. The Catchment has both governance forms, with different implications for sustainable catchment management.

Communal grazing is based on *ad hoc* use of available grazing in no specifically defined area, and managed communally through no particular or consistent system, and often with short term/crisis management objectives (O'Connor & Kuyler 2009, SANBI 2013). There is no intentional aim to manage stock numbers (which can be three-times higher than the carrying capacity), grazing patterns, or grassland conditions other than through repeated *ad hoc* burning to stimulate fresh growth (often at inappropriate times of the year that stress the grassland further) (O'Connor & Kuyler 2009, SANBI 2014). The result is a 'tragedy of the commons', where the grassland has been highly abused, without rest or rotation, and is characterised by low graminoid diversity (usually the most hardy and unpalatable graminoid species being left through niche displacement of more palatable or climax species), and low non-graminoid diversity (with high local extinction rates of the original biodiversity) (Mucina & Rutherford 2006, SANBI 2014). Consequently, catchment value is compromised, erosion is excessive, riparian zones are skeletal in function, and a form of desertification is in progress (i.e. replacement of grassland with a mix of ruderal weeds, karroid shrubs such as *Euryops floribundus*, *Felicia filifolia*, *Lycium* spp., or invasive succulents such as *Agave*, *Opuntia* etc.) (Mucina & Rutherford 2006, SANBI 2013, 2014).

Livestock is an important asset to community members and cattle are regarded as most important, followed by sheep and goats (Heard-Hoare, 2015). Livestock numbers declined since the betterment planning in 1965 and

currently livestock is mainly kept for consumption or sale (Heard-Hoare, 2015). Flocks of livestock are mostly left to graze in and around the village on a daily basis, with grazing management being limited to keeping the animals in a kraal at night (Heard-Hoare, 2015). Ngwenya (2016) found that the higher hills around the Shukunka Village is important grazing land, especially in summer and during droughts. Animal numbers appear to fluctuate around the maximum number that can survive on the natural grazing (limited additional feeding) and fluctuates with drought, theft, disease, etc. During winter, grass availability and quality is very poor and feeding of animals is limited due to high feed costs.

Commercial rangeland management is generally based on well-established patterns of grazing camps, rotation systems, fire regimes, and stocking rates (O'Connor & Kuyler 2009). As indicated by O'Connor & Kuyler (2009), and supported by the author's personal observation, most grassland in private hands (either as commercial stock farms or as private game reserves) along the eastern Great Escarpment in South Africa is generally in reasonable to excellent condition from a biodiversity conservation and catchment management perspective. The management of these grazing areas is almost always based on some form of science or protocol well supported by research (Bembridge 1990; informal discussions by the author with numerous landowners over 10 years), with adjustments made by the farmer in response to fluctuations in rainfall and other external factors. The livestock are farmed for commercial benefit, and are usually in good condition (barring exceptional drought). In times of grazing limitation (drought, winter, snow), additional fodder is added to the system from external sources or from locally grown lucerne, hay or other pasture crops. Because in most instances the carry capacity is adhered to, the grassland is usually high water-yielding, with low erosion and high *in situ* biodiversity (of graminoid and non-graminoid species). Some farmers have several farms, thus animals are often moved between farms in order to optimize production. There is the very real concern that land removed from private ownership and placed in communal hands as part of land reform may exacerbate the problem of degradation (Palmer & Bennett 2013).

2.2.9. Fire management

There are three main types regarding fire management in T35A-E: i) Private landowners in the upper catchment grazing cattle, sheep and game mainly with commercial agriculture on flat land; ii) PG Bison in the upper to middle catchment with pine and Eucalyptus plantations and some large stock rangeland activities; and iii) subsistence farmers in the lower catchment on communal land running cattle, sheep, goats, donkeys and pigs and planting around homesteads and on flat land.

The private landowners do planned annual block burns on a rotational basis to manage range. This rotation process can take 3-6 years to cover the entire farm. The veld is mostly burned during late winter (July-August) when conditions prove ideal for cooler and easily controlled fires. Firebreaks are maintained on mostly follows ridge and fence lines. Fires started by lightning or through arson are controlled with every effort, often with the help of neighbours and WoF.

PG Bison do annual burns of the areas surrounding their plantations. This buffer can be 100m to several kilometres wide to optimise fire control. Further firebreaks are put in place between the plantations to help manage potential fire risk. Firebreaks and controlled burns are done early winter (June) to reduce fire risk. Unwanted fires are

controlled with every effort and includes help from WoF.

Subsistence farmers use fires as a form of grazing management in winter to bring on an early flush of green to improve late winter and early spring grazing. Fires are lit by herders and is often done on the higher ground away from villages. Not much is done in terms of fire control and fires are left to burn until limited in some way, e.g. physical barrier of fuel load. Fires are lit mostly mid to late winter (July and August).

2.2.1. Fuel wood, water and medicinal plant use

Acacia mearnsii (Idywabhsi), *Acacia karoo* (Umga), *Aloe ferox* (iKala), *Eucalyptus Globus* are important fuel wood species (Heard-Hoare, 2015). *Acacia mearnsii* is a preferred fuel wood source as it is multifunctional and generates a good flame, but comes at a cost as state officials have to be paid and it needs to be transported from plantations (Heard-Hoare, 2015). *Acacia mearnsii* thickets, despite being an important fuel source, are seen by residents from the Shukunxa Village as a place where crime takes palce, such as livestock theft and rape incidents (Ngwenya, 2016). *Acacia karoo* is locally available on abandoned lands and is used during periods of low cash income (Heard-Hoare, 2015).

The following important plant species are harvested from forests and grassland and used for human and animal medicinal purposes: *Alepidea amatymbica* (Iqwili), *Asparagus africanus* (Mathunga), Masixabane (species unknown)**,** *Euphorbia bupleurifolia* (Inkamamasane**)** and Ntsibane (species unknown), *Kniphofia sp.* (Ixonya), *Aloe ferox* (iKala), *Cotula anthemoides* (Umhlonyane), *Chionanthus foveolatus* (Umqumaswele) and *Helichrysum gymnocomum* (Imphepho) (Heard-Hoare, 2015).

Water is sourced from various sources for domestic use. State installed water reticulation systems are not always functional, thus rainwater, springs, seeps, tributaries and larger rivers are used as water sources (Heard-Hoare, 2015).

2.3. Key social-biophysical links

Kate Rowntree, Mike Powel and Bennie van der Waal

The major social-biophysical links are currently best illustrated in the TP conceptual framework (Fabricius *et al.* 2016) Figure 1-1. This graphic illustrates the core components of the TP SES system and where the major linkages occur.

Some of the key social-biophysical links that influence nrm in the Tsitsa River catchment are briefly mentioned below, but given in more detail in Section 3.

- Variable climate, steep topography and high soil erodibility makes reliance on agriculture challenging and fuels poverty.
- Livestock numbers are culturally important with less focus on their productivity. This drives range degradation and low cash income.
- Breakdown of local government systems reduces control over resource use and leads to degradation.

- Degraded lands make agriculture challenging without technology such as tractors, water and soil nutrient additions, and keeping small farmers below a threshold where they become successful.
- Limited marketing for produce and livestock reduces cash income. Transport is expensive and precludes access to reliable markets.
- Government grants reduces dependence on agricultural activities and investment in nrm.
- Able bodied people move to larger centres, thus less labour for working fields and livestock.
- Poor schooling reduces ability to engage in economic activity and entrenches poverty.
- Poverty and poor health reduces resilience to environmental shocks and ability to improve circumstances.
- The youth are largely interested in urban attractions, with a certain disconnection form their environment and a disinterest in physical work related to nrm.
- Lack of land ownership fuels the disconnection from the land and a will to look after it.

2.4. Existing (e.g. working for…) and planned (e.g. Dam, roads, etc.) initiatives that interact with this plan

Various land users are present in the catchment that influence nrm. Below is an overview of current activities, projects, issues and longer-term plans (where available). Most of the information was sourced from online sources such as municipal development plans, annual reports, etc.

2.4.1. Agriculture

One of the government programmes called Massive Food Production (consolidation of land for commercial production purposes) helps emerging farmers with agricultural activities. So far, limited success has been reported, with the farmers only registering a profit one year out of the programme's five years of operation (Elundini Integrated Development Plan 2016/7).

The Department of Rural Development and Agrarian Reform's support include food security, cropping, fencing, renovation of dipping tanks and shearing sheds. Support issues, such as timing of help with seed and tractors, are blamed for failures. Emerging farmers in Umnga (32 farms) and Pitseng show poor performance, mostly as they are not operated commercially (Elundini Integrated Development Plan 2016/7). Local extension officers (Department of Rural Development and Agrarian Reform) blamed the lack of commitment and dependency culture for failures, whereas emerging farmers complained about the capacity of the extension officers.

The commercial farming sector is well organised through farmer associations and Agri-East Cape (Elundini Integrated Development Plan 2016/7). Agri-East Cape has sub committees that support members with water and environmental issues, such as soil conservation, disaster management, invasives, etc. The National Farmers Union (NAFU) is not well organised and inactive (Elundini Integrated Development Plan 2016/7).

Proposed agricultural activities linked to the proposed Ntabelanga Dam include irrigation agriculture (2 900ha;

45 farms of 60 ha each) for a small area north of the proposed dam, some adjacent to the Tsitsa River below the confluence with the Inxu River and the majority will be west and south of Tsolo and fall on previously cultivated land (Figure 2-8; ILISO Consulting 2015).

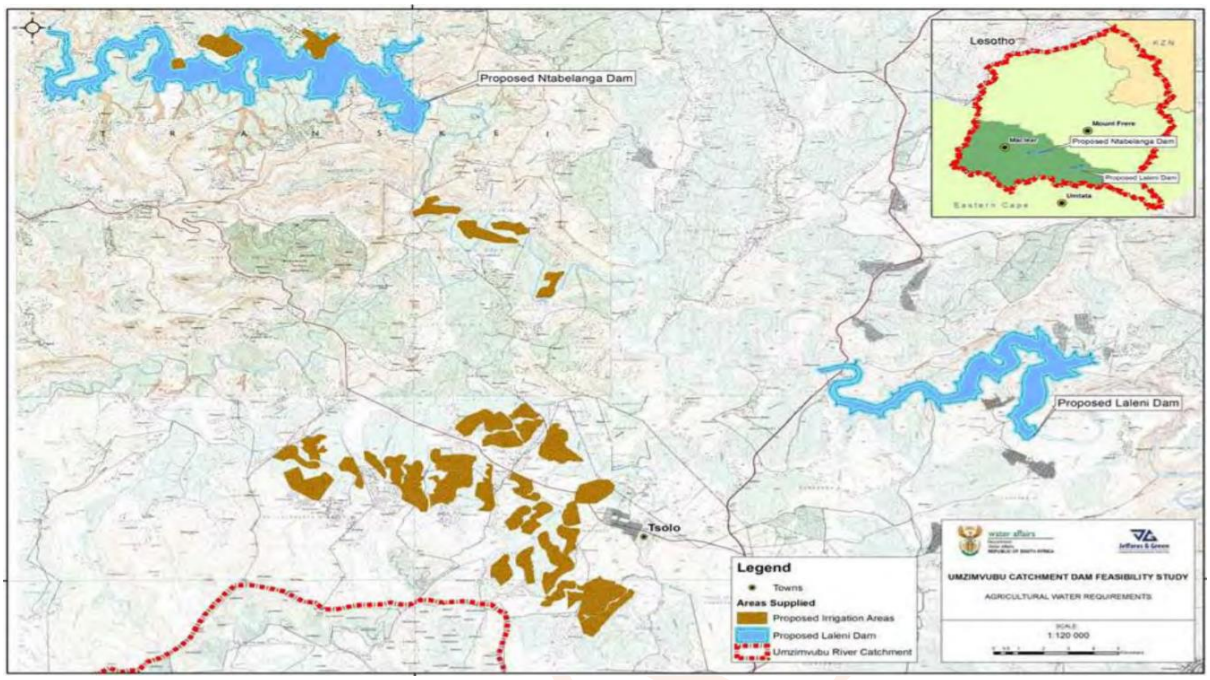

Figure 2-8: Proposed irrigation areas fed by the proposed Ntabelanga Dam (source: ILISO Consulting 2015).

ASGISA-EC propose irrigated cropping of 40 000 ha by 2029 and dryland cropping of 500 000 ha in the EC by 2034. The area irrigated with the proposed Ntabelanga Dam water will form part of this, but the exact location of the planned dryland cropping is unknown.

2.4.2. Forestry

PG Bison is growing 19 772 ha of pine and 3 376 ha of *Eucalyptus* spp. around Maclear and Ugie. DWAF MEG is growing 724 ha of pine, 24 ha of eucalypt and 40 ha of wattle at Ntywenka (Greenline Business Management, 2007). PG Bison plans to increase Eucalyptus plantations by 1 000 ha and pine plantations by 1 677 ha to keep up with the new board factory demand. Community based forestry feasibility studies identified suitable land near Katkop, Chevy Chase, Bethania, Black Fountain, Nxaxa, Tinana and Ntywenka Communities (Elundini Integrated Development Plan 2016/7). New plantations were developed north-west of the Ntywenka area since 2014 (visible on Google Earth).

ASGISA-EC propose to develop 100 000 ha of new plantations in the EC by 2024 (http://www.asgisa-ec.co.za/forestry.html). Undeveloped areas in the catchment were identified as being biophysically suitable for forestry, but no details are available at present about the preferred locations. It is possible that wattle could be harvested where large infestations are accessible and financially viable.

2.4.3. Livestock

Livestock figures for Elundini are as follows: cattle 61 800, sheep 190 000 and goats 76 868 (Elundini Integrated Development Plan 2016/7). ASGIsSA-EC propose livestock development of 1 000 000 LSU in the EC by 2019. This could have a significant influence on veld condition of T35A-E. The wool demand is increasing, with various wool handling facilities being established, thus sheep numbers could increase in the near future.

2.4.4. Roads

The Elundini municipality do not propose any major new roads, thus most of their actions will concern maintenance and resurfacing of existing roads (Elundini Integrated Development Plan 2016/7).

For the proposed Ntabelanga Dam development, access roads will need resurfacing, river crossings need upgrading and sections of existing road that will be inundated will need re-alignment (ILISO Consulting 2015). Approximately 80km of road will be upgraded and re-aligned, see Figure 2-9. Road upgrades will cross sensitive landscape features such as drainage lines, seeps, riparian systems and valley bottom wetlands (ILISO Consulting 2015).

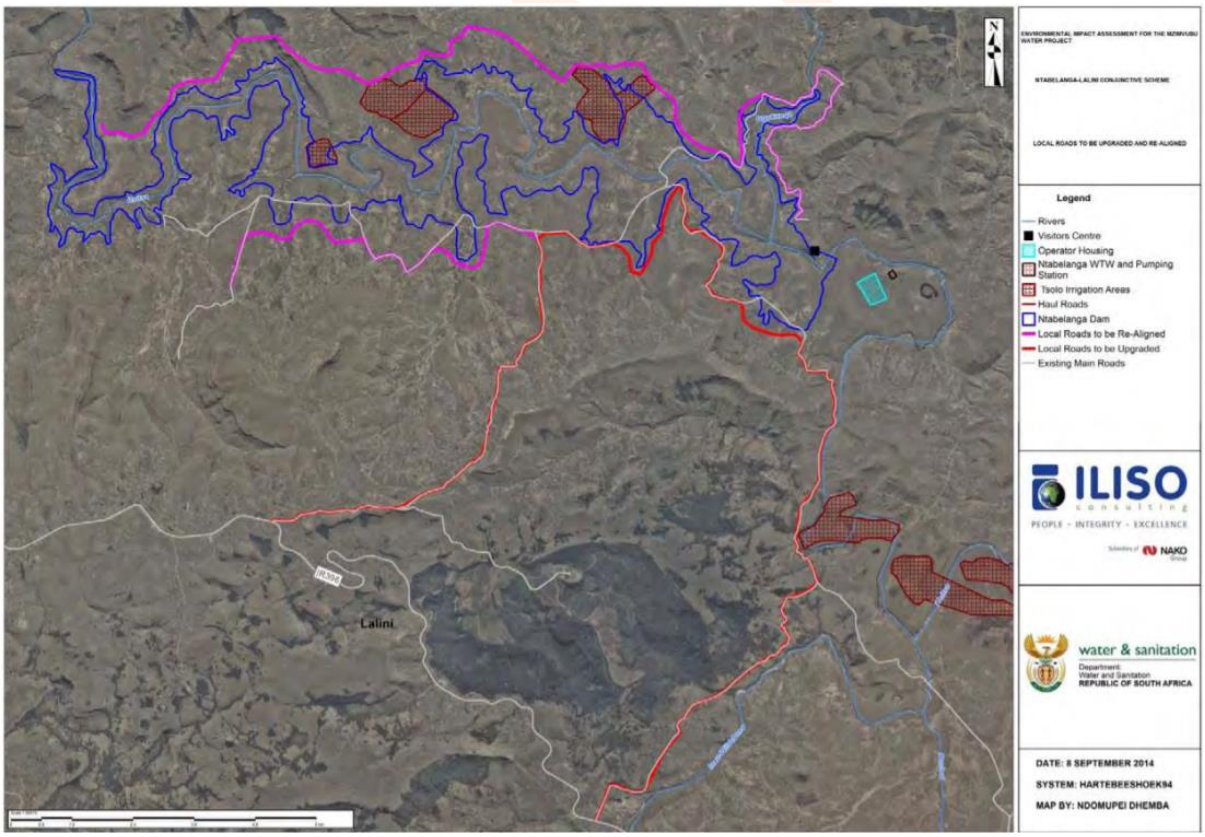

Figure 2-9: Road upgrades and realignment around the Ntabelanga Dam (Source: Iliso Consulting 2015).

2.4.5. Power and water infrastructure

Linked to the proposed Ntabelanga Dam development will be primary and secondary pipelines (~375 km) downstream of the Ntabelanga Dam catchment, mostly to feed the Tsolo and Qumbu local areas. Pipes will follow existing roads where possible to limit impact, but will still cross sensitive areas (such as drainage lines and wetlands). Trenches for pipes can be up to 3,5 m deep and 2,5 m wide and impact a corridor of up to 30 m wide. The Water treatment works will be directly below the proposed Ntabelanga Dam, with pump stations and nine bulk water storage reservoirs strategically located throughout the downstream landscape (ILISO Consulting 2015).

Powerlines within the inundation footprint of the proposed Ntabelanga Dam will be realigned and linked to nearby powerlines that are not affected by the dam inundation. New powerlines will run from the Lalini hydro station to the most suited national power grid point (~9km; ILISO Consulting 2015).

Small-scale piped water developments are ongoing in rural villages in Elundini as they have received funding from the Netherlands – see Elundini Integrated Development Plan 2016/7.

The Elundini Local Municipality has developed a Stormwater Master Plan (SMP), completed in November 2013 but is not available online.

2.4.6. Mining

For the proposed Ntabelanga Dam development, rock quarry and sand borrow areas will fall mostly within the dam full supply level (ILISO Consulting 2015). Topsoil from mined areas can be used to rehabilitate degraded land. Small-scale Illegal sand mining is ongoing throughout the catchment.

2.4.7. Tourism

Tourist attractions are mostly on private land and at a low level of development (Elundini Integrated Development Plan 2016/7). Possible extension of the Ukhahlamba Transfronier Park further south along the Drakensberg Escarpment was mentioned, but limited information is available (Provincial Spatial Development Plan 2010). Lower down the Tsitsa River the Lambasi Nature Reserve has been proclaimed, but very little information is available at present. It is supposed to include sections of the lower Tsitsa and Thina River.

2.5. Real world implementation realities

Michael Kawa, Michael Braack, Japie Buckle, Kate Rowntree, Jay Le Roux, Bennie van der Waal

2.5.1. Social realities

Various social issues relating to the history and management of the area were described in Section 2.1.1.

2.5.2. Biophysical and land use realities

Various challenges affect the physical rehabilitation efforts of the Ntabelanga and Lalini catchments such as:

- Ongoing land use pressures that potentially caused the rapid degradation over the past decades continue (e.g. frequent burning and continuous grazing).
- Large areas with dispersive/duplex soils, widespread in the vicinity of Ntabelanga Dam, are easily eroded after disturbance
    - Duplex soils inhibit root growth and limit infiltration;
    - Duplex soils are prone to tunnel erosion. They have a permeable horizon that overlies a less permeable one, causing water to infiltrate and saturate the top layer where it moves in a predominantly lateral direction as sub-surface flow. This leads to tunnel erosion, especially in dispersive soils;
    - Duplex soils in the central part of the catchment are dispersive and easily lose aggregation because of high sodium absorption.
- Zones of flow accumulation and saturation along drainage paths with a large contributing area results in high-energy runoff and limited sediment accommodation space.
- The steep topography results in high-energy runoff and limited sediment deposition zones.
- High rainfall-erosivity throughout the catchment (to be assessed from rain gauge network).
- Access is difficult due to poor road network and high relief.
- Sediment yield from commercial farms and forestry is unknown but may be significant.

How do communities view this? There is a widespread awareness of gully erosion, which has been prevalent for the lifetime of older people in the community. The biggest threats are to houses and gardens and to livestock. Drought and heavy rains are seen as the main causes. They would like help in stopping erosion. Erosion control work completed by the former Transkei government is seen as beneficial (though in some cases structures in active gullies on dispersive soils are collapsing).

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3. SES Processes, drivers and risks

Kate Rowntree, Bennie van der Waal, Harry Biggs

Interactions between social and ecological systems are closely linked in the Tsitsa River catchment (Figure 3-1). Several of the inherent physical and ecological features and functioning influence the socio-economic activities in the catchment. Similarly, socio-economic factors influence land use and land cover. These links and drivers are briefly described below.

3.1. Climate

Highly variable climate, oscillating between drought and flood. Unreliable rainy seasons - late start to rains delays planting; early end to rains does not allow plants to come to maturity. Springs used for water supply to homesteads and livestock not reliable. Heavy rain on land with a low vegetation cover increases erosion risk. This influences a steady income and links with markets.

3.2. Terrain

Steep slopes with shallow soils associated with high erosion risk and high runoff potential. Footslopes often host deep colluvium with dispersive duplex soils and a high gully erosion risk. Access is difficult for commercial machinery, and high energy runoff destroys agricultural developments on steep slopes. It is a high risk to develop on these steep slopes.

3.3. Soil properties

The soils in the catchment have some agricultural potential, but are vulnerable to soil erosion. Agriculture is possible, but needs nutrient and water additions at critical times to make it viable in the variable climate. Fallow land is rapidly eroded without continued preventative care. Dispersive soils and low fertility enhances risk of erosion and poor vegetation cover. Constant investment in nutrient additions and water will be needed for commercial agricultural operations.

3.4. Land degradation

Land degradation is a process that reduces of the productivity of the land. Degraded land is less able to support the people who live on it. In the Tsitsa catchment land degradation is due to the loss of vegetation cover and associated soil erosion and loss of soil fertility. Land degradation also includes loss of grazing productivity due to encroachment by woody vegetation, reduction in the abundance and vigour of palatable grass species or invasion of hillsides and water-courses by wattle.

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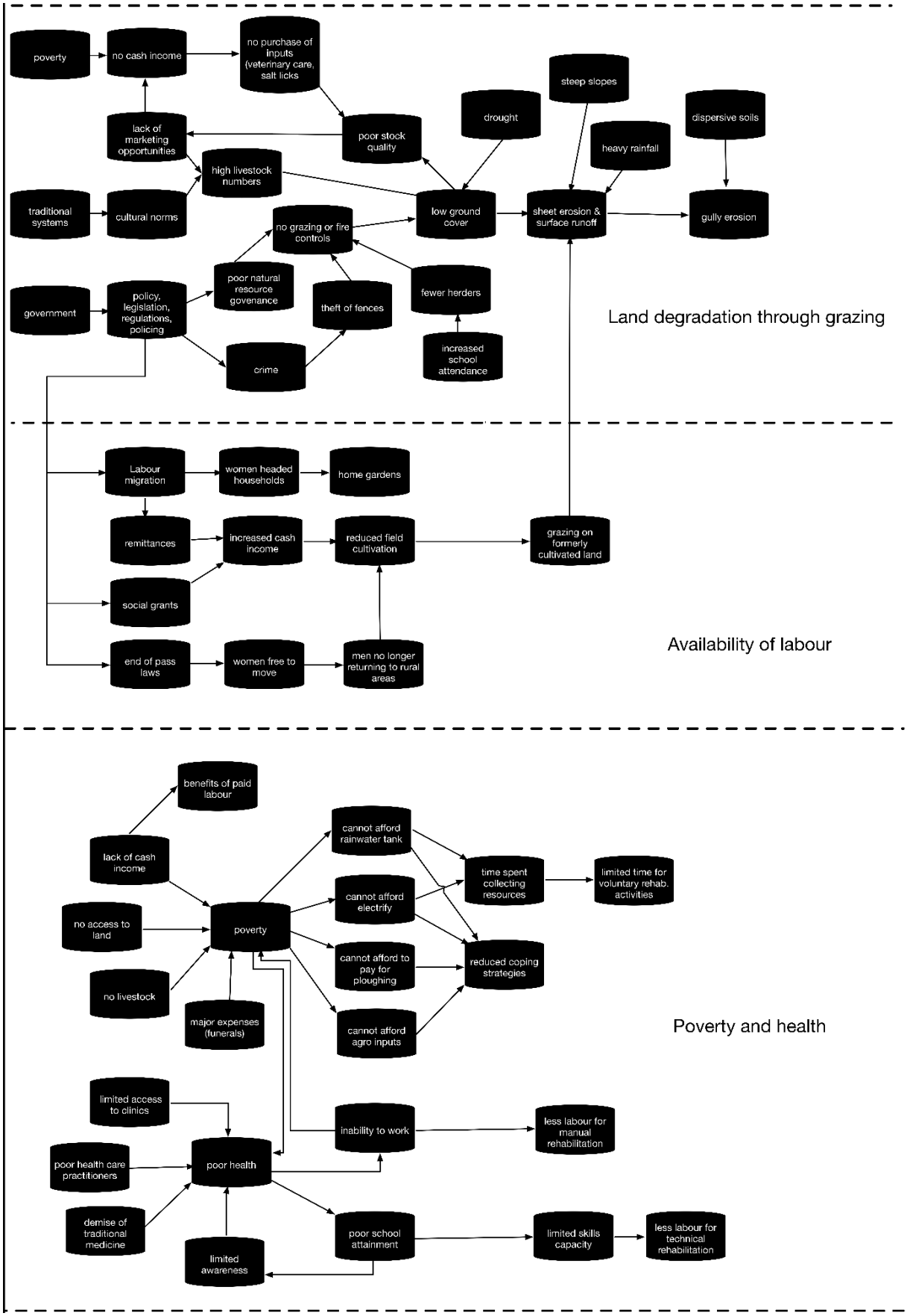

Figure 3-1: conceptual diagram of SES linkages

Surface erosion causes fertile soil to be washed from fields, gardens and grazing land. Seeds and fertiliser are also lost. Gullies are a sign of serious degradation. Not only do they represent a loss of land, the remaining land is dissected and becomes difficult to access, even by foot, let alone by machinery. Incision causes the adjacent land to dry out, as is often seen along the edges of gullies. Gully erosion threatens houses, gardens and graveyards. Gullies are a danger to children and livestock. Gullies collect rubbish. This degradation poses a great threat to sustainable livelihoods.

3.5. Climate change

Ziervogel et al. (2014) review current understanding of climate change in South Africa and research on climate change adaptation. They point to much uncertainty as to the direction that climate change will take but there is evidence that eastern areas of South Africa will generally be wetter but rainfall will be more variable, with an increased risk of drought and floods. In their assessment of climate change impacts, Ziervogel et al. (2014) predict that the grassland biome, as is characteristic of the Tsitsa catchment, will be at risk to encroachment by woody vegetation. With increased evapotranspiration, there will be an increased water demand for all crops and greater vulnerability to drought. In the summer rainfall region maize is a crop that will be significantly impacted. Maize is grown on all cropland throughout the catchment. Pests and pathogens are also projected to increase. There is also an increased risk of fire.

Health risks are various, including direct effects such as heat stress (people, livestock and plants) to indirect effects related for example to malnutrition (Ziervogel et al. 2014). Higher temperatures will affect people's ability to work outdoors, having a negative impact on food production, especially in communal areas.

Adaptation to climate change includes ecosystem restoration, such as is promoted through TP, changing agricultural crops to those more tolerant of heat and/or water stress, soil and water conservation measures, and measures to protect livestock from heat and water stress.

Recent research on rainfall variability in the Tsitsa catchment and nearby areas highlights the risk to periods of drought and floods but to date there is no evidence of an upward trend in either phenomenon. The last two wet seasons (2015-16 and 2016-17) have typified droughts, with a significantly delayed start to the rains. Drewett's (2015) analysis of rainfall data from Mtata Dam confirmed the cyclical nature of annual rainfall totals but did not identify any long-term trends. Likewise, data from Maclear from 1978 to 2012 showed no increasing trend in annual rainfall totals. Neither do daily totals, which is a good indication of flood and erosion hazard. The occurrence of drought and floods showed some coincidence with El Niño and La Niña conditions but it is clear that ENSO is not the only climatic driver.

3.6. Importance of livestock

Livestock are an important form of wealth and represents an investment. Off-take of small stock will take place more frequently than cattle. Livestock has a cultural value that may outweigh its monetary value. Number of livestock and coloration is the focus, with less emphasis on productivity. This results in large numbers (often old animals), poor grazing management and high levels of infertility. This pressure degrades the already vulnerable landscape, especially around villages. Poor winter grazing with limited or no supplementary feed contribute largely to the poor condition of the animals. As a result, veld is burned to bring on a flush of green grass to help sustain the animals. This happens annually and depletes grass reserves and soil organic material, preventing grass proliferation.

In the early twentieth century government controls on movement of livestock significantly reduced stock sales and may have led to the current reluctance or inability to sell stock due to the lack of a local market. There is a growing appreciation in the Mzimvubu region that livestock can generate cash income if markets can be developed.

3.7. Governance and land use

Break down of local governance systems leads to lack of control over resource use. Livestock are free to roam, with few controls on burning, theft of camp fences, over harvesting of fuel wood etc. All of these leads to a degradation of vegetation cover and hence to erosion. With a degraded landscape the land users are less able to support themselves from the landscape and more vulnerable to weather extremes.

Functioning local committees provide an effective means to engage a community in rehabilitation practices.

3.8. Schooling and availability of participants

Increased school attendance (Bantu Education Act, 1950s) took young men away from herding without giving them a relevant education. Increased educational opportunities post 1994 has enabled this trend to continue. Schooling levels have increased significantly from 2001 to 2011 in the upper Tsitsa Catchment (Hodgson, 2016). Poor education hindered rural populations from becoming part of business opportunities, new developments and connecting to the wider catchment/world. They were merely seen as a labour force that was given little opportunity of economic growth.

The migrant labour system removed able bodied men from the rural areas; created a dependency on wages/remittances; female headed households became common; field cultivation was reduced due to lack of labour. Children were brought up with less technical and agricultural knowledge of their landscape, further disconnecting them from their environment.

End to pass laws post 1994 has increased rural-urban migration so more women and young adults are leaving the rural areas (Hodgson, 2016). Fewer people are available on the ground to do agricultural work.

Currently, the media and bright city lights make it less desirable to be involved in hard physical work related to agriculture, thus there is large cohort of young people that are not interested in using the land or improving its functioning. Moving between the rural and larger centres enhances this disinterest.

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3.9. Alternative income sources

Increased cash income from remittances and social security grants reduces reliance on land-based income and home-grown food. Reduced availability of labour plus alternative income sources means that there is less cultivation of arable fields. Female headed households favour garden cultivation.

3.10. Health

Health affects a person's ability to undertake any form of work, but especially physical work. Illness impacts on a child's school attendance and ability to learn. This limits their employment opportunities in later life, and the number of people in the area who can take on employment requiring technical abilities. Health is affected by nutrition, access to traditional medicine, access to clinics, the quality of medical care available at clinics, by awareness of symptoms and risk and, in the case of HIV/AIDS, by social practices and taboos. A healthy community is more likely to have both the energy, capacity and interest to undertake soil and water conservation activities.

3.11. Poverty

Poverty can be in the form of low cash income, lack of traditional resources such as livestock or access to land. Poverty reduces capacity to develop alternative coping strategies at the household level and increases vulnerability to environmental hazards. Households become stressed by large social expenses such as funerals or traditional ceremonies. Poor households do not have the financial capacity to pay for someone to plough their garden, buy fertiliser or seed or to contribute to soil and water conservation practices. Without livestock there is no kraal manure to replace fertility and organic matter.

If a family cannot afford electricity or a rainwater tank more time is spent collecting fuel wood and water. Without refrigeration, perishable food has to be purchased more frequently, which may increase expenditure on taxi fares. Poor households will have less time available for community related activities and may be under nourished and less able to do physical work. These are people who would benefit most from paid labour.

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4. Principles for restoration and stakeholder engagement

This section is a summary of the current thinking of guiding principles that should be applied when doing restoration work and engaging stakeholders.

4.1. Restoration principles

Sediment & Restoration CoP, Bennie van der Waal, Kate Rowntree

Below is a list of restoration principles that the Sediment and Restoration CoP established. The principles are further grouped under 'what' to prioritise (ordered according to priority - first is most important) and important restoration points on 'where and how' that apply to all interventions.

What

- Address the anthropogenic drivers of landscape degradation (too frequent fire, no grazing system, etc.) as soon as possible as restoration under ongoing causative pressures is highly likely to fail.
- Reduce surface runoff and increase sediment retention on hillslopes using 'soft' options and grazing management.
- Target active erosion (e.g. gully head erosion in areas vulnerable to gully erosion or renewed gully incision) as soon as possible.
- Manage runoff from tracks and footpaths and roads.
- Protect vulnerable areas not yet eroded or damaged ecologically (e.g. overgrazing in seeps).
- Restore and protect degraded or incised wetlands (this includes gully floor wetlands).
- Maintain existing interventions.
- Secure dams that are vulnerable to erosion (i.e. resulting in breaching the wall and releasing sequestered sediment).

How

- From a restoration aspect, reduced runoff velocity, increased (palatable in non-dispersive soils) vegetation cover and rooting mass are very important factors to address ongoing erosion (Russell *et al.*, 2009). Use methods that will contribute to all three these aspects.
- Introduce grazing management and livestock marketing as a way to improve veld condition and contribute to household income.
- Raise awareness about negative effects of poor fire management and facilitate adoption of fire management strategies in communal areas.
- Use appropriate 'soft' options on hillslopes to trap water and sediment; protect from grazing and fire until vegetation has re-established. Select and adapt according to soil type and slope gradients.
- Seed with unpalatable grass seeds to speed up recovery and improve veld condition.
- Plant vegetation plugs (e.g. vetiver) to reinforce silt fences etc. and to create persistent sediment and

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nutrient traps.

- Use ‘hard’ structures and/or reshaping to stabilise gully head erosion.
- Use ‘hard’ structures in incised wetland channels and gullies to trap sediment.
- Put a monitoring plan in place, using local people as far as possible to collect data. Set up a system for data collection, analysis and feedback to implementers and researchers. Monitoring should (a) check on the interventions themselves to make sure they are not damaged and (b) monitor their effectiveness at reducing erosion and restoring vegetation cover.

Where

Catchment-wide

- Identify sub-catchments with the highest sediment yields – through monitoring, remote sensing and modelling.
- Identify areas with the greatest social need – high levels of unemployment, low household income, significant labour force (age class 20-50)
- Identify areas with greater chance of success (good leadership, social cohesion and willingness).

Local level

- Exclude:
    - All areas falling within the full inundation levels (1:100 year flood level) of the proposed dams. Erosion will be monitored within the water fluctuation level of the dam and will be addressed if proven to be problematic.
    - All areas upstream of existing reservoirs/dams, regardless of dam size, at least in the short to medium term. Areas producing vast amounts of sediment in these dam catchments will need to be addressed in the longer term as these dams will become less efficient at trapping sediment as they fill in with sediment and stand the risk of releasing large volumes of sediment if breached.
- Identify locations where soft options can be used effectively
    - Hillslopes where soft options can reduce current erosion and sediment movement.
    - Hillslopes and seep areas which are at high risk but not yet gullied (Section 5.6).
    - Shallow gullies that can be reshaped.
    - Identify areas of dispersive soils and/or active tunnel erosion; avoid concentrating or storing (ponding) water in these areas.
    - Prioritize interventions on low angled slopes as flow energy is less and sediment trapping volume will be optimised.
    - Start restoration on the low angled upperparts of the landscape (catena). This will retain water and sediment higher up in the landscape, ultimately reducing energy downstream and allowing downstream areas to stabilise to some extent. Once the upper parts are stable, move restoration to lower parts.
- Identify locations where hard structures can be used effectively (due to high cost there might not be many of these structures).

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    - Active gully head erosion working into deep sediment stores. (Leave if gully head erosion is near a resistant rock outcrop; shale outcrops are highly erodible).
    - Locations on the gully floor that can act as effective sediment trapping sites - have an outcrop of resistant rock, low slope gradient and sufficient catchment area to provide sediment.
- Negotiate priority areas with local communities.
- Dispersive soils are a special case and can't be treated in a standard way. Dispersive soils will erode at any hydraulic gradient (even at a centimetre scale), thus important not to disturb or accumulate water in dispersive soils where possible (Russell *et al.*, 2009).
- Russell *et al.* (2009) developed a decision tree for the various gully interventions in wetlands. The principles are similar for dryland restoration, but the cost effectiveness of large structures on much steeper slopes (compared to low angled wetlands) could render the option non-feasible. Assess the cost effectiveness of various options.
- Experimentation (prototyping) is crucial and can guide adaptive management. Get community to understand that it might fail.
- Monitoring plan for the rehabilitated area/structures – need a dedicated person to process the monitoring data and relay it to management and scientists. Findings need to be used to improve implementation.

4.2. Principles for engaging and including stakeholders at all levels

Kate Rowntree, Tally Palmer and Margaret Wolf

Elliot (1994) proposed five prerequisites for sustainable local development:

1. Initiate a dialogue with the interested parties and stakeholders and be prepared to modify the aims and objectives of the 'experts'.
2. Identify and understand the priorities of the households and rural communities and make these the most important outcomes of the project.
3. Establish whether the communities will have long-term security and rights to the gains they are seeking.
4. Ensure self-help and the sustainability of the innovations by letting communities help themselves rather than establishing dependence on outsiders.
5. Ensure that the 'outsider' staff are competent, dedicated, motivated, and involved throughout the duration of the project (Fox 2000 p. 226).

Fox (2000) makes the point that these pre-requisites are at odds with the neo-liberal growth model because they are based on socio-economic rather than economic approaches to development. These pre-requisites are well aligned to the vision of TP and, hopefully, the NGP that attempts to combine a neo-liberal approach with a more developmental one.

These five pre-requisites capture much of what is needed for successful rehabilitation. The following points talk further to the practice of working with communities for a jointly conceived outcome.

4.2.1. Engage with the community

The most important principle, reiterated many times in the literature, is that the sustainability of any rehabilitation programme depends on the support, commitment and active participation by the local people. It is important to engage with communities from the start, allow them to take responsibility whenever possible and be part of decision-making.

4.2.2. Learn about local conditions and respect local governance

Every community and every land area is different. Take time to learn about the local demographics, local land institutions and rights to land, access to services, existing income opportunities and available labour.

To be successful, any project must work within existing institutions of local governance. It is important to create an institutional space that allows a free flow of information and building of trust between different levels of governance. Disregarding local power dynamics can cause the downfall of a project. This can be difficult when the people one is working with do not disclose information about community politics or accepted procedures.

The administration of access to land and rights to hold land is variable within communal land areas. The chief is often the person who distributes land to households and controls how land can be used. The persistence of land rights is an important factor. If land can be held only for a few years, there will be less incentive to conserve it. It may be necessary to develop a local land register.

The chief may also be the person who determines who should be employed on a project. This responsibility can also be delegated to the headman. Not going through the correct channels when employing people can have negative consequences for a project.

Rehabilitation will normally increase the labour demands, whether in mechanical works or increased cultivation effort. Labour can be affected by a number of factors including poor health or preference to undertake other activities. It is necessary to know who is normally responsible for what tasks, for example, the men do the ploughing and women the weeding. Lack of men to do ploughing has become a limitation on cropping in Sinxaku.

4.2.3. Good facilitation is paramount

The employment of a good facilitator cannot be over-emphasised. In most development projects the facilitator is the communication channel between the community and the rest of the project team. The facilitator needs to:

- build a trusting relationship with both the project team and the community, based on respect for both parties;
- be aware of actual and potential conflicts and be able to advise the project team accordingly;

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- have a sound knowledge of the aims of the project, including its technical and scientific aspects;
- be able to speak clearly with authority;
- be skilled in interpretation and translation;
- be flexible.

4.2.4. Be ethical in all undertakings

Clear contracts and agreements outlining rights, roles and obligations of all parties should be put in place early on in the project. Be open about your own agenda and the limits as to what you can offer the participating community. It is also important to encourage ethical practices within the local governance bodies. If carrying out scientific research with a local community, bear in mind that local people are not well-equipped to check the validity of research findings; don't raise false hopes or unnecessary alarms.

4.2.5. Maximise benefits

Local people need to see the benefit to themselves of the rehabilitation. It is imperative that rehabilitation is linked to improved livelihoods in both the short and long term. While the real ecosystem benefits of rehabilitation may take years to manifest themselves, there need to be clear short term benefits to the community. Multiple benefits can often accrue from rehabilitation, including income generating opportunities. However, top down job creation programmes that do not engage communities in an effective way should be avoided.
There should also be a minimum risk to the community from project failures.
"…the concept of a farmer managing land according to an ethic of land stewardship is an inappropriate base for soil conservation" Morgan, (2005) p.155.

4.2.6. Build capacity

A training programme aimed at building skills is an essential part of any sustainable initiative. These should include the following aspects:

1. Recognising the causes of land degradation
2. Understanding the social and ecological benefits of rehabilitation
3. Skills training to enable participation in rehabilitation
4. Entrepreneurial training to maximise the benefits of rehabilitation
5. General capacity building to empower communities to participate in decision making at a number of levels in the catchment.

4.2.7. Build trust

Time is also required to build trust between the facilitating agency and the community. Be aware of conflicts and take time to address these as they arise. Conflicts can arise due to a lack of communication, or miscommunication. Be prepared to say sorry when things go wrong. Take a co-learning approach with the community, where you learn from each other. Respect local knowledge and support and learn from communities who want to make a difference.

4.2.8. Build partnerships

In order to increase funding opportunities and access to technical expertise and expert knowledge it is important to develop partnerships with external players, both public and private. It is also important to engage local learning institutions. While external funding is probably essential to start up a project, working with the community to design its own village resource development plan, identify funding sources through partnerships, as well as raising its own internal funds for the project, will enable long term sustainability.

De Groot *et al.* (1992) make the point that it is initiatives that should be sustained rather than the project itself. Financial sustenance of these initiatives requires developments of many options, approaches and experimentation in partnership with the community.

Building strong partnerships with local implementing agencies is important. De Groot *et al.* (1992) point out that "community based development implies some independence of thought and action by local populations that can be threatening to the administrative structures in whose jurisdiction they lie, and to the sources of financial support." De Groot *et al.* (1992) p. 79. Ainslie & Kepe (2016), writing about the Eastern Cape, point to the "widely held belief among government officials that traditional authorities block development projects simply to discredit elected representatives, while municipalities are said to limit development in areas where traditional authorities appear to be vocal and strong". Bringing the parties together to support a common goal can be challenging but may be essential for success.

4.2.9. Raise public awareness

Putting time and resources in raising public awareness is an important precursor to developing partnerships to support initiatives. Awareness raising should be at both the local and catchment scale and if budget allows at the provincial and national scale.

4.2.10. Engage the community in monitoring

Monitoring is important both through the duration of a project and once external funding and facilitation has ended. Preferably this should be carried out by an enabled community. Everson and Everson (2014) describe simple tools that were used for monitoring rehabilitation works in the Okhombe catchment, KwaZulu-Natal. Monitoring will be addressed further in section 9.

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4.2.11. Transdisciplinary practice principles

The following set of enabling transdisciplinary practice principles (Palmer *et al.* in press, Palmer, Biggs & Cumming 2015, Palmer *et al.* 2007) are well aligned with the above principles:

- Tolerate and even welcome discomfort and unresolved tensions; they are often gateways to knowledge and trust.
- Be sensitive to "aha" moments or insights, and note that irritation and conflict often signal moments of insight and a learning opportunity.
- Engage with balanced generosity; listen and share.
- Practice tolerance, build integrity and mutual trust.
- Be sensitive to "arrivals" of both people and ideas.
- Create and use reflective opportunities.
- Manage discontinuities (people come and go, and arrangements change suddenly).
- Sustain enquiry (keep going when it is tough).

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5. Stakeholder engagement, restoration and sustainable land management options

This section outlines the recommended options for stakeholder engagement, restoration and land management.

5.1. Stakeholder engagement plan

Lawrence Sisitka, Tally Palmer and Margaret Wolff

Stakeholder engagement is the key foundation for the vision of supporting sustainable livelihoods becoming a reality. The overall research framework has livelihoods at the centre, and each research project will define the stakeholder engagement needed to reach project outcomes (Figure 1-1). In the case of stakeholder engagement to support operational activities the scale of the necessary stakeholder engagement foundation is different.

At present operational restoration includes the usual "Working for…" activities of alien vegetation clearing; building gabion-based anti-erosion structures; and the innovative use of geo-textiles, vegetation cuttings and grass seeding to reduce and halt erosion in shallow gullies; the use of textile based silt traps to slow water flow and trap silt on the landscape to become possible revegetation sites. These "person day" livelihood contributions are dependent on the longevity of the programme and must be translated into longer term, more sustainable livelihoods.

Linking operational restoration with long-term sustainable livelihood will not happen by accident. It will be important for the catchment residents across the whole area to experience opportunities for livelihood beneficiation from DEA-NRM restoration investment.

A practical proposal for stakeholder engagement is given below that addresses the key stakeholder groupings that currently exist in the catchment.

5.1.1. Levels and Scales

The various levels of influence and governance were described in Section 2.1.2.1. Some of the main challenges to effective stakeholder engagement are presented in terms of the different levels of decision-making structures. These structures need to be involved at different scales on which land and landscape management processes can take place. Exacerbating these challenges is the issue whereby political boundaries rarely correspond with natural geographical or landscape boundaries. Indeed traditional boundaries, such as tribal authority areas, do not correspond with elective political boundaries, such as wards. Given the inherent complexities posed by such diversity in level and scale, and the different processes within the programme, the TP will need to agree at which levels (essentially political, decision-making levels) the programme will work. It is also essential to identify what scale(s) would be appropriate for different activities, including engaging with stakeholders in essentially landscape-scale management, such as with Catchment Management Forums (CMFs).

Perhaps the single most important consideration in this respect is to avoid overlaying yet another set of boundaries which do not correspond with existing political/cultural boundaries (this needs to be tested with the communities

to ascertain if they would perhaps prefer another boundary structure). In the case of the establishment of CMFs this is particularly crucial. A further, vital consideration is the avoidance of a tendency for activities to be focussed on specific areas or villages, which can become intervention 'hotspots', to which all manner of research and other programmes gravitate. When operating on a catchment scale it is essential that activities are dispersed across as wide an area as feasible, involving as many local stakeholders as possible. There are, of course, both practical and budgetary constraints to how wide the net can be spread, with certain activities only appropriate in certain areas, and funding limitations reducing the potential for interventions in all areas.

5.1.1.1. Governance and Decision-making Levels with respect to the TP activities

Formal governance processes in South Africa, as defined in the Constitution, operate at essentially three (3) levels: national, provincial and district/local (although some consider these to be two separate levels, therefore in contravention of the Constitution). In the former homeland areas, such as the majority of the Ntabelanga/Lalini catchments, a further layer of formal governance, that of the tribal (or traditional) authorities, operates. Again, this additional layer is considered by some commentators to be contrary to the constitutional dispensation. At the very local level, more informal governance structures and institutions can be found, in local associations and committees of various kinds. In engaging with stakeholders, the TP will need to be very clear as to at which levels it will conduct such engagements.

5.1.1.2. National Government Level

The TP is a project of a national government department/directorate (DEA:NRM). As such, there is inevitable engagement with other national departments, in particular the DWS, responsible for the probable construction of the two dams proposed for the area. While this engagement has some implications for the TP activities on the ground, this is quite indirect and may only filter through over some considerable time. National-level engagements are in the hands of senior DEA officials with responsibility for the TP. The Chief Director's office of the DEA NRM are taking the responsibility for constituting a national level advocacy committee of the key stakeholders (DWS, DEA, WRC, DST etc). This high-level support committee will have a core function to galvanise collective governance and coordination at the highest level, including investment.

5.1.1.3. Provincial Government Level

The TP (and the construction of DWS's dams) falls under the MWP, one of 18 Strategic Infrastructure Projects (SIP), declared by national government in 2012 as part of the National Infrastructure Plan (NIP). The MWP is itself overseen by the Eastern Cape office of the Premier, which has commissioned the Eastern Cape Socio-Economic Consultative Council (ECSECC) to co-ordinate and mediate the project. Their main role has been to facilitate meetings between key role-players, although this had proven increasingly problematic with ever fewer stakeholders attending such meetings. From the provincial government perspective, therefore, the stakeholder

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engagement is very much in the sphere of the larger MWP, involving government departments. It has little, if any, effect at the local level. It is not directly concerned with the engagement of local communities, leaving this to the various projects, such as the UCPP running within the programme. The TP will certainly need to retain contact with the MWP, through the Premier's Office and ECSECC, and share information in this way. However, in terms of the on-the-ground activities the meta and meso-level forums described here are much more appropriate in terms of ensuring real engagement of the concerned communities (Figure 5-1). In essence it would seem inadvisable and unnecessary for the TP to spend valuable resources, time and energy on establishing a provincial-level structure when the Premier's office has already established this structure to facilitate and co-ordinate activities within the MWP.

5.1.1.4. District/Local Municipality Level – proposed 'meta-level'

These are the levels of formal government which are most directly concerned with developmental and other activities within their constituencies (see Figure 5-1). They need to sanction all such activities, which should be located within the Integrated Development Plans (IDP) and Spatial Development Frameworks (SDF) of the relevant local authorities. It is strongly recommended therefore, that the 'meta-level' of stakeholder engagement for the TP is at the District Municipality level. There are two District Municipalities covering the area:

- The Joe Gqabi DM, in the western portion, including the private and commercial farming and forestry areas in the upper catchments, and a large area of former Transkei homeland in the middle catchments. Only one Local Municipality, Elundini, falls under this DM within the catchments.
- The OR Tambo DM, in the eastern portion, encompassing large areas of the former Transkei homeland, and with two local municipalities, Mhlontlo LM (Ntabelanga and Lalini) and Nyandeni LM (only Lalini) falling within the area.

In order to facilitate the stakeholder engagement at this level it is proposed that two co-ordinating committees are established centring on each of the two District Municipalities. Strong representation from the local municipal level should obviate the need for a separate LM-level forum. The composition of each committee may be slightly different in each case, but could include:

- Senior planner from the DM
- Senior planner(s) from the LM(s)
- Local Economic Development (LED), environment and agriculture representatives from the DM and LM(s)
- Relevant ward councillors
- Relevant traditional authority chiefs (including, in the case of OR Tambo, a representative of the AmaMpondomise Royal Council)
- Representatives from the regional offices of the provincial Department of Rural Development and

Agrarian Reform (DRDAR), and Department of Economic Development, Environment and Tourism (DEDEAT)

- Representatives of the various farmers' associations: The MFA and the Joe Gqabi DM African Farmers Association of South Africa (JGDMAFASA), in the Joe Gqabi DM forum; The OR Tambo DM African Farmers Association of South Africa (ORTDMASAFA) in the OR Tambo DM forum
- Representatives from WoF, WfWetlands, WfEcosystems, WfW and other public works programmes
- Two TP management representatives
- Perhaps a representative from the provincial office of Cooperative Governance and Traditional Affairs (CoGTA)

The precise make-up of the committees will take considerable negotiation, but perhaps it is important to try and keep them relatively small, as the larger the forum the less effective it is likely to be. This is the case even in a non-executive structure such as a co-ordinating committee, which is essentially consultative. It is also critical to avoid situations where progress is hampered by absenteeism, and a quorum (usually 50% + 1) is agreed. However, as the structure will be negotiated it is likely that there may be insistence on, for instance, the involvement of municipal managers and other government officials, and the committee is likely to be larger than ideal.

Such committees could meet three or four times a year to be kept informed of progress and agreed plans/locations for future activities. New research or implementation projects under the TP banner should be introduced to these fora and advice sought on appropriate areas (traditional or geographic) for these.

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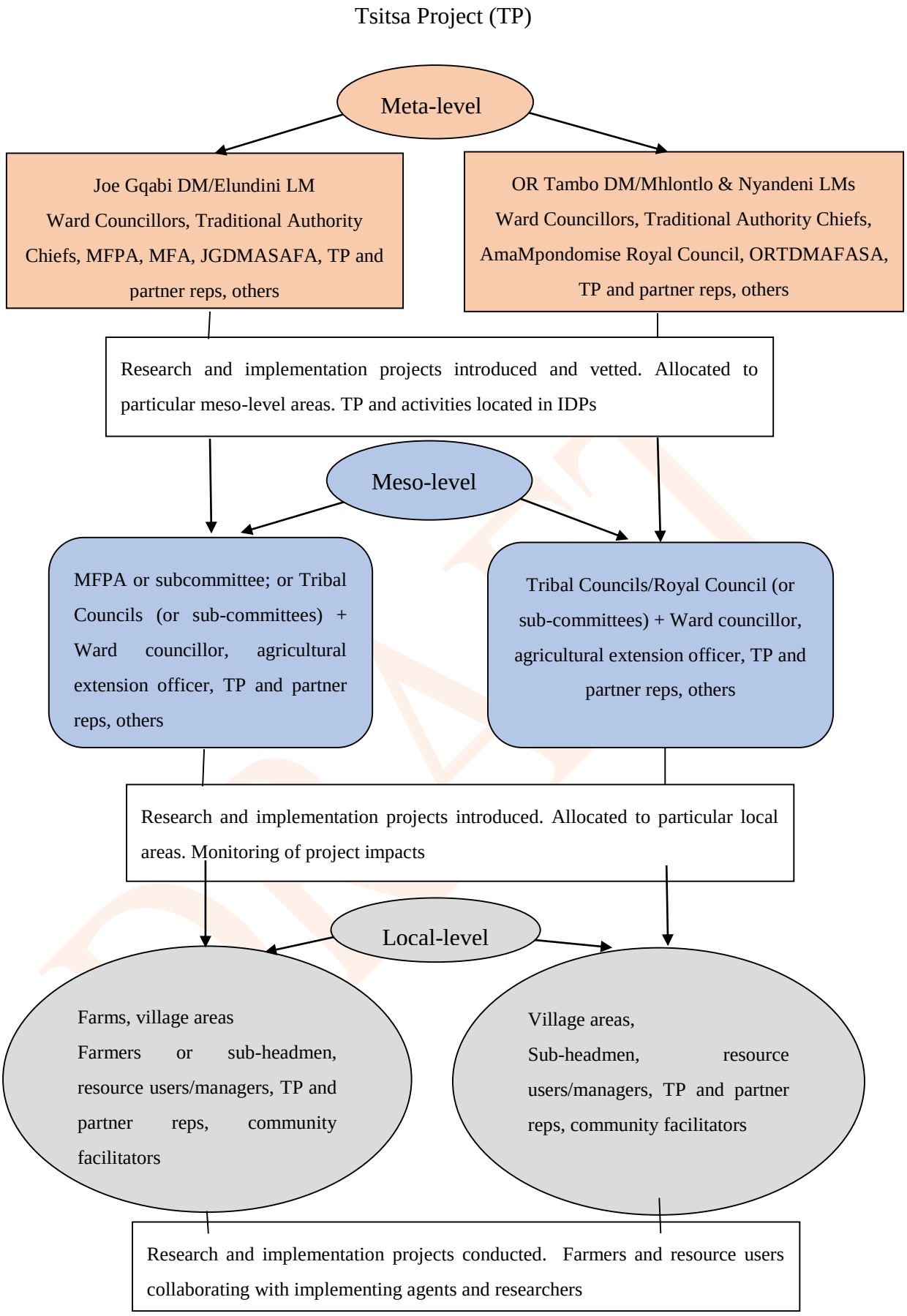

Figure 5-1: TP Stakeholder Engagement Model (ver1).

It is at this level that a good spread of interventions across the catchments, whether research or implementation, should be ensured. These decisions can then inform negotiations at the 'meso-level' (see below). A further function of these committees should be to inform the TP of any external actors operating in or proposing to operate in the area. These could include new research programmes or different interventions.

5.1.1.5. Ward/Private-commercial farming and forestry/Traditional Authority Level – proposed 'meso-level'

One challenge, as previously mentioned, is that there is no real correlation between the ward boundaries and either the commercial farming area boundaries or the traditional authority boundaries. However, it is possible to identify 'clusters' (as suggested in the TP Stakeholder Analysis; Fabricius *et al.* 2016) incorporating the different geographies of private ownership and elected and traditional governance. In the stakeholder analysis, these clusters were identified as including the local and district municipalities, but in terms of practicalities they comprise more local stakeholders, with the municipalities represented almost solely by the ward councillors.

This 'meso-level', as described by the TP Stakeholder Analysis, is the level at which day-to-day decisions on land and natural resource allocation, use and management are made. The proposal to establish 'governance committees' across the sub-catchments (made in another section of this paper) is very sound, but essentially these already exist in the form of the MFPA and the tribal councils, although these would need to be capacitated, and enhanced by the inclusion of other stakeholders in order to take on additional responsibilities. An alternative, and probably the most likely solution would be to seek the approval of the MFPA and the tribal councils to establish TP governance sub-committees within their areas, and involving some key leaders within these areas. It would be unwise to impose another independent stratum of governance into an already complex situation.

Private/commercial area

In the private/commercial farming and forestry sector, land and natural resource use and management decisions are taken to a large extent, by individual farmers, with advice and support from their agricultural suppliers. PG Bison, with a land-holding of over 70 000 hectares in the area is managed almost entirely as a commercial forestry and timber concern and makes its decisions based on commercial considerations within the constraints of the appropriate legislation. However they also have plans to extend the cattle ranching project they have initiated on the areas unsuitable for forestry, or excluded under the legislation, to some 5000 head in the next 2 years. This area, in the Ntabelanga catchment, is covered by the Elundini LM Wards 1, 4 and 17, although there seems little recourse to, or reliance on, by the farmers, either the local or district municipalities. There is a Maclear Farmers Association (MFA) including almost all commercial farmers in the area and the Maclear Fire Protection Association (MFPA) of which all commercial farmers and PG Bison are members. This latter organisation is where farmers actively co-operate to reduce the risk of fire damage.

The proposal for this group is that the Maclear Fire Protection Association (MFPA), which covers a considerable area of the upper catchments, is considered by the TP a 'meso-level' co-ordinating structure for project activities in the private/commercial area. It would be entirely impractical to facilitate meetings including

the entire membership of the MPFA, but it should be possible to negotiate a consultative structure comprising:

- Representatives of the MFPA (and the MFA – although these are likely to be the same)
- A senior representative of PG Bison
- Relevant Ward Councillors
- Representatives from the regional offices of the departments of water services, environment, agriculture and forestry
- Representatives from the TP
- Representatives from the various Extended Public Works programmes operating in the area.

The main role of such a structure would be to remain informed about developments in the TP, and agree activities and locations for these within their area of geographic coverage. New research or implementation projects should be introduced to this forum once agreed at the meta-level and advice sought on specific locations for these.

Former homeland 'communal' area.

The critical fora in the former homeland area are the traditional councils, which usually meet every month, and often involve, in addition to the chiefs, headmen and sub-headmen, the relevant ward councillors and agricultural extension officers. While there is considerable contention regarding the roles and constitutional relevance of the traditional authorities, the reality is that it is these councils which determine most if not all land use activities within the boundaries of the particular authority. The traditional authority boundaries and structures are also, in a context of shifting political allegiances and ward boundaries, likely to endure, and remain fixed features in an otherwise uncertain terrain. A further reason for strongly recommending that, in the former homeland area, the tribal councils are the only natural and logical structures with which to build relationships at the meso-level is that the people living in a tribal authority area do have a strong concept of it as their tribal land. They have a far better understanding of its geographical limits and of its landscape and resources that they do of any other politically or naturally defined areas. This presents therefore the best opportunity to work with people on a landscape scale.

It is strongly recommended that the TP consider the tribal councils (or possibly agreed governance structures within the tribal areas and operating on behalf of the councils) as the 'meso-level' structures for stakeholder engagement in the former homeland area.

In addition to the traditional leaders, most of the key stakeholders, including the ward councillors and agricultural extension officers, are already involved with the councils. Other contributors could be suggested by existing members, or invited on an *ad hoc* basis (as they are currently). For instance, new research and/or implementation programmes could be introduced through these fora (subsequent to approval by the meta-level fora).

The main function of these fora, in relation to the TP, would be to remain informed concerning progress of the programme and agree on the activities appropriate for their area and the precise locations for these. It would be at this level that equable distribution of interventions within the commercial farming community or within the traditional authority areas would be determined, depending, of course, on the specific rehabilitation and management needs of each site, based on the research and other scientific information available, such as that

included in this plan. A further function would be to provide oversight for the activities, including some monitoring of progress.

Engagement with all clusters at this level should be regular throughout the lifespan of the TP, with direct interactions every 2nd or 3rd month to ensure continuity of relationships and effective sharing of information. Where interventions are underway, interactions may be on a monthly basis.

5.1.1.6. Village/farm level – 'local-level'

This is the level at which direct engagement with individual land and natural resource users and managers, the focus of most other contributions to this stakeholder engagement component, will take place. Clearly, some important decision concerning the locations of various interventions will have been taken at the other two engagement levels, but the specific nature of these interventions, the levels of involvement of local land-users, and detailed plans for subsequent management can only be determined at the local level. However, it is unlikely to be feasible for the TP itself to work at an individual village level, hence the suggestion for the meso-level as the primary local-level decision-making structures, with TP sub-committees covering clusters of villages or perhaps headman areas being the most local level of engagement and implementation.

At the level of individual commercial farms or forestry enterprises the engagement will be relatively simple; dealing with the individual landowner directly (or through effective forums such as the MFPA, this needs to be tested).

At the village level, within the former homeland, there is likely to be considerably more complexity in dealing with entire communities comprising people with varying and often competing interests. It is here, most of all, that following the principles of stakeholder engagement, articulated elsewhere in this document, will be most essential and require most skilled facilitation. It is also here that the need and potential for capacity building may be greatest.

Some villages may still support Village Committees, who liaise closely with their sub-headmen and/or headmen in matters of importance to the villagers, including matters related to land and natural resource use and management. Where such Committees exist they would appear to provide the ideal forum for the detailed discussions around interventions in their area. Otherwise, it may be advisable to support the sub-headmen to establish such committees for the express purpose of engaging with the TP. Engagement at this level should be continuous throughout the lifetime of any research or implementation interventions, with provision made for substantial follow-ups for monitoring purposes.

5.1.2. Processes and Protocols

The establishment of the various levels of stakeholder engagement described above will also require the agreement of clear processes and protocols for engagement with the various structures and the people living and working in the area. This is perhaps not the place for detailed discussion of these, and they will in any event require considerable consultation, but to set the scene, some of the key processes could include:

1. Initial introductions of the TP at meetings with DM, LM and traditional authority representatives (chiefs or royal council reps) in the two District Municipality areas. This should also provide the opportunity to agree on the establishment of the meta-level committees and their composition, and initiate discussions on access to the MPFA or tribal councils as the meso-level structures. It is understood that the programme has been introduced in various fora over the past two years, but it is necessary to develop a stronger sense of coherence around the programme, and in the understanding of the programme. A (re)introduction is therefore necessary at this stage.
2. Agreement of the composition of the meta and meso-level structures and setting of dates for the first meetings.
3. Once the structures are established, all ideas for new research or implementation interventions associated with the TP should be introduced to the relevant meta-level committees where decisions should be taken as to the most appropriate locations for these, and the appropriate meso-level structures through which they should be introduced to the people in the area.
4. The ideas for any new interventions are then taken to the appropriate meso-level committees for detailed discussion on specific sites and specific activities appropriate to these.
5. Finally, the intervention proposals are taken to the farms or villages identified by the meso-level committee, where detailed discussions are held on the proposed activities, or alternatives proposed by farmers or community members.

One key question is in relation to who should represent the TP in these structures and who should represent individual research or implementation proposals. In most cases, this will require senior representatives from the TP management, certainly at the meta-level, and project leaders also at this level. It is critical that such representatives are in a position to take decisions such as making changes to any proposals (within certain limitations) as a result of consultation with the structures. At the meso-level, any representatives should also be mandated to take decision on behalf of the TP or independent research or implementation organisations. At this level. The programme and project representatives may need the support of a stakeholder engagement specialist.
At the local (farm/village) level the main interactions are likely to be between the people tasked with conducting the research or implementing the activities and the farmers and other people active in the area. Sensitive facilitation is required here and specialist support is likely to be needed, especially in the former homeland villages, but perhaps less so in the private/commercial areas. TP has in principle taken the decision to appoint a specialist service provider that will assist with the community engagement and capacity building at the very local level. This CE will be centrally coordinated but require a permanent presence in the catchment and have locally embedded Community Liaison Officers who would be responsible for the flow of information at the farm/village level.

5.1.3. Governance in relation to the TP Research and Implementation Partners

The TP is in an interesting position in that it has partners working directly under the programme funding, and therefore obliged to follow any rules or protocols for stakeholder engagement developed by the programme. It also has partners who are operating in the Ntabelanga and Lalini catchments, under different programmes with different funding, independent of the TP. These partners clearly have no formal obligation to follow such rules and protocols. However, currently it appears that the informal relationship between the TP and these 'external' partners, most of whom share a concern for the genuine and central participation of local land and natural resource users in their projects, and in the TP more generally, is quite strong, and there is a good sense of collaboration. Indeed, some of these projects are seen by local communities and others as TP projects, although they are not. On the one hand this is a strong affirmation of the growing strength of the TP 'brand'; on the other it does show some confusion as to what is, and what is not, part of the TP (this also plays out in relation to the dam construction, from which the TP is keen to distance itself). There needs to be some resolution of this confusion, especially as new projects come on line and start to operate in the area.

Following the processes and protocols, proposed above, should go some way to reducing the confusion and establishing some level of coherence in stakeholder engagement, but partners from outside the direct influence of the TP have no formal obligation to comply with such processes. These are subject to the requirements of their own funders and the demands of their own logical frameworks, and cannot be expected to fall in with any frameworks developed by the TP. It is a moot point as to whether the TP can ever be in a position to insist that any activities taking place in the area should be subject to any rules developed by the programme. However, it is incumbent on the TP to follow up on any information regarding new activities, not connected to the programme and establish a working relationship with them, perhaps inviting them to present at the various consultative levels. For research and implementation partners with an already close relationship with the programme it may be possible to develop Memoranda of Understanding (MOU) to agree adherence to specific aspects of the processes and protocols in relation to how they engage with stakeholders in the area.

5.1.4. Phasing

The establishment of a profound culture of stakeholder engagement is a process requiring considerable dedication and time and, of course, adequate funding. Such a process can be considered to comprise three distinct, but merging phases:

1. *Developing trusting working relationships* – stakeholder engagement is founded on trust and on genuine and equal relationships between the various parties. To date the TP has developed strong relationships with its core partners, the key researcher groups and implementation agents, but has not as yet established strong working relationships with most stakeholders in the area of operations. While this is in some ways unfortunate, there are real opportunities, through adopting the approaches and processes described here, to begin to develop such relationships across the sub-catchments with all the key stakeholders. These could also build on the contacts already established through the various Extended Public Work Programmes, such as Working for Water and Working on Ecosystems initiated by DEA in the area.

The current situation is that research programmes are underway, having been developed without the input of the people working the land, and rehabilitation and other activities have been implemented for some time, with extensive plans for further such interventions, again, without input from the people on the ground. The programme is therefore not yet meeting its aims in terms of stakeholder engagement as described in the programme documentation. It is not possible to hold back on further research or implementation, given the funding and other imperatives underpinning the programme. However, it is entirely possible to begin a real process of relationship building through the introduction of proposed research and implementation activities in agreed locations within the sub-catchments. In this way, the relationships can be established on the basis of the pre-existing research programmes and implementation plans, with potential for negotiation around the details of these. Within the TP 10-year time-frame this phase, starting now, may occupy the years 3 and 4.

Throughout the process it must be remembered that while trusting relationships can take years to establish, they can take mere hours to destroy.

2. *Consolidation and transfer* – In this phase the working relationships are consolidated and set on a sound footing, with all parties fully aware of their rights and responsibilities within the relationship, and, with luck, fulfilling their duties in relation to it. It is also the stage at which transfer of some planning and management responsibilities is made from the intervening agents (in this case the TP and core partners) to the farmers and communities and their local support networks. In essence, this is when the local partners start to make substantial contributions to the decisions concerning their land and natural resource use and management, in relation to the TP objectives. In particular, the local partners become directly involved in all aspects of research and implementation activities, including the monitoring and evaluation of the impacts of these, and providing inputs into the development of research agendas. Within the TP 10-year timeframe, this phase may occupy years 5 to 8.
3. *Handover* – This phase is very rarely if ever reached by programmes such as the TP. It is where the major responsibility for planning, implementation and monitoring of land and natural resource use is taken on by the local partners with 'light-touch' guidance and support from the external partners. In this phase, the local partners should also play a central role in determining research agendas to gain insight into issues that directly concern them. The final couple of years of the TP should be focussed on ensuring a smooth and effective handover and a clean exit.

5.1.5. Capacity Building

Capacity building at all levels and for all stakeholders, including in this case the core TP partners and management team, is an integral feature of any effective intervention. Much capacity building takes place on an informal basis, through strong and consistent interactions between the partners, sharing experiences and ideas. However, there is also need for carefully focussed formal capacity development processes to develop the skills necessary for the long-term sustainability of the interventions. In particular, local partners need to have the skills to manage their land and natural resources effectively and sustainably.

Conventionally in similar interventions, capacity building of local partners has generally been limited to basic practical skills relating to the various rehabilitation activities. However, for any chance of sustainability, there needs to be capacity building at more conceptual and management levels, in order that local partners can, in the future without external support, make critical decisions regarding their use and management of the land and natural resources. Such capacity requires a degree of analysis and reflexivity that is not often evident in rural communities, but is readily developed through appropriate educational processes.

The proposal for the establishment of Stakeholder Engagement and Livelihood Development (SELD) teams, of trained facilitators and rangers, described elsewhere in this document, is one approach that could be taken to capacity building within the meso-structures. Another approach was posited in which a number of local partners would undertake a Rhodes University certificated course on land and natural resource use and management and community engagement, and then be mentored in implementing their learning by experienced facilitators from the other partners. Both approaches take the view that a considerable number of people within the local partner communities will need to be capacitated to a high level in order for there to be any chance of future sustainability of the TP interventions.

The recommendation here would be for a comprehensive capacity development strategy to be developed by the TP management team, complete with a realistic budget, which can then be negotiated.

5.1.6. Communication and Information Sharing

The TP Stakeholder Analysis (Sisitka *et al.* 2016) provides some insight into the communication challenges faced by initiatives such as the TP. It describes the essential lack of effective communication in the three dimensions: vertical (through hierarchies); horizontal (among peers, neighbours and colleagues); and diagonal (between senior personnel in one government department and junior personnel in another). The analysis argues that we can never assume that information given to one person (such as a ward councillor) at a meeting will be shared with their fellow councillors, or government officials, or their constituents. The last dimension, composed as it is of a combination of the first two is inevitably the weakest. Yet it is extremely important for the TP that accurate information about the programme and its activities and progress is shared widely at all levels and across the catchment.

The key arenas for communication and information sharing will inevitably be the committees at various levels, including the most local level structures. However, not everyone attends such meetings and the TP will need to ensure that these people, too, are kept informed.

A further means of information sharing is the information portal developed for the TP by the Institute for Natural Resources at the University of KZN. However, most of the information here is highly scientific in nature, and of course only accessible to those with good internet access.

To have any chance of achieving effective communication and information sharing, the TP will need to become much more media savvy, and utilise every available channel for sharing different kinds of information at different levels, in different languages and in different forms. The starting point would be to access research already conducted into the communication channels and media used by rural people in South Africa, with some original

research into the media used most in the area of operations. While some may have ready access to the internet, and use websites, Facebook and other web-based social media, others may be limited to the printed word, when available, and television and radio. Considerable research has been conducted into rural communications, and indicates that WhatsApp is growing in popularity as the preferred medium of communication between people in a working relationship. The main advantage of this is that anyone in the network can post ideas, issues, questions, which can be responded to by anyone else. Radio is also a powerful medium in rural areas, and a regular slot on the appropriate station can provide a strong link to stakeholders in the area.

The TP needs to take cognisance of such research and develop a communication strategy to meet the needs of their partners at all levels. One element could be the production of a quarterly bulletin or newsletter, which can be posted on the various websites of the municipalities, posted on a TP Facebook page or blogsite, and produced in printed form in isiXhosa for distribution among the villages.

Communication and information sharing is such a critical aspect of the TP's work that it warrants the services of a communication specialist to ensure the effective flow of information at all times, across all media to all stakeholders. Without an effective communication strategy any efforts towards real stakeholder engagement are likely to be severely handicapped.

5.2. Erosion control and restoration options

Bennie van der Waal, Ralph Clark, Japie Buckle and Kate Rowntree

Erosion control and restoration work will be decided with the local land users to capture their key landscape problems and their preferred restoration priorities (Figure 5-2). The type of interventions that are suitable for the identified problem is largely decided by the biophysical nature of the site and the support of the local land users. This work includes dryland and wetland work and discharge is the key determining factor for the use of hard or bioengineering options (Figure 5-2).

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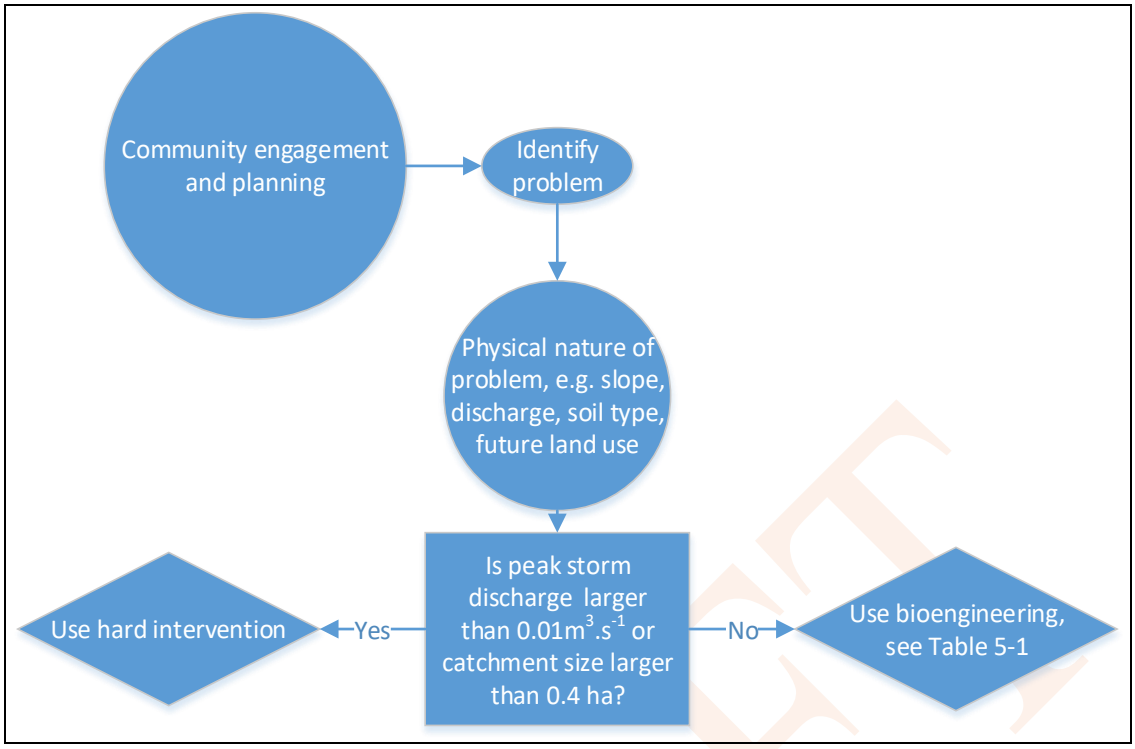

Figure 5-2: Decision tree for choosing restoration intervention types (After Russell et al. (2009))

The suitable hard structure will be designed by an experienced engineer to ensure longevity of the intervention, e.g. a drop inlet to stabilize gully head erosion. If bioengineering is the right solution, then options for bioengineering can be picked from Table 5-1 below. These options can be planned by experienced managers.

Table 5-1: Suitability of different interventions for various erosion types (copied from Russel et al. (2009)).

	Supporting applications					
Erosion problems	Brush mattress Live cuttings	Brush mattress	Brush mattress Wire and pegs	Vegetative bundles	Brush fences Live cuttings	Brush fences
Temporary erosion control	√	√	√	√	√	√
Sheet and rill erosion	√	√	√	√	√	√
Dissipating wave action	√	√	√	√	√	√
Stream channel		√	√	√	√	√
Gully erosion		√	√	√	√	
Gully head erosion			√			

Table continued

Applications	Hydro seeding	Nets	Mats	Mattresses	Fibre Rolls	Fibre Bags	Sediment fences
Temporary erosion control	√	√	√		√		√
Sheet and rill erosion	√	√	√	√	√	√	√
Dissipating wave action		√	√	√	√	√	
Stream channel		√		√	√	√	
Gully erosion		√	√	√	√	√	√
Gully head erosion				√		√	

5.2.1. Runoff management

The section below deals with increased downslope water and sediment routing through footpaths, livestock tracks and roads.

5.2.1.1. Footpaths and livestock tracks

Rehabilitate paths and avoid leading livestock through sensitive areas. This can be done by diverting water out of eroded pathways onto vegetated areas where water can spread out on the surface and soak in. Be careful not to direct water onto an area that is sensitive to further surface and subsurface erosion. Diverted water can be used for water harvesting purposes. Use methods that allow people and animals to still use the pathways to some extent. Flow pathway length and connectedness increases as you change vegetation cover from good grass cover to poor grass cover (density and diversity of species). This increases water, sediment and carbon export (Puttock et al., 2013).

5.2.1.2. Roads

Capture and redirect road runoff to where it can be put to beneficial use (e.g. garden cultivation, watering fields). Pechenick et al. (2014) note that road network density and its proximity to drainage pathways will increase its efficiency to transport water and sediment. They also found that steeper roads were associated with more frequent erosional features.

Ultimately the TP Restoration Plan will need to have a thorough assessment of all the storm-water and road runoff drainage planning and mitigation. Where possible TP ecologists will need to become interested and affected parties in further road and quarry developments – and if necessary build in mitigation measures for poor planning at provincial, district municipality and local municipality levels.

The same would apply to all other developments that have an impact on vegetation cover, soil profiles and revegetation exercises (e.g. new pipelines, telephone lines, etc).

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5.3. Land management

Ralph Clark and Bennie van der Waal

Land management plays an important role in the state of the ecological infrastructure in T35A-E. Vegetation cover is influenced by grazing and fire management and can be negatively impacted by invasive alien plants. Below are options for improving range, fire and alien vegetation management.

5.3.1. Range management

Continuous grazing is detrimental to range productivity and sustainability (Figure 5-3). For degraded rangelands passive rehabilitation might be most cost-effective and practical for the Escarpment Grasslands (steep upper catchment), as these are in better condition than the Sub-Escarpment Grasslands (middle and lower catchment) and better able to self-rehabilitate if grazing and trampling pressure is alleviated. The remote and rugged topography would also make active rehabilitation more costly to implement than in Sub-Escarpment Grasslands. Ideally livestock should be excluded for five years, but this is unrealistic due to the monetary and cultural importance of livestock. Ideally it would also be good to exclude fire during the five year recovery period, but this is unlikely to be practical due to the high prevalence of lightning strikes.

Figure 5-3: Difference in grass height and production of seed due to fencing in the upper Sinxaku Village.

5.3.1.1. Degraded Sub-Escarpment rangeland management

The Sub-Escarpment rangelands would need a combination of passive and active rehabilitation, depending on more site-specific contexts. As for Sub-Escarpment Grasslands, a five year exclusion of grazing and fire is recommended, but realistically these highly degraded grasslands probably need a rest period of at least ten years. This will allow grass cover to increase, grass and non-graminoid diversity to recolonise, and to allow the best results for combination with active rehabilitation. Active rehabilitation will be necessary where there is severe

erosion, barren lands, or very low grass cover, and it is likely that former cropland and riparian areas will need particular focus. It might be worth considering paying local communities to not have livestock for this period of time, reassess the rangeland conditions every year, and re-introduce stock depending on the level and speed of rangeland rebound.

Failing a complete livestock exclusion plan, it would need to be considered which livestock are most detrimental to the Catchment, and how these can be mitigated. This would need to involve a livestock census, using categories for species present (i.e. sheep, goats, cattle, horses, donkeys, pigs) and their grazing habits in the Catchment. Cows for instance leave the lower 5–6 cm of grass, sheep down to 3 cm, horses close-crop the grass, goats prefer browsing on bushes but also use grass, and pigs can root out entire plants (Organic & Sustainable Agriculture Research & Extension Programme, University of Wisconsin-Madison, sine anno). The age class of the animal also determines how it grazes and what impact that has on the vegetation; middle-age sheep and goats might have more impacts than younger or older animals for instance, as they have attained their full sets of teeth but not yet lost any (Organic & Sustainable Agriculture Research & Extension Programme, University of Wisconsin-Madison, sine anno). The various animals also differ in terms of selectiveness, for instance cattle and horses are more selective in their grazing than sheep and goats (Organic & Sustainable Agriculture Research & Extension Programme, University of Wisconsin-Madison, sine anno). These factors all combine to impact the Catchment, and if known, it might be possible to promote a compromise plan that encourages only cattle and horses and excludes sheep and goats, or favours younger and older animals but not a majority of middle-ages animals (as if there would be any sense or practicality in this, as herds are always mixed ages). O'Connor et al. (2010) for instance indicate that continuous sheep grazing has the highest negative impacts on biodiversity (grass included) while continuous grazing with cows the least (stocking rates dependent). Interestingly, game farming has the lowest impacts, stocking rates dependent (O'Connor et al. 2010).

5.3.1.2. Escarpment rangeland management

While never 'perfect', and certainly with local challenges, commercial rangeland management in private hands combines the best of economic productivity, water catchment management and biodiversity conservation in the Grassland Biome (O'Connor & Kuyler 2009, SANBI 2014). As a result, these areas do not require immediate interventions, as the rangelands are in overall good condition. However, of concern to many conservationists and rangeland ecologists is the growing popularity among commercial farmers to adopt Holistic Management principles (as promoted by the Savoury Institute) over conventional management systems (Kirkman 2012, Nordburg 2016, pers. obs.). Holistic Management suggests that high stock densities, high grazing pressure and short rotational cycles will increase the grazing value of the rangeland. An in-depth critique by Nordburg (2016) of Holistic Management philosophy indicates that many of the benefits touted by the Savoury Institute are not grounded in scientific reality, are exaggerated, or even contradict well-founded science-based recommendations, and that the methods proposed actually aggravate degradation. Kirkman (2012) however suggests that there is commonality of purpose between Holistic Management and conventional systems. While there is much controversy in the debate (Chatikobo & Hawkins 2015), personal observation on commercial rangeland in the

Stormberg area (as an example) suggests that Holistic Management replaces catchment-friendly perennial grasses with weak annual grasses (many of which are non-native species in the genera *Poa*, *Hordeum*, *Triticum*, *Phalaris*, *Festuca* etc., or perennial invasive genera such as *Nassella*), as well as encouraging weedy, ruderal species typical of disturbed areas; furthermore, the desired outcome of 'grazing lawns' of dense grass cover is detrimental to non-graminoid plant and endemic animal diversity (it is the author's experience from 10 years of Escarpment fieldwork that 'grazing lawns' invariably have low species diversity and non-graminoid species present are regularly widespread annual species typical of degraded environments; this is admittedly also incidental data and not empirically tested). Based on the very few 'Savoury-approved' research papers on Holistic Management, the interview or anecdotal data in those papers (as opposed to empirical evaluation and comparison with conventional management), concerns around Holistic Management's attitude to fire (considered not necessary), and perceived negative impacts on endemic biodiversity (Chatikobo & Hawkins 2015, Nordburg 2016), a precautionary approach to Holistic Management should be taken by commercial farmers in the Catchment (although it might be useful in the highly degraded communal Sub-Escarpment rangelands; see point 6 under section 6.3). We emphasise this based on the precautionary approach inherent in South Africa's environmental philosophy (as outlined in the National Environmental Management Act, Act No. 107 of 1998) and encapsulated in SANBI's (2014) warning: '*The bottom line is that it is relatively easy and rapid to cause extensive damage to grassland, and extremely difficult and expensive to undo this damage, especially at a scale anything larger than a camp. Once plant diversity, basal cover and then soil have been lost from a grassland, they are unlikely to return in a meaningful management time frame. This emphasises the need for a precautionary approach in all management to ensure damage is not done in the first place*'. This is especially true in Escarpment and Sub-Escarpment Grassland, which dominate the Catchment, as these grasslands recover extremely slowly from disturbance and seedling establishment is slow (SANBI 2013, 2014). Any disturbance through inappropriate management is exacerbated by the steep gradients and limited growing season, encouraging erosion and colonisation by invasive species (particularly *Acacia mearnsii*, *A. dealata*, *Nassella trichotoma*, *N. neesiana* and *Rosa rubiginosa*). It is the author's personal opinion that Holistic Management is possibly better suited to semi-arid and arid areas where the original mass movement of indigenous herbivores (such as Springbok) can be emulated (e.g. Namaqualand and arid Savannah areas), but is not appropriate in high rainfall grasslands dominated by perennial grasses and characterised by vulnerable duplex soils on rugged topography. (See Kirkman 2012 and Chatikobo & Hawkins 2015 for an overview on the debate).

Secondly, there is the very real concern that land removed from private ownership and placed in communal hands as part of land reform may exacerbate the problem of degradation (Palmer & Bennett 2013). Should there be such reform in the Catchment, it will be necessary to hold the new land-managers to account as South African citizens responsible for the long-term condition of the land (in terms of the various legislation). Aggravation of degradation through mismanagement would simply add further burden to the State in the form of catchment yield loss, welfare demands, and costly rehabilitation.

A final challenge is loss of formal management and replacement with *de facto* communal use, through abandonment of commercial farm land from stock-theft, security risks and challenging economics in border areas of the Eastern Cape and KwaZulu-Natal (SANBI 2013). As the Catchment includes a 'hard' border with Lesotho

and a 'soft' border between commercial and communal land areas, this could be an important factor in rangeland management in the Catchment.

5.3.1.3. *Possible rangeland management opportunities*

The following key considerations came out of the UCCP Workshop (7–9 March 2017) as are applicable to the Ntabelanga Dam Catchment for consideration by the restoration team.

Rotational grazing

The rotational grazing being encouraged in communal areas as part of the incentive to commercialise communal cattle for auction in the red meat trade can be considered for the Catchment as an incentive to reduce stock numbers and improve rangeland management. Two examples of grazing management that are being implemented are full growing season rest and an intentional rotational system.

Stock pens & Alien Invasives

Intensive kraaling and grazing of livestock on areas cleared of dense Wattle invasion has proven to be effective in similar areas such as Matatiele, having a tremendous benefit to rehabilitation of those areas. The trampling and manuring were able to break up the surface hard-pans and to encourage grass colonisation. She noted that Holistic Management per se was not the best for the region, but components of it in this context were very helpful.

Protected Area Expansion

The Eastern Cape Parks & Tourism Agency (ECPTA) intends to bring as much of the upper portions of the Umzimvubu Catchment (forming part of its 'north-east grasslands' priority area) into some form of stewardship programme as part of the Eastern Cape Protected Area Expansion Strategy. In terms of implications/opportunities for the Ntabelanga Catchment, this could (1) potentially secure quality catchment rangeland through ascribing Protected Natural Environment status to the Escarpment and sub-Escarpment commercial rangelands in the Ntabelanga Catchment, and (2) improve communal rangeland conditions in the long term for the Escarpment communal rangelands through creation of a Nature Reserve. This could be reasonably easily facilitated as the ECPTA is looking for recommendations on 'low-hanging fruit' in this regard.

Indigenous Antelope

There is a 'wild card' option on the periphery vision of the UCPP (through the ECPTA) to groom communities to run indigenous antelope in communal areas with/in place of livestock. Information is scanty at present, but (assuming rational stocking densities) indigenous antelope are considered to be the least impacting on rangeland over every other form of land-use (O'Connor & Kuyler 2009).

5.3.1.4. *Community buy-in and ownership of rangeland management*

A grazing management plan will need to be co-developed with the local community and must be adapted to take account of local needs and practices. Where land is grazed communally, there must be buy-in from all livestock owners. Fencing was used effectively in the past, and communities ask for new fencing to help with grazing management (Heard-Hoare, 2015). The introduction of an appropriate marketing strategy provides an incentive

to improve veld and stock condition together (See Matatiele project www.).

5.3.2. Fire management

Fire is a natural abiotic driver of the Grassland Biome (Mucina & Rutherford 2006), and is a valuable and essential tool for proper management of grassland (SANBI 2014). Fire would naturally have occurred in the catchment prior to human activity from lightning strikes, and possibly from dolerite boulders sparking when falling (Shroyer & Blignaut 2003). With most of the Catchment landscape now artificially managed, wild fires are perhaps less common and have been replaced with management fires (or managed wild fires in the case of lightning strikes) and arson.

SANBI (2014) outlines that all landholders are legally required to draw up and implement appropriate fire management plans (for approval by the local Fire Protection Association). It is probable that most commercial farmers will have this in place, particularly in light of the fire-sensitive timber plantations in the area. The basic principles of good fire management are:

- Fire at the wrong time of the year (e.g. summer to late autumn) can adversely affect rangeland conditions. The best seasonality for burning in montane grasslands (as in this catchment) is late winter (July to September).
- Too frequent burns can detrimentally affect rangeland (repeated burns annually or inter-annually on the same sites).
- Exclusion of fire completely can detrimentally affect rangeland (O'Connor et al. 2010), and can encourage invasion by alien invasive species (in this case *Rosa rubiginosa* (Sweetbrair rose) and *Pinus patula* (Patula Pine)) and indigenous bush encroaching species (in this case *Leucosidea sericea* (Ouhout). Fires that manage bush must be hotter than usual, and require specific pre-planning measures.
- Biodiversity is best conserved when a mosaic burning pattern is adopted.

Areas where active erosion control and reseeding was done must be protected from fires. Most of the soil erosion materials, such as soil blankets, fibre sausages and silt fences are highly flammable. Firebreaks will be needed around these restored areas. Where fuel load is low, such as in areas in the communal land, firebreaks can be relatively narrow (~3 m wide). If fences are used to protect restored areas from grazing, they should be protected from fire, possibly by firebreaks or active firefighting teams in the vicinity.

Fire management on private land and forestry areas are managed and coordinated by the MFPA and WoF. Liaising and supporting these organizations will be crucial to ensure good fire practise.

5.3.3. Alien management

Ralph Clark

There are large areas under dense *Acacia dealbata* (Silver Wattle), *Acacia decurrens* (Green Wattle) and *Acacia mearnsii* (Black Wattle) invasion (probably thousands of hectares in total). If these were freed up to become rangeland (or at least reduced to manageable woodlots under biocontrol) it would help relieve grazing pressure on existing grasslands, and provide a much more catchment-friendly surface area for 'water farming'. Integrated planning with community input ensures that fuel and building resources remains near communities, while areas prone to crime will be cleared need. Strip clearing is used to optimise for grass recovery to avoid the rapid transition from closed canopy to no cover. Debarking and leaving the trees standing replaces mechanical and chemical process to manage the alien trees. Areas indicated by the communities as important resources will be mangaged by biocontrol. This is done to address community dependency on certain invasives, so pragmatic phase-out becomes important in managing 'useful' aliens (Ngwenya 2016). More information on the planning in the AIP management plan (Huchzermeyer et al. 2018).

A number of alien invasive species have been recorded in the Catchment (Henderson 2001; Appendix 12: Table 1), and many others probably also occur or have the potential of invading in the short to medium term (Appendix 12: Table 2). An 'early detection and rapid response' policy in the Catchment would probably be very valuable in addressing new invasive species from elsewhere. For example, *Rosa rubiginosa* (Sweet Briar) might already be a problem in the Catchment (as it certainly is throughout the eastern Free State, Lesotho, Griqualand East and the Cape Midlands Escarpment), but if not, it should be addressed as a high priority on arrival. Likewise, the potential for invasion by Campuloclinium macrocephalum (Pompom Weed) is probable in the future (<5 years) and would undo all efforts at rangeland restoration. Unfortunately, stressed grasslands (such as is prevalent in the Catchment) provide ideal colonisation and proliferation opportunities for this species.

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6. Integrated planning for SLM and restoration

The integrated planning follows the SLM thinking where our first priority is to avoid further degradation, followed by a reduction in degradation and lastly the rehabilitation or reversing of degradation (see Figure AS; Cowie et al., 2018). Avoiding and reducing degradation addresses drivers and pressures related to degradation, whereas reversing land degradation improves the state of the ecological infrastructure (Figure ER). As resources are limited, the TP will focus on selected smaller hydrological catchments where drivers and pressures can be targeted in combination with restoring ecological infrastructure.

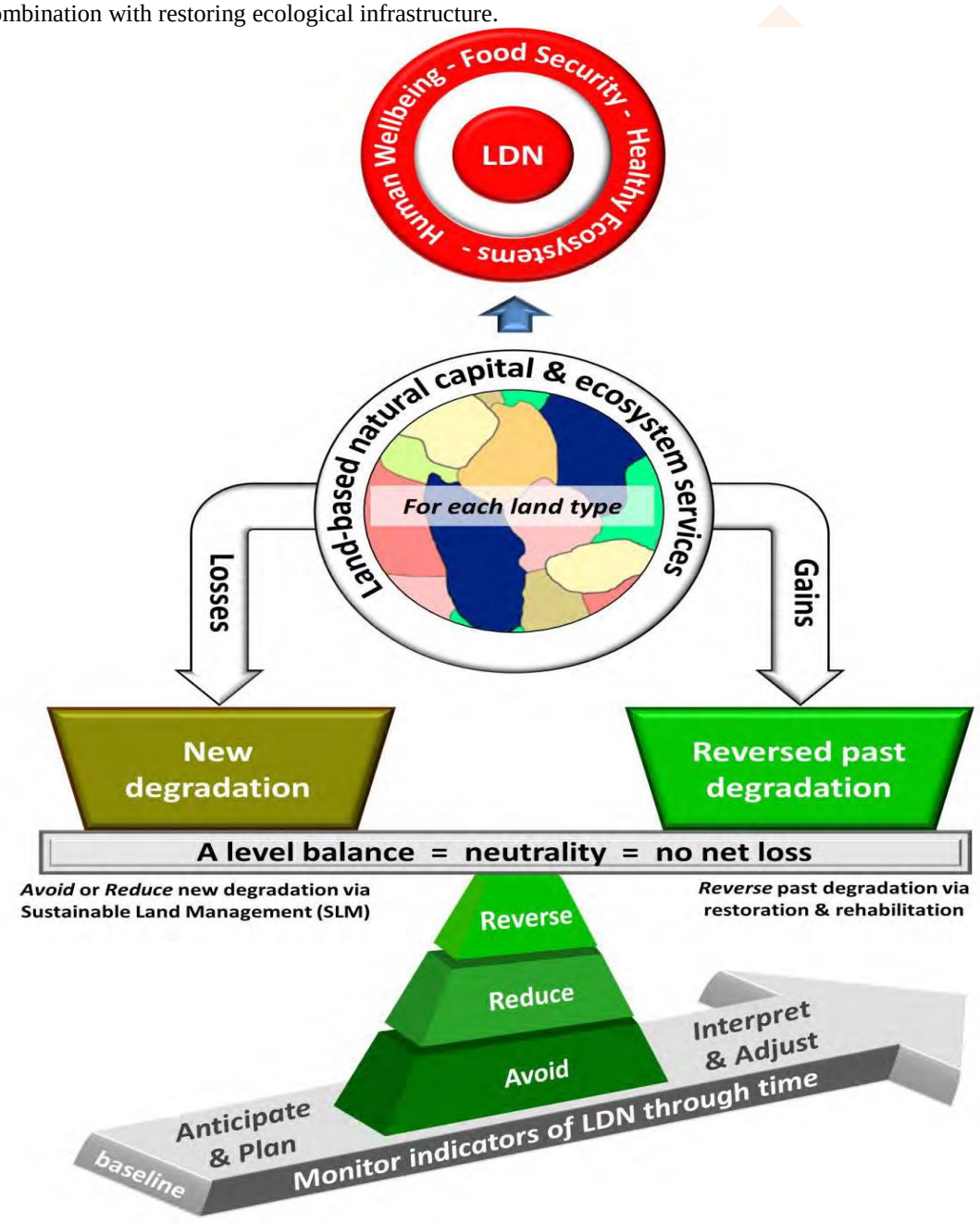


Figure AS: The Land Degradation Neutrality diagram with the focus of prevent and reduce degradation to maintain the current level of ecosystem functioning (copied from UNCCD SCIENCE POLICY BRIEF 02— September 2016).

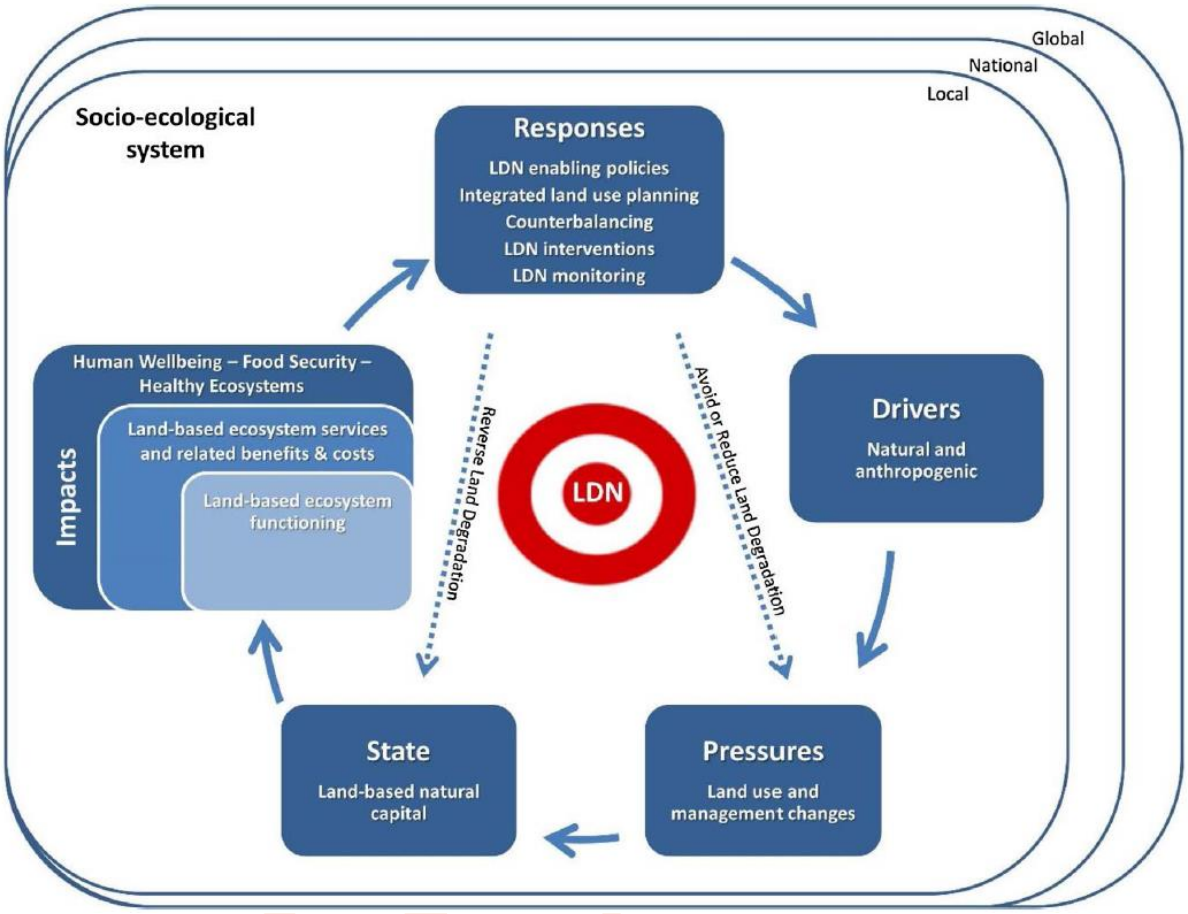


Figure ER: LDN cause and effect model (Cowie et al., 2018).

6.1. Selecting priority subcatchments for integrated planning

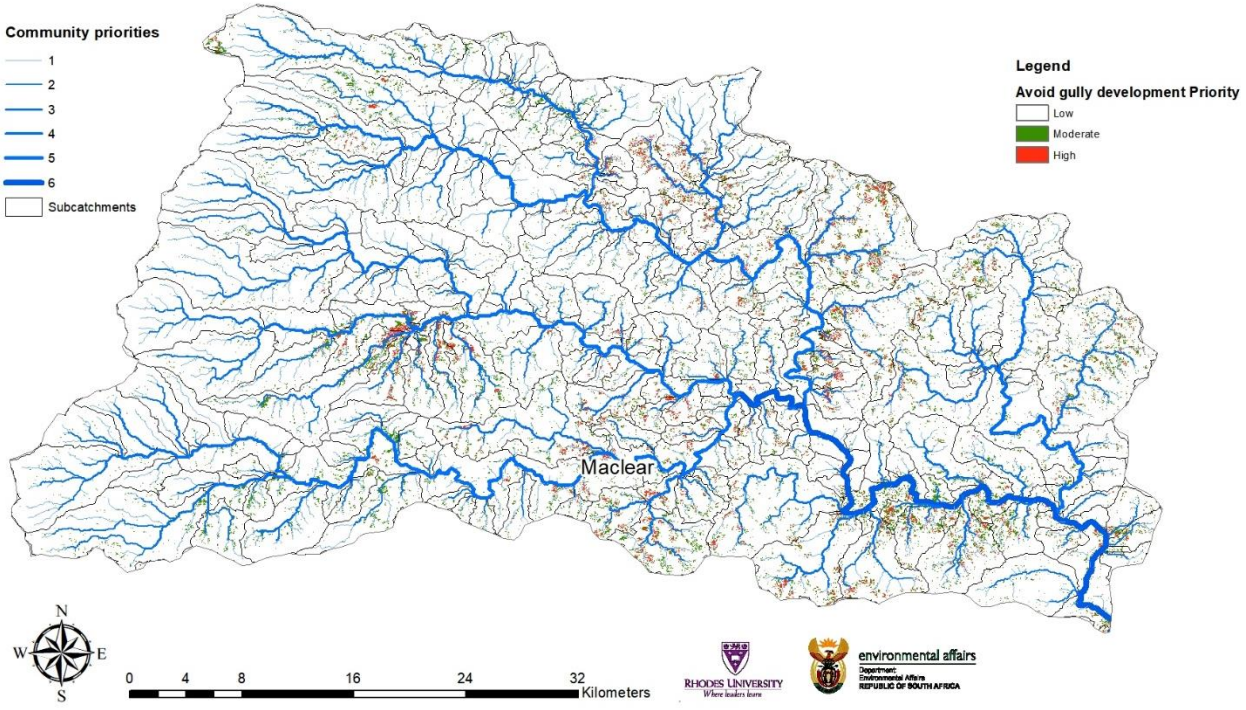
This section details how the priority catchments were selected for integrated planning. In line with LDN thinking, the TP approach is to prevent gully type erosion of productive land units, such as wetlands and gently sloping colluvial deposits. These areas serve as important sediment and water buffers and given their valley floor position (areas where water is concentrated), are associated with a multitude of ecosystem benefits that support local livelihoods. The wetlands and colluvial deposits that are not yet degraded will receive the highest priority for intervention. Subcatchments with the highest density of colluvial deposits susceptible to gully erosion will form the highest priority engagement units (Figure DF), and where these overlap with the community voice (currently only for the communal land) are the starting focal points for integrated restoration planning. This focal point overlap falls entirely on communal land and will complement and respond to the engagement that has taken place to date. These focal points are limited in extent, but will allow for future expansion based on resources, adaptive management, lessons learnt over time and ongoing community engagement.

We acknowledge that the sensitive productive areas are hydrologically connected to upstream and upslope areas, and cant be treated in isolation of one another. This means that a suite of interventions need to be applied to the hydrological catchments of these areas sensitive to erosion. Interventions will mainly address drivers and

pressures of degradation, such as continuous grazing, inappropriate fire regimes, increases in hydrological connectivity (roads and livestock tracks), invasion by invasive plant species, large areas of bare soil on abandoned fields, trampling of springs, etc. High and moderate priority wetlands within these focal subcatchments will be included in the immediate restoration planning, but due to a small number of feasible options high priority valley floor wetlands elsewhere in the larger T35A-E catchment will be included (Figure ER; wetland prioritisation process described in Schlegel et al 2018).

Method of selecting subcatchments for avoided degradation

The 30m SRTM DEM was used to determine the stream network (> 45 ha contributing area) and Strahler river order. Subcatchments were extracted for 2nd order and larger streams. The modelled susceptibility for large gully erosion (Le Roux, 2017) was used to rank catchments based on % area susceptible to large gully formation.



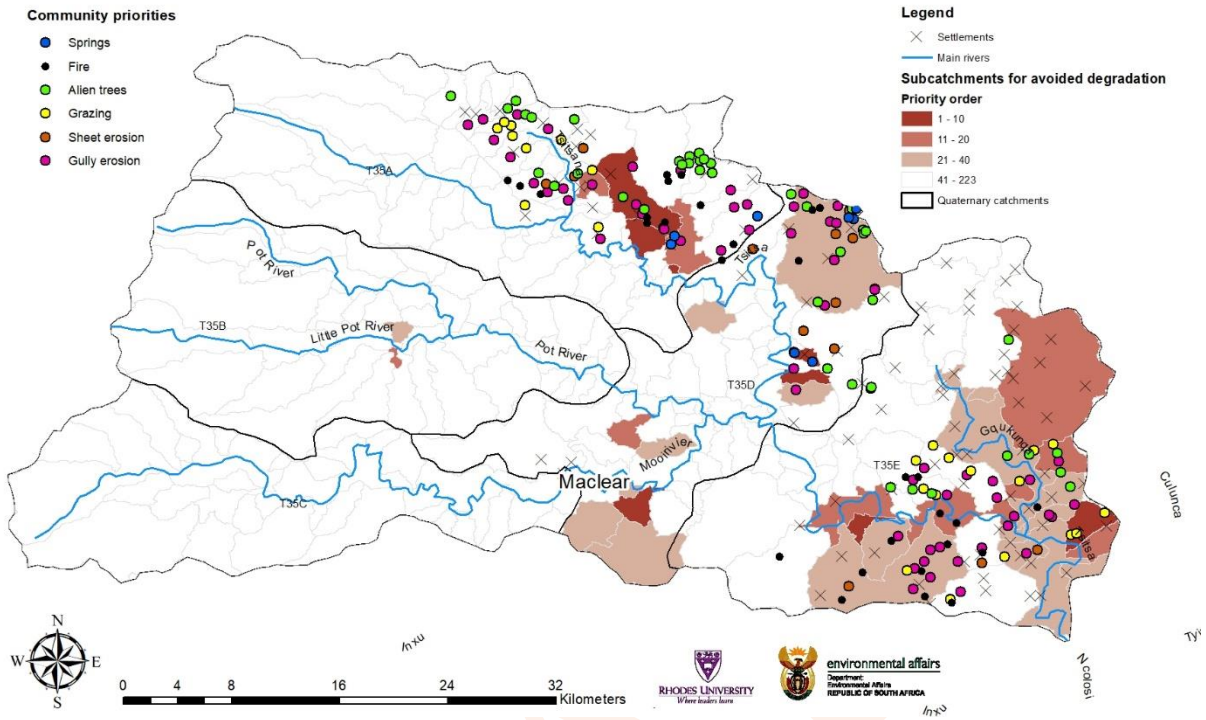


Figure DF: Community priorities and avoided degradation within T35A-E.

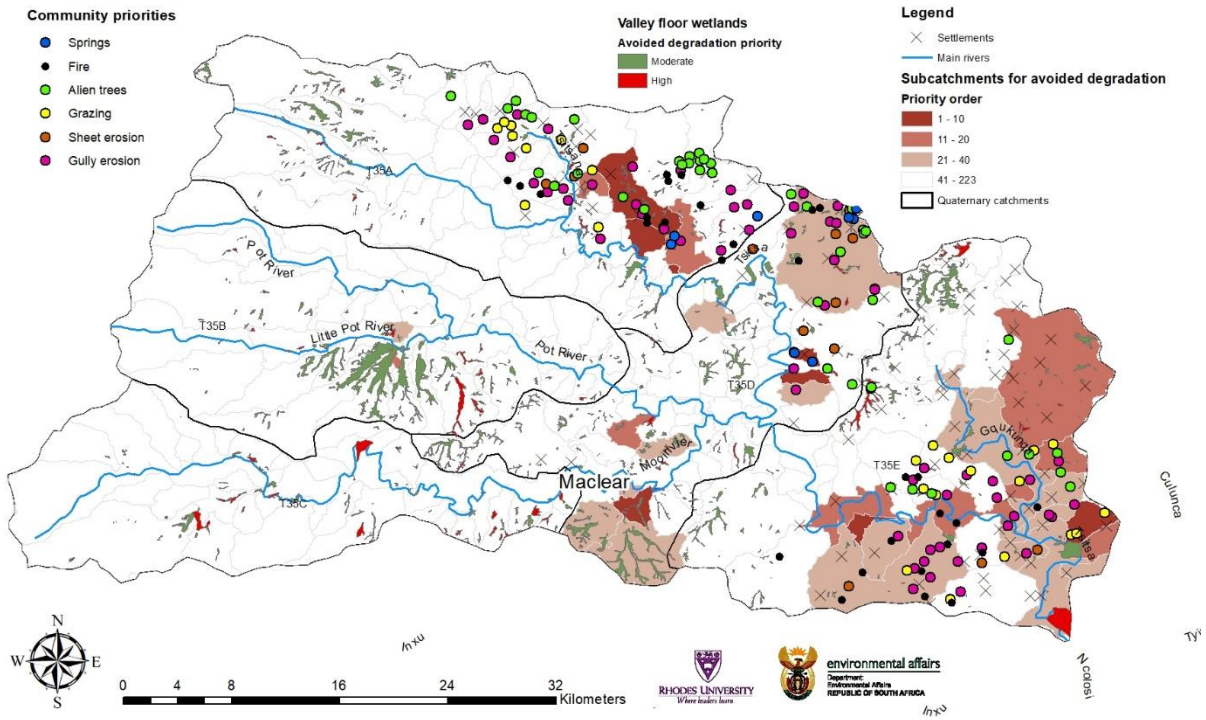


Figure ER: Avoiding valley bottom wetland degradation priority map

6.2. Selecting interventions needed for the focus subcatchments.

The activities that will take place within the focus subcatchments will be selected based on high definition mapping and community voice. The management plans for each of the components are given in Table XC.

Table XC: Restoration plan topics and reference

Restoration plan topic	**Reference/Appendix number**
Old fields	Pending
Wetlands	Schlegel et al. 2018
Roads and connectivity	Pending
Forests	Pending
Fires	Pending
Grazing	Pending
Hillslope restoration	Pending
Alien invasive plant species	Huchzermeyer et al. 2018a
Small dams	Huchzermeyer et al. 2018b

detail the priority areas and interventions needed within the focus subcatchments. For some cases, such as wetlands, forests and grazing, management might target areas outside the focal subcatchments as intervention resources can cover larger areas than currently presented in the focal subcatchments. These areas will be selected to protect vulnerable systems that are still functional.

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7. Operationalisation

Michael Braack, Michael Kawa, Mike Powell, Japie Buckle, Bennie van der Waal

This chapter deals with how the implementation will play out as envisaged by the DEA managers. It covers the budget allocation (and possible fluctuations thereof), spatial and temporal planning, who will do the implementation, stakeholder engagement, monitoring and learning.

7.1. Budget allocation

The budget allocation as presented with 20% in Stakeholder Engagement was acceptable to the DEA NRM project managers (Table 6-2). The largest concern was the total budget allocation that could be less than the R45m a year that was initially mentioned. If it is less, it will be dealt with on a pro-rata basis See Appendix 13 for an example budget allocation between the interventions and quaternary catchments for R26 million. This is something the NRM managers don't have much say over as budgets are decided by treasury and higher levels in DEA. It could be or should be that other organizations contribute to the total budget.

DEA NRM does its own M&E, but additional community based socio-ecological data, institutional data and other non M&E data, will be collected by community members. They will be paid from operational budget and will fall under Community Engagement & Capacity Building (Table 6-2). It will generate person days and can be managed by an implementer. The name 'remunerated monitors' was proposed for these Community Liaison Officers (CLO).

Research and DEA NRM Monitoring and Evaluation (M&E) will fall outside the implementation budget (separate budget).

7.2. Spatial and temporal planning

For the immediate 2017/8 year, where funding is much less than the anticipated R45m pa, the plan is to carry on with the available resources to do dryland and wetland restoration as was done in 2016/7 (see Section 7.1.2. and 7.1.3.). Stakeholder engagement has been ongoing in and around Sinxaku (Green Village), thus community plans and wishes are incorporated in the planning in that immediate area. Plans for large gully structures around Sinxaku Village will be finalised and undergo EIA processes and could be implemented towards the end of 2017. This will allow time for budgets, stakeholder engagement, community co-construction and further planning to take place for the larger portion of T35E and selected areas in T35A-D for the following year (Figure 7-3).

Tentatively, stakeholder engagement will take place at a catchment level. This will allow catchment wide stakeholder engagement, with a focus on the area that has the highest estimated sediment yield and where community engagement has taken place up to date. Dryland rehabilitation, fire and livestock management will follow the same pattern to stakeholder engagement as inputs and feedback from communities are received through further stakeholder engagement. A feasibility study will guide/dictate how stakeholder engagement will best work.

Wetland and vulnerable farm dam restoration will be prioritised at a catchment level where 'vulnerability to further degradation' will be the key determining factor. Working for Wetlands will handle dam rehabilitation as they are already dealing with planning and EIAs, thus the practical solution for the next funding cycle.
In the light of limited budget and stakeholder engagement for 2017/8 the following is proposed:

- Use Le Roux's susceptible area data to guide dryland restoration plan south of proposed dam in areas where community has been consulted (Figure 7-4). Areas classified as high and moderate risk – no ponding to be done, but all other interventions. Sinxaku will be the starting area as teams are already operational. Teams will target prioritized NBal Compartments (see Figure 7-4). Teams will be focussed on small areas to prepare areas for hydro seeding. Desktop planning would be completed by the TP team in May 2017, field based planning and training was completed 2-4 April 2017. The Gamtoos Irrigation Board (GIB) has mobilised eight teams south of the proposed dam that can't be moved to the north of the dam due to social issues (Residents from south of the proposed dam are not allowed to work north of the proposed dam, as workers for the area north of the proposed dam should be sourced from the same area). New teams will be needed for the area north of the proposed dam, but is budget dependant.
- No interventions within 100m of dam boundary as severe erosion is expected with dam level fluctuations.
- No large structure budget approval yet – plans will be submitted soon for EIA. Fixing dams will have to follow the same process, thus omitted for 2017/8.
- Seven households in Sinxaku will grow vetiver to sell to TP/GIB. Additional Vetiver nurseries will be planted early spring in filled-in gullies around Sinxaku.
- Wetland work will continue in upper catchment implemented by Working-for-Water.
- TOR for Community engagement, capacity building and quality control officer will be needed before May 2017 so they can start in June 2017.
- For the 2017 year, DEA NRM regional office (EC) will ring fence restoration budget by 28 February, Annexure C will be signed for this year with detailed planning following in April by the DEA Regional Restoration Coordinator.

Planning for 2018 - 2020 will be dependent on the feedback from the stakeholder engagement and will guide areas and methods where communities are open to restoration. Use community input to select and plan restoration efforts in conjunction with the Le Roux (2017) gully susceptible area layer.

7.3. Who will do the work and quality control?

It was proposed that two main implementers are assigned: one to do the dryland rehabilitation and building of interventions; and a second to handle the stakeholder engagement and remunerated monitors (Figure 8-1). The implementer responsible for stakeholder engagement will implement the capacity building through remunerated monitors. This implementer/s will need the right skill set to deal with stakeholders, communities and capacity building. The implementer should be based in the catchment to reduce logistical costs but also to gain legitimacy

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in the eyes of the stakeholders and the communities. A steering committee ('B team' including researchers and DEA managers) will be involved in drawing up the TOR and quality control protocols for the implementers. The TOR will state expectations of implementer clearly. For the proposed budget allocation (R1,3m) this will result in 37 people over 200 days per year – possibly too much time for them in the field for monitoring, but capacity building component will be the main outcome. The remunerated monitor can engage with other activities, such as eradicating free standing wattles, pack stones in rills, etc., on monitoring routines to keep meaningfully busy.

Quality assurance of structural interventions will be monitored by these CLOs. A separate full time quality control officer will need to be instated to keep a close eye on implementation processes and remunerated monitors. This person would likely be managed by the stakeholder engagement implementer.

Dams and wetlands will fall under Working-for-Wetlands as they deal with designed structures and legal processes frequently. Implementer B will be responsible for dam and wetland work.

DEA managers (especially the Regional Restoration Coordinator), specialists and researchers will be involved in quality control and learning (possibly as a steering committee that assess interventions, data captured by remunerated monitors and project learning) on an annual basis.

Currently, sediment sampling (administered through Rhodes University) is done per sample and will have to remain that way to ensure correct sampling intervals and data integrity, but admin and payment can be migrated to the implementer. Piecework sample payment system works well at the moment, so only to hand it over to the implementer once this piecework payment system is developed sufficiently by the implementer to handle it.

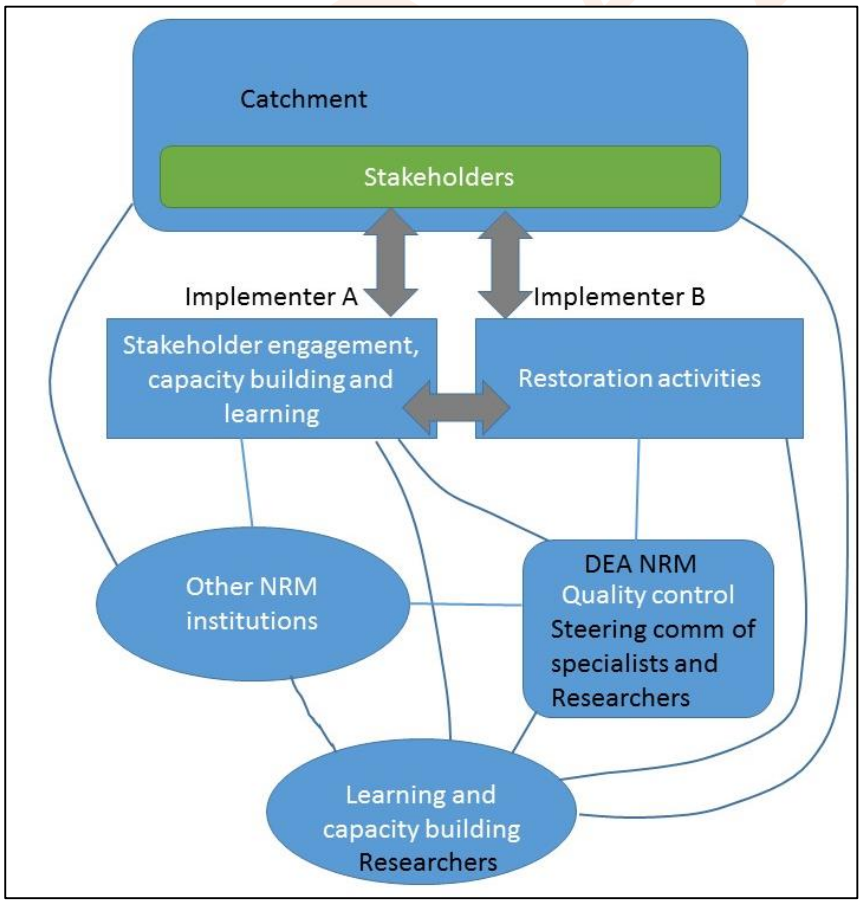

Figure 8-1: Diagram of the interactions between the stakeholders, implementers, NRM related institutions and researchers.

7.4. Key dates and bottle necks

The DEA NRM programmes work on a 3 year funding cycle. Proposals and tenders to reach the office by November. These are reviewed by February and then passed on to the legal department and signing at head office. A portion of the funds are released after 1 April. Annexure B with detailed planning is handed in by August of the first year and Annexure C is handed in each November up to year 3. Bottlenecks are often experienced in head office with signing and legal processes. Paper work can come back with minor edits needed that delays the process by weeks to months. Payments are prompt, normally within 30 days following the invoice.

Where >5m^2 of soil is moved in or near a water course an EIA is needed. This requires an approved plan that normally takes eight months from planning to implementation date. Smaller structures can be done now that won't require an approved plan.

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8. As implementation now occurs, it must be sensibly monitored and evaluated

This section was taken from the executive summary of the PMERL by Botha et al. (2017). More details on the PMERL and the various indicators are given in Appendix 9.

This section describes a framework for a Participatory Monitoring, Evaluation, Reflection and Learning (PMERL) plan for TP. PMERL systems can support adaptive management if the methodologies reflect, and can account for, the level of complexity and diversity of the environment – such as the one in which TP is implemented. The purpose of this PMERL is to support on-going learning towards strategic adaptive management and to pilot an innovative approach that collects quantitative, indicator-based data as well as qualitative, case study-based data in a mixed-method or hybrid approach. Ultimately, the goal of this is to continually refine this PMERL framework to foster learning on different project levels, ranging from the individual, collective and the institutional levels.

The PMERL framework recognises that TP is characterised by a diversity of stakeholders, with different value systems and who hold different forms of knowledge, such as technical/managerial, indigenous and spiritual. This framework values and integrates all these perspectives, drawing on various research methods and methodologies from the social and natural sciences. It foregrounds learning as an essential ingredient of PMERL, which ties together monitoring, evaluation and reflection to promote innovation, adaptive management and governance, as well as meaningful sharing of what has been learnt beyond TP and the catchment.

Le Roux (2016) gives details on remote sensing options for erosion measurement (see Appendix 8).

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9. Information Flow/data access and Communication

Mike Powell

The TP has a number of components that need to synchronise and complement each other and provide the synergistic effect for the TP team. The Institute for Natural Resources (INR) has been commissioned to design and populate an Operational Support Framework (OSF) for TP. The final product is not completed, but will be a web-based portal for all the TP data and information for stakeholders to access. For the non-academic and people without access to the internet, relevant information (or based on demand) will need to be translated and made easily accessible in the form of brochures, posters, radio broadcasts and other appropriate media. This work will largely be coordinated and managed by the TP Community Engagement Coordinator. The collecting, collating and distilling of the vast amount of data (the TP will collect is envisioned to generate) will become the mandate of the PMERL implementation plan (see Figure 10-1). A permanent PMERL coordinator will be responsible for the implementation and coordination of all the classic M&E data but also the less tangible social learning information that does not get captured. The PMERL coordinator will be responsible for collecting information and knowledge generation from the institutional learning in the TP management team, right down to the community-level grass roots learning. This will require a close level of cooperation with the TP team, the SE Coordinator and the Stakeholder Engagement and Capacity Building service providers.

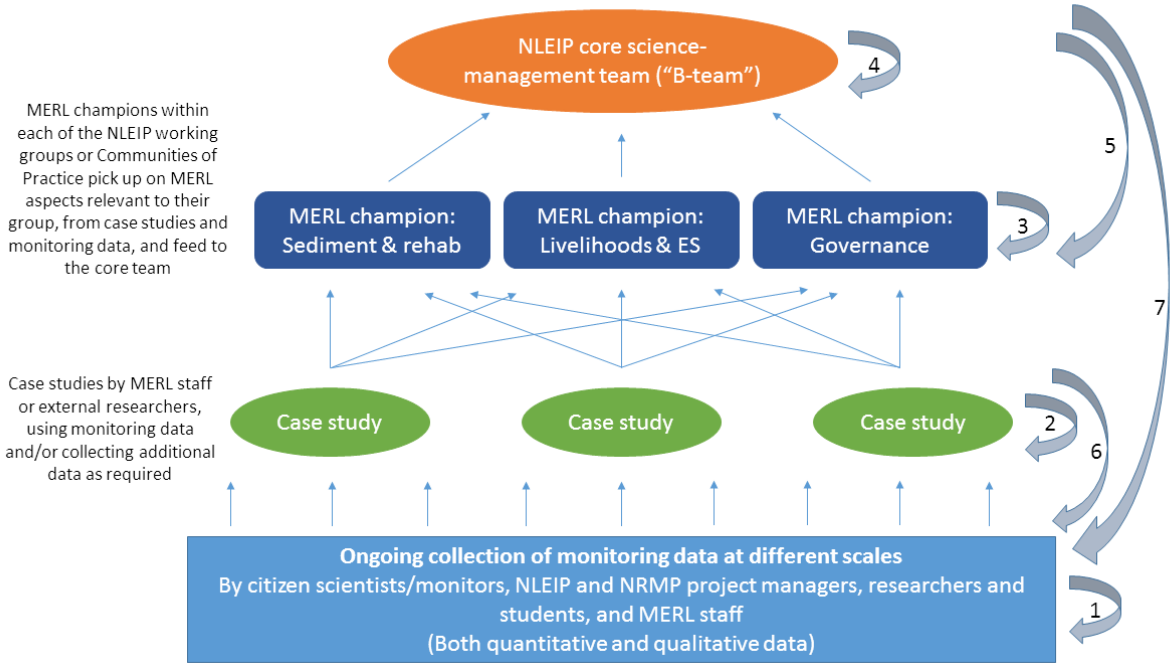

Figure 10-1: TP PMERL system overview, showing flows of information (thin blue arrows) and learning loops (thick grey arrows). The learning loops are explained in the PMERL Implementation Plan (Botha *et. al.* 2017).

Communication between the various academics, managers, students and implementers will happen regularly through the Science-Management Forum Meetings and their various communities of practice. Although community members are welcome and encouraged to attend, the Science-Management Forum is not the right vehicle for a broad-based communication channel. The Science-Management Forum may expand to become the Science-Management-Society Forum in the future.

From the Science-Management meetings the progress and learning would be documented by the PMERL coordinator and disseminated to all the role-players in the form of newsletters and other appropriate media.

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10. The way forward and future versions of this dynamic report

Harry Biggs

The team has made good progress with getting to the point in the last year that persons from widely differing disciplines and approaches have managed to reach what is now a partly unified confluence and a provisional plan (of options?) that looks pragmatic and feasible. It is acceptable to most of the participants if not written entirely in their native style or paradigm. Getting this far augurs well for future work, as the broad agreement allows represents a strong point of departure for further productive collaboration, and even what is termed co-construction or co-creation.

But major steps still need to be taken, in particular engaging communities living in the catchment, not only on technocratic or politically top-down terms (as often happens) but on their own or jointly-brokered terms where they have a stronger voice. It takes time to build the trust to get this far, but TP has a solid plan now. We should not be too ambitious in the time-frame within which the final version 1 of this report is expected, and can realistically only expect the first broad layer of these opinions beliefs and wishes to be reflected there. The engagement and especially its sequelae (such as ongoing community-driven extension and learning) will continue - perhaps indefinitely if the project is one day deemed to have been successful. But even within the lifespan of TP, this plan will need to be a living document, and it is hoped that subsequent versions show vibrant learning supporting the likelihood of what we define together as our sustainability expectations. So how do we plot a way forward?

Firstly it would be foolish, given the framing of the project in complex social-ecological terms, to expect the project course to be deterministically predictable. Strategic adaptive management says it is nevertheless necessary, if not essential, to have a flexible game plan like this one. But we must expect not only the goals to evolve over the course, but the road along which we reach our "destination" (as a milestone in a longer journey) to be a windy one. These statements are simply the tenets of adaptive planning (Roux & Foxcroft 2011) and the reader will have sensed the provisionality of approach throughout the various sections. It is far more important in the strategic adaptive management philosophy, to generate and support the ability to navigate the windy road to a (often slightly or even sometimes very) different endpoint than the one to which we started the journey, than to achieve concrete outputs but largely or completely actually miss the broader outcome. The MERL learning system we have been fortunate to enlist will act as a compass, and its concept of single, double and triple loop learning leverages the changes we have just described, to get us (including the residents and more permanent stakeholders) closer to the level of adaptive capacity we need to flourish. The MERL system will also help us all.

Secondly, as is already close to obvious when this approach is followed, the journey must be productive, and although we aim at an endpoint, the old adage applies – the journey is indeed more important than the destination. Each version of this report (perhaps updated one a year, perhaps more often, but at least in totality every two years) will be a new flag in the ground, but each report is merely the concrete written record which helps us be sensibly reflexive and also plot the next provisional leg of the plan. It is what happens in between that is far more important. Enculturating an ongoing reflexive and adaptive approach at the individual and various group levels,

whether administrative, political, scientific, implementational or whatever else, is the key to building adaptive capacity, also known as resilience.

Thirdly, it may be helpful to explicitly recognise the limitations of this report and its underlying approach (to be done before V1 final) and to consider how we might collaboratively understand and anticipate system behaviour possibly through collaborative dynamic modelling (a socially robust implementation of SDM, already being used in its more conventional form in TP) and/or with scenarios probing alternative futures in a humanly-engaging way. It might be highly subject to the available funding in the near future, but the TP team deeply seeks to bring innovation to the integrated natural resource management in the catchments. This automatically implies that a ***document*** is merely a first step in gaining consensus on a way forward for collaboration and collective action. TP needs to incorporate the systems dynamic modelling component in order that ALL the stakeholders gain a thorough SYSTEMIC understanding of the complex SES that is receiving this substantial investment in restoration. This will improve the resolution of the data (especially the rates and fluxes in the system) in order that TP can make the most informed and equitable decisions in terms of the trade-offs that will need to be made. The vision is also to partner with a leading institution that can assist in co-designing a GIS-based decision making tool that incorporates all the collective wisdom of this document (and version 2), the dynamism of the systems dynamic modelling (community collaborative) to enable the DEA NRM and its partners to make informed, cost-effective and community-friendly management decisions. The scale of the TP implementation and the inherent complexity will require a robust and highly computerised decision-making tool. This tool will need to incorporate all the monitoring data and knowledge that will be collected and collated in the MERL Process, but at the same time be able to adjust implementation plans with additional budget, change in fire regimes, and general geo-politics.

Once this report appears, one of the most useful initiatives we can use it for (apart from the obvious “current implementation plan” as such) is a group meta-reflection on its meaning and role, perhaps at an TP Science-Management forum. Through that we can better engage is higher-order learning and realise reflective value. After all, this report is only a piece of paper – it is the ideas, aspirations, and actions, and above all learnings, that got us here, and that we are inspired into doing as a continuation into the future, that really make us adaptive, reflexive and hopefully one day, more sustainable regarding the way the catchment future unfolds.

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Appendix 1: TP Integrated Social Ecological Framework

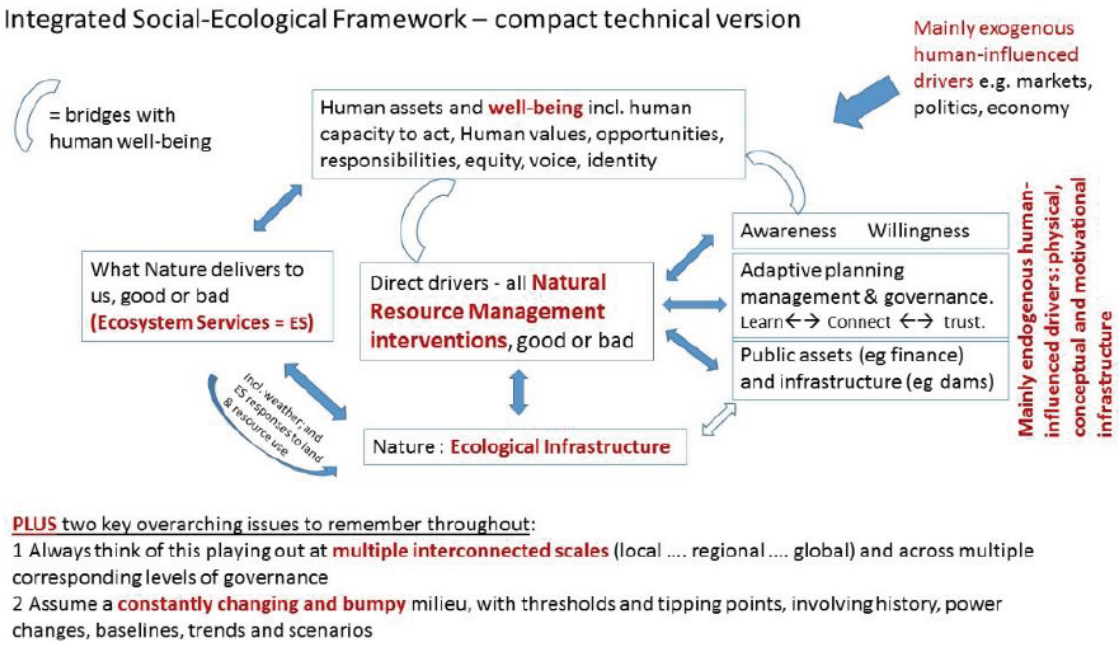

Figure 6: A social-ecological systems framework for integrated natural resource management, understanding and action in the Tsitsa catchment. At the centre of the hub in our framing are natural resource management (NRM)MP – suggest having a different acronym for the activity e.g. SRM (sustainable resource management) interventions which impact on ecological infrastructure (bottom block), in turn influencing ecosystem services (left block; the reason for the curved return arrow is to remind us that sometimes certain exogenous natural happenings like floods or droughts can impact ecological infrastructure without necessarily any human involvement). The ecosystem services in the left block go on to interact with human assets and well-being in the top block. The three closely-positioned blocks on the right refer to endogenous "human infrastructures/capitals" which play a key role in influencing NRM, whilst the strong arrow coming from the top right-hand corner depicts exogenous human drivers usually out of our control as local residents or actors. The empty arrow shows a linkage usually of less interest to this program. The open curved shapes (bridges) designate overlaps where it may sometimes be difficult to place an attribute in one or the other block category, or the two blocks and their links may need more unpacking than shown here to be clear. Two overall messages (1 and 2 at bottom) apply throughout. For most purposes in this programme, arrows tend to *usually* proceed in clockwise direction.

Appendix 2: TP Conceptual framework for implementation phases

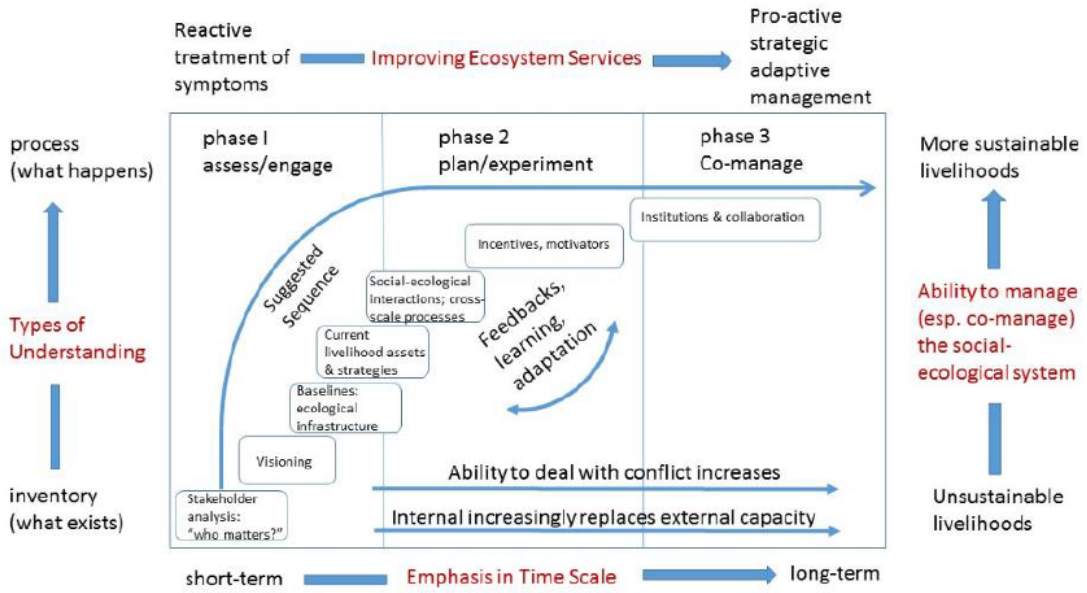

Figure 8. Conceptual framework for implementation phases. This operational framework depicts three phases: assessment and engagement; planning and experimentation; and co-management. The process starts with a coarse-scale stakeholder analysis, visioning, baselines of ecological infrastructure, and descriptive analysis of current livelihood strategies and assets. It then proceeds to understanding the interactions and feedbacks between elements of the SES, followed by action research on adaptive co-management which includes institutional analysis and active collaboration. Facilitation is essential, with an initial bias towards externally-driven capacity development, shifting towards more internally-driven capacitation and to an increased ability to handle conflict management. Over time, research insights evolve from understanding what exists, to understanding 'what is going on'. Thinking changes from shorter to longer term, the management of agreed-on ecosystem services becomes more pro-active and, through encouraging the use of feedbacks for learning, more adaptive in a structured and strategic way. Unsustainable livelihoods hopefully evolve through management (including at least some forms of co-management) to become more sustainable, in a way that shows a greater feeling of agency.

Appendix 3: TP Research Investment Strategy

Due to the size of this document it will be available electronically on the TP Google Drive or request it from Mike Powell via email at m.powell@ru.ac.za

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Appendix 4: Current point of departure for TP flyer

Current Point of Departure for the Ntabelanga and Lalini Ecological Infrastructure Project (TP)

July 2016

The Big Picture

The Upper Tsitsa landscape has been identified by the national Department of Environmental Affairs (DEA, particularly DEA-NRM), as a vital part of the Umzimvubu River Catchment. In order to provide the best protection to the water resources, and to strengthen the livelihoods of residents, the Department has prioritised the area for intensive collaborative actions to improve the management of the land and water resources in the area. This improvement becomes even more important if the two large dams, planned by the national government (Department of Water Affairs and Sanitation, or DWS) for the area, are built. Dams come with both positive benefits (irrigation, hydro-power, water supply, and the business and employment opportunities associated with the construction phase) and threats e.g. sometimes the main beneficiaries of the improved water and power supplies live in cities far away from the dams). One concern of DEA is that these dams are at risk of filling with silt very quickly if there is no improvement in the land management in the catchment. The aim here is to reduce the silting up of the dams to a level that is manageable and acceptable. This will require both rehabilitation and improved future management of degraded lands. It is also in any event crucial (even if there weren't dams involved) that the capacities and livelihoods of all groups in the area are strengthened to enable everyone to deal with the existing challenges of poverty and lack of opportunity, and future challenges including that of climate change.

A Shared Vison for a More Sustainable Future

This provides an exciting and unusual opportunity to work together towards more sustainable land and water management in this catchment, and in that way improve livelihoods. This way of working sees active relations between all role-players,

placing the residents who are most closely connected to the natural resources at the centre of the future management of the area. One main aim is to facilitate the development of a shared vision by residents, drawing on their values and aspirations, with other role-players utilising their expertise and resources to realise the future vision of the area, and agree strategies and plans at workable scales to achieve that vision. The idea is that all land-based, water-based and other natural resource based activities should be guided by the agreed strategies and plans, and contribute to the achievement of the vision. Central to this aim is the need to increasingly and as far as possible fully involve the resident users of the natural resources in all stages of planning and implementation. Relevant systems, support and capacity needs to be developed to ensure resource users become the effective managers of the resources.

Identifying the Main Role-Players and Activities

An initial stakeholder analysis has been conducted (in the Ntabelanga component) to identify all the main role-players, the existing collaborations and relationships between them, and the activities currently taking place in the area. These role-players include (but are not be limited to):

- National government departments
- Provincial government departments
- District and local government departments and elected representatives
- Traditional authorities
- Resident land owners and land users
- Resident users of the water and other natural resources
- Non-governmental and community-based organisations
- Academic and research institutions
- Consulting and contracting companies

The analysis has included existing structures and institutional arrangements for the management of the natural resources, such as:

- Farmers Associations
- Water User Associations
- Catchment Management Agency
- Catchment Management Forums

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 Traditional/local natural resource management structures
 Village Committees
 Traditional Healer Associations
 Livestock Associations
 Research Forums

The TP Activities will include (but not be limited to):
 All land, water and other natural resource uses
 Land rehabilitation programmes
 Phase 3 Extended Public Works Programmes, such as Landcare, Working-on-Fire, Working-for-Water, Working-for-Wetlands, Working-for-Forests and other land or water-based Community Work Programmes
 Research programmes
 Collective governance and collaborative action to include all of the above

This stakeholder analysis should form the foundation for all future collaborations.

Collaboration: Working Together

The main difference between this and the many other programmes that have been implemented in similar situations is that it is essentially collaborative. It needs everyone at all levels to work closely together. Indeed, it is not possible to achieve what is needed without real collaboration. Without working together it is highly likely that all the time and resources being committed by the DEA-NRM and others will be wasted, and no real changes will take place in the management of the land and water resources or the livelihoods of residents. All the role-players will need to locate their activities within the agreed strategies and work with others to implement the agreed plans.

To do this many people may have to change their way of thinking and working. Unless a radical directional change in the way each role-player works both separately and jointly, can be effected in the first few years, there will be little likelihood of achieving either the "together" or for that matter the "sustainable" part meaningfully. This will require complete commitment to the vision and the

strategizing, planning and implementation processes by all role-players over a considerable period of time.

Variability and Adaptability

There are two further key threads that will need to run through all the collaborations,
whether around strategizing, planning or implementation. The first is the need to recognise and respect the enormous variability not only between different ecological and social contexts, but also between the various role-players. This variability comes in terms of their backgrounds and culture, education, experience, authority and status, and indeed their interests. For effective collaboration the aim should be to meld this variability into a coherent whole in the interests of a healthy landscape and vibrant livelihoods. The second thread is the unquestionable need to recognise and foreground the need for adaptability in all activities. This will require a reflexive approach, involving constant monitoring and evaluation to ensure that what is happening is what is required, and make necessary changes when this is not found to be the case.

Understanding the centrality of both variability and adaptability to all processes and
activities are essential to achieve the flexible, organic approach that is needed to manage the Upper Tsitsa landscape for the benefit of everyone. Projects such as this one have seldom worked in this way in the past, and we will expect quite a learning curve for everyone involved, and therefore also need goodwill to support each other as we find our way.
The Upper Tsitsa catchment therefore provides a wonderful opportunity to demonstrate what can be achieved though genuine collaborative working, drawing on the considerable skills, understandings and experience of all role-players. The DEA-NRM, and all the partners (especially the Water Research Commission, WRC, and the Department of Science and Technology DST), are keen that the collaborative model of working together developed in this area is shared with other

catchments across the country. The model needs to work.

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Appendix 5: Ntabelanga Lalini Stakeholder Analysis Report – part 1.

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Appendix 6: Trans-disciplinarity figure.

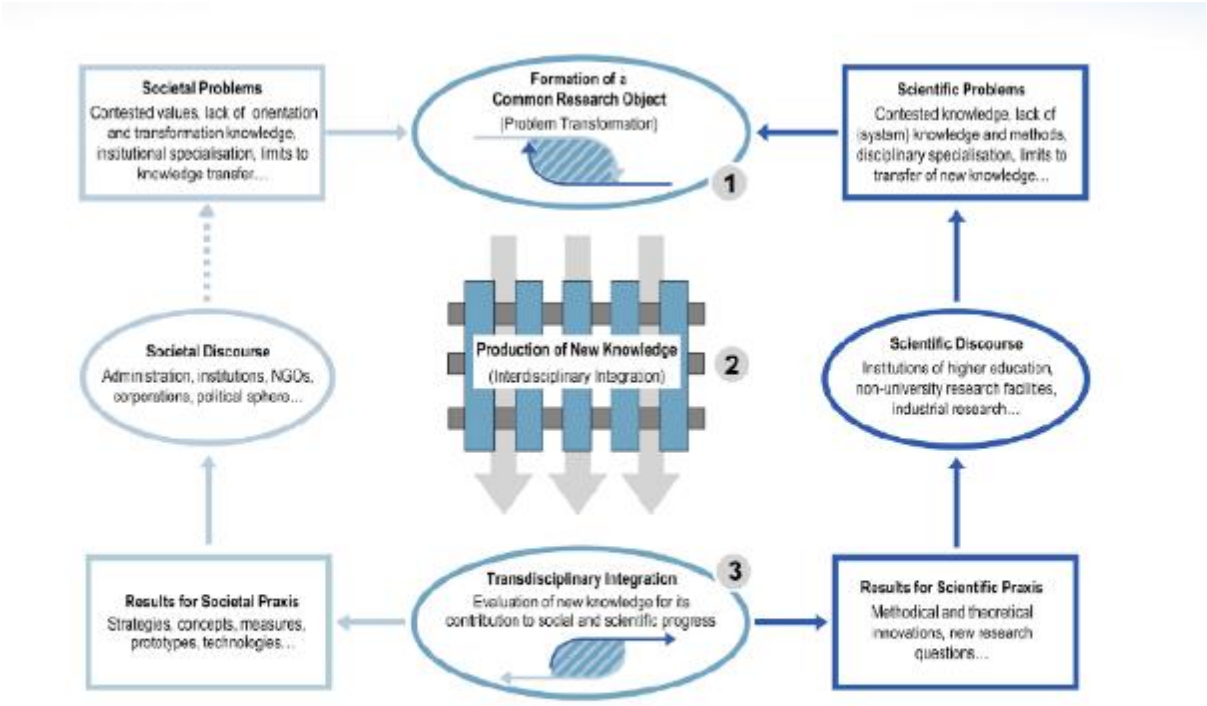
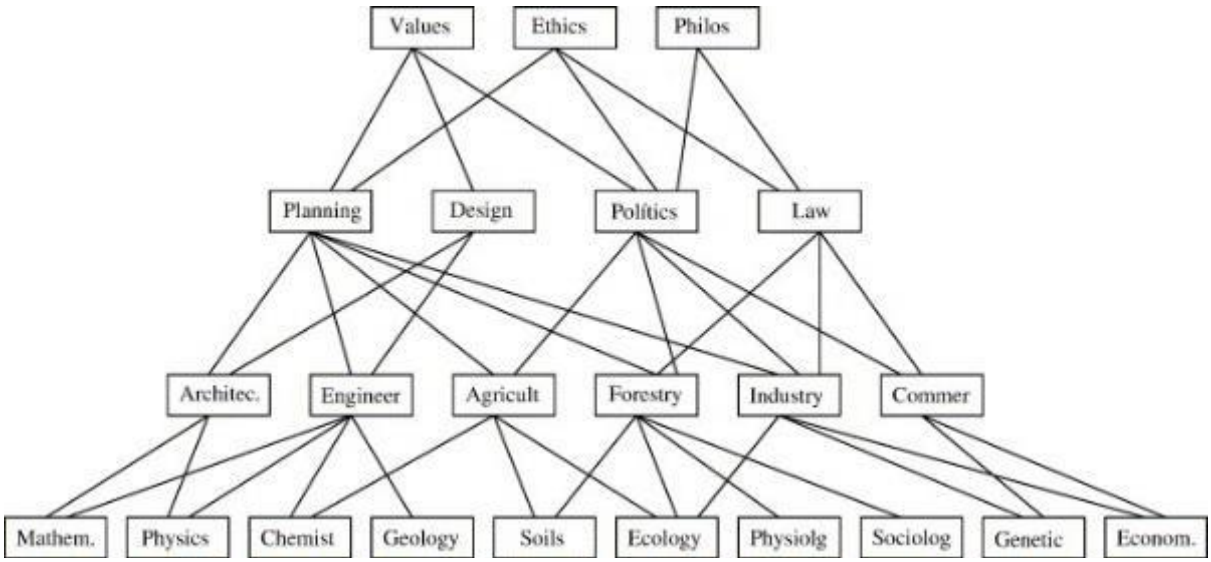


Figure 5. Trans-disciplinarity starts with a common problem, which leads to the production of new knowledge (inter-disciplinarity) and culminates in trans-disciplinary integration, with benefits for societal and scientific praxis. From Jahn (2012).

Appendix 7: Transdiscipline by Max-Neef (2005)

Image copied from Max-Neef (2005).



Transdiscipline. Reading the graph from bottom to top, the lower level refers to *what exists*. The second level to *what we are capable of doing*. The third to *what we want to do*. And finally, the top level refers to *what we must do*, or rather, *how to do what we want to do*. In other words, we travel from an *empirical* level, towards a *purposive or pragmatic* level, continuing to a *normative* level, and finishing at a *value* level. Any multiple vertical relations including all four levels, defines a transdisciplinary action.

Appendix 8: Avoiding degradation report in the Ntabelanga Dam Catchment (Le Roux 2016).

A preliminary report for the
Adaptive Implementation Plan for Sediment Mitigation and Restoration

and

TP Science Management Meeting
November 2016

by

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INTRODUCTION

Recent soil erosion studies indicate that the Ntabelanga Dam Catchment consists of highly erodible soils with widespread soil erosion evident (Le Roux *et al.* 2008; Le Roux and Sumner, 2012; Mararakanye and Le Roux, 2012; Le Roux *et al.*, 2015). Based on sediment yield results and digital elevation data in a GIS, Le Roux *et al.* (2015) estimated that the life expectancy of the Ntabelanga Dam Catchment could be less than 50 years without proper siltation prevention or design measures. The Tsitsa River Catchment in which the Ntabelanga and Lalini Dams will be built, consists of approximately 9 000 gullies, affecting an area of approximately 7 000 ha. Due to limited resources it will not be feasible to rehabilitate these gullies with large and costly structures at the catchment scale. Not only are large structures costly, it is postulated that structures in the Ntabelanga Dam Catchment will silt up rapidly. Furthermore, structures in the erodible dispersive soils will enhance subsurface accumulation of water and cause further erosion around the structure (worsening the problem). Therefore, in order to implement resources and investments optimally, it is important to prevent further erosion by protecting areas that are not eroded.

It is postulated that another 7 000 ha is intrinsically susceptible to erosion but are currently NOT eroded (still vegetated and used for mainly grazing). These susceptible areas must be protected before erosion is extrinsically triggered or accelerated by land use and human-induced reduction of the vegetation cover (grazing and cultivation). Susceptible areas will need to be carefully managed to avoid further degradation including further spreading and development of new gullies. Failure to do so will cause existing gullies to spread and new gullies will develop, as well as lead to increased sedimentation of the future dams. If not protected, these susceptible areas could contribute more than 300 000 tons of additional sediment per annum to the river network. Thus, in ten years another 3 million tons could be deposited in the Ntabelanga Dam, subsequently reducing its life expectancy with a third (50 years - 15 years = 35 years life expectancy). Soil erosion prevention will not only reduce the sediment yield and increase dam life expectancy, but will also benefit the local communities by preventing further soil degradation of their land.

Before prevention or remediation of soil erosion can be undertaken, however, the spatial extent of susceptible areas should be assessed. This could be achieved by mapping gully-free areas susceptible to gully development in the Ntabelanga Dam Catchment, illustrating different classes of susceptibility (from least to highly susceptible).

Proposed methodology

The methodology can be divided into four main steps:

1. Identify/map gully-free areas susceptible to gully development (4 month timeframe);
2. Follow a Community-Centered Participatory Research and Development Approach in susceptible areas identified above (3-year timeframe);
3. Fence susceptible areas, followed by area-specific rehabilitation with/by communities (simultaneous with 2 above);
4. Monitoring and maintenance of susceptible areas with/by communities (continuous).

Step 1: Identify/map vegetated and/or gully-free areas susceptible to gully development. Gully-free areas susceptible to gully development will be identified by mapping areas that have the same topography, geology, land types and/or terrain soil associations than gullied areas but which are still gully-free. Gully-free areas will be classified and mapped into different classes of susceptibility according to the dominance of gully contributing factors identified by Le Roux and Sumner (2012). These factors include DEM-derived topographical variables (i.e. slope, contributing area, a topographical wetness index, terrain units), parent material-soils interactions (i.e. geology maps, land types, soil erodibility maps) and remotely sensed cover management (i.e. land use and vegetation

cover). For example, a gully-free and/or vegetated area will be mapped as highly susceptible if it consists of gentle slopes in zones of saturation along drainage paths with a large contributing area, erodible duplex soils derived from mudstones. The best available spatial datasets will be used including the detailed soil map that will be produced for part of the catchment by Digital Soils Africa. The final implementation plan of the susceptible areas will depend on the locations and exact sizes of these susceptible areas. Negotiations with, and training of, the relevant communities should occur in order to protect the most susceptible areas. These areas should be protected until the communities are trained and equipped to sustainably manage it themselves.

Possible hindrances with regards to step 1 include the following. Some susceptible areas are relatively small and are probably scattered throughout the catchment in between eroded areas. It will be necessary to select the most feasible susceptible areas in association with field visits. Furthermore, susceptible areas could erode, even if fenced, due to current erosion processes (e.g. gullies that expand) in between some of the susceptible/intact areas. Therefore, it will be necessary to implement rehabilitation or soil conservation techniques within these areas as well (briefly described in steps 2-4 below).

Step 2: Follow a Community-Centered Participatory Research and Development Approach. This approach aims to develop and empower communities, including farmers and other key stakeholders to participate, to learn and to be innovative (Bloem *et al.*, 2009; Smith, 2006). This approach empowers communities with new knowledge and skills, to be self-reliant, and be able to identify, develop and adapt soil conservation and rehabilitation techniques. After a stakeholder analysis, during which all relevant stakeholders are identified (within the susceptible areas), an awareness strategy will earmark the start of a long-term training/learning process. A multiple-season training process for participants will introduce key soil conservation principles and practices in a very practical, hands-on manner. Training should be aimed at frequent social learning events to initiate and facilitate feedback, reflection and adaptation of rehabilitation activities and technologies. Such a participatory research model can also, in future, be used to implement so-called Conservation Agriculture Technologies (CATs) (e.g. rotational grazing, minimum or no till practices etc.) in some of the susceptible areas.

Possible hindrances with regards to step 2 include the following. Soil conservation and rehabilitation strategies (especially soft options) require long-term commitment from communities to succeed. Due to limited short-term advantages to communities, the long-term adoption rate to participate could be very low. Furthermore, due to the susceptibility of duplex soils in the catchment, **some** areas identified in step 1 will have to be fully protected (fenced off and left undisturbed where grazing is prohibited) until the communities are trained and equipped to sustainably manage it themselves. However, the feasibility of full protection and exclusion of land remains questionable. Such an approach may require exhaustive negotiations with the local communities to purchase land in order to fence off and police susceptible areas.

Step 3: Fencing susceptible areas, followed by area-specific rehabilitation. Since some of the susceptible areas are relatively small and are possibly scattered in between eroded areas, it will be necessary to select and fence clusters of susceptible areas. The number of clusters, their sizes and diameters will be calculated in a GIS to obtain a cost-estimate (for fencing). Furthermore, as mentioned above, susceptible areas could erode, even if fenced, due to current erosion processes (e.g. gullies that expand) in between some of the susceptible/intact areas. Therefore, it will be imperative here to implement area-specific rehabilitation. Since it will not be feasible to rehabilitate all the gullies in the catchment, gullies can be ranked from most to least important according to criteria that need to be considered for rehabilitation. Rehabilitation efforts should be based on criteria such as gully location, dimension, growth/activity, erosion rate, gully-river connectivity, and sediment delivery potential. Most of these parameters have already been mapped and modelled by Le Roux *et al.* (2015). Gully expansion from footslopes onto concave midslopes should be minimized with site-specific construction

of structures and protecting the vegetation from overgrazing (especially upslope along drainage paths situated on duplex soils). Furthermore, the use, or the protection of, existing sediment sinks is highly recommended. Several small wetlands occur between and within the gully networks (see Figure 1). These wetlands should be protected and extended if possible, as well as rehabilitated if in a poor state. Likewise, small farm dams that currently trap sediment should be secured to prevent dam wall failure.

Possible hindrances with regards to step 3 include the following. Duplex soils are highly erodible and favour continuous gully development mainly due to the marked increase in clay content from the topsoil to subsoil horizon. As a result, duplex soils have an abrupt transition between the topsoil and the subsoil with respect to texture, structure and consistence. These soils limit intrinsic permeability since water does not move readily into the subsurface matrix, which leads to increased subsurface flow causing tunnel erosion (Beckedahl, 1998). In addition, duplex soils in the central part of the catchment are dispersive and easily lose aggregation because of high sodium absorption. Therefore, structures such as check dams and gabions can only be used on nondispersive soils. Structures should be avoided on dispersive soils. When soil is dispersive, structures usually enhance subsurface accumulation and cause further erosion around the structure (worsening the problem). Vegetation with deep root systems and soft structures are more appropriate in dispersive soils. However, aforementioned options is not effective in large active gullies that feed massive amounts of water and sediment downslope during rainfall events. The rehabilitation of large active gullies in dispersive soils remains a major challange. Another potential problem with regards to step 3 relates to step 2; soil conservation and rehabilitation strategies (especially soft options) require long-term commitment from communities to succeed. Due to limited short-term advantages to communities, the adoption rate to participate could be very low. Soft and/or hard structures will fail if vandalised or not maintained.

Figure 1: Photo of a small wetland on the upper-midslope of a large gully network that is hydrologically connected with the Tsitsa River (taken on 18 July 2016).

Step 4: Monitoring and maintenance of susceptible areas with/by communities. Long-term measurement and modelling of discharge and sediment load is recommended, including losses from evaporation and future releases for irrigation in water bodies and sediment trap efficiencies. The ability to account for sediment supply from gullies will be an important feature in the Ntabelanga Dam Catchment where gullies are the predominant source of sediment. In addition to sediment yield measurement and modelling, continual monitoring and maintenance of susceptible areas by TP stakeholders together with community members will be imperative. Frequent field visits to inspect soil health and the condition of structures in these areas will be the most effective monitoring technique (number of field visits depending on budget). Susceptible areas should be visited frequently, especially

during the rainy season from November to April. It is recommended that field visits occur after large rainfall events (>20 mm per day). At a catchment scale, the use of remotely sensed data is also recommended. SPOT 6 & 7 imagery at 1.5 m can now be acquired at a national scale from 2015 (free of charge for educational and research institutions). Colour digital aerial imagery at 0.5 m can now be acquired at a national scale from National Geospatial Information (NGI) between 2008 and 2012 (also free of charge). Appendix A briefly reviews remote sensing techniques and data available for monitoring erosion features at a catchment scale. However, remotely sensed data with the required spatial and temporal resolution is costly or unavailable.

Possible hindrances with regards to step 4 include the following. The number of field visits for monitoring purposes will probably be limited due to limited financial resources. Furthermore, the use of remote sensing techniques is challenging at a catchment scale. Remote sensing techniques cannot always express individual gullies with the required accuracy due to their spectral complexity over large areas (Mararakanye and Le Roux, 2012). However, monitoring should be targeted at susceptible areas. As mentioned above, the biggest challenge in this regard will be to obtain imagery with the sufficient temporal (new, up to date) resolution.

Envisaged outcomes

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The main outcome of this study will be a map of gully-free areas that are susceptible to gully development in the Ntabelanga Dam Catchment (T35A-E). For illustration purposes (not for implementation), a preliminary estimate was achieved around the future Ntabelanga Dam. Figure 2 illustrates areas around the future Ntabelanga Dam that are intrinsically susceptible to gully erosion, yet are vegetated and gully-free. These areas have the same topography, geology, land types and/or terrain soil associations than gullied areas but are still gully-free. More specifically, these areas consists of gentle slopes in zones of saturation along drainage paths with a large contributing area, erodible duplex soils derived from mudstones. Most of the susceptible areas (shown in dark green) are relatively small and are scattered between eroded areas (shown in red). These areas are relative small since they represent zones of saturation along drainage paths with a large contributing area. Therefore, it was decided to group susceptible areas with high densities into cluster polygons (shown in light green). Table 1 shows that there are 14 susceptible cluster polygons around the Ntabelanga Dam. Cluster sizes range between 88 and 1 268 ha, totalling 4 700 ha, whereas their diameters range between 3 728 and 15 023 m, totalling 100 925 m.

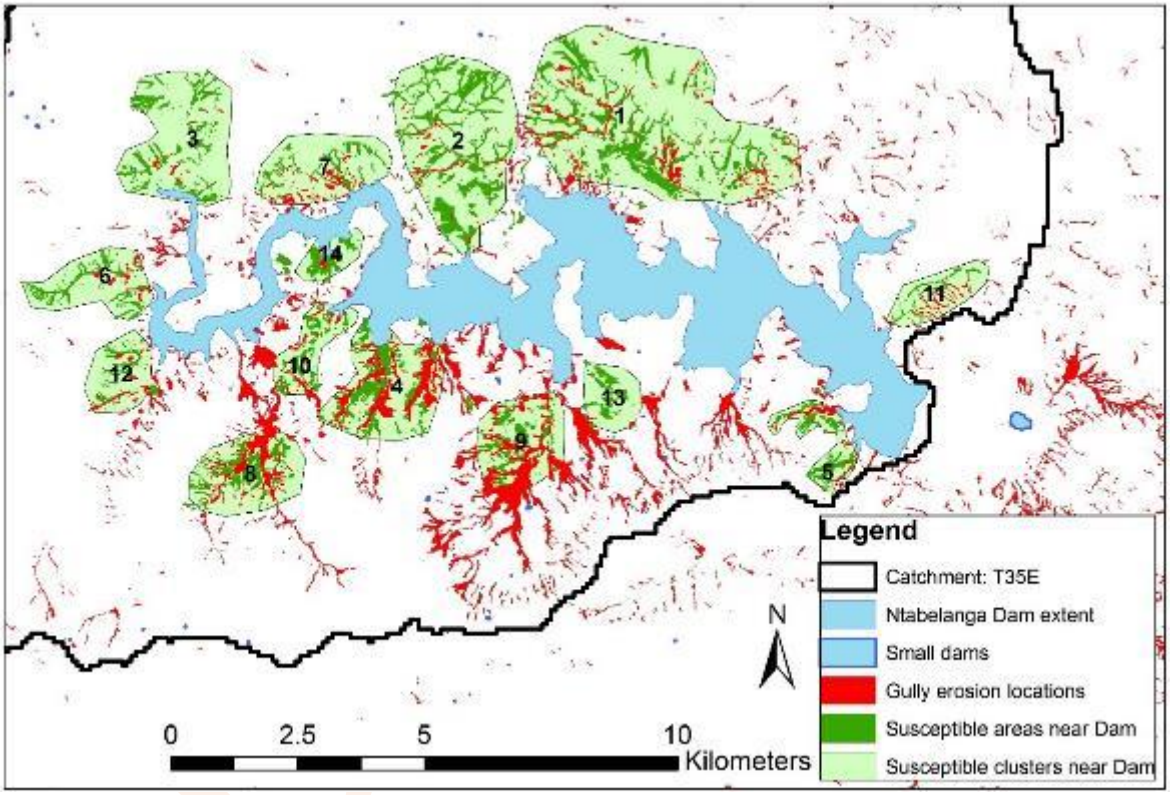

Figure 2: Susceptible areas around the future Ntabelanga Dam and gully erosion locations (**preliminary estimation, not for implementation**).

Table 1: Sizes and perimeters of 14 susceptible clusters around the future Ntabelanga Dam (**preliminary estimation, not for implementation**).

Cluster #	Area (m^2)	Perimeter (m)
1	12680021	15023
2	6854239	10390
3	4641046	9128
4	3940965	8897
5	1251675	7640

6	2289527	6827
7	2919824	6781
8	2943240	6429
9	2760688	6126
10	1482656	5687
11	1445344	5200
12	1640430	4806
13	1281153	4263
14	883927	3728
Total	**47 014 735**	**100 925**

Conclusion and recommendations

Soil erosion prevention will not only reduce the sediment yield and increase dam life expectancy, but will also benefit the local communities by preventing further soil degradation of their land. First, the extent of gully-free areas susceptible to gully development should be assessed in T35A-E. Appropriate strategies need to be designed for these susceptible areas in order to protect the current vegetation cover. However, such a strategy will only be successful if the communities are involved. Therefore, the next step will be to follow a Community-Centered Participatory Research and Development Approach in the susceptible areas (e.g. Smith, 2006). Communities should be involved from hereon, including fencing of susceptible areas, area-specific rehabilitation, and monitoring and maintenance of susceptible areas.

Due to the presence of gullies in between the susceptible/intact areas, it will be imperative to implement area-specific rehabilitation. However, it will not be feasible to rehabilitate all the gullies in the susceptible clusters of the Ntabelanga Dam Catchment. Therefore, it is recommended that gullies within susceptible cluster polygons be ranked from most to least important according to gully location, dimension, growth/activity, erosion rate, gully-river connectivity, and sediment delivery potential. Furthermore, as mentioned above, the protection of existing sediment sinks (wetlands and small dams) is highly recommended, especially in the susceptible clusters. It is further recommended to assess, by means of scenario analysis, how much sediment will be yielded from the susceptible areas (currently gully-free) if gully development occur.

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Monitoring erosion features

Remote sensing techniques have been widely used to map eroded areas, the assessment of off-site impacts and erosion controlling factors, as well as for data integration for erosion modelling (Vrieling, 2006). Various techniques have been used ranging from simple visual interpretation of images to complex image manipulation (Smith and Pain, 2009). Sensors are carried by aircraft or satellites and are mostly identical in terms of primary output data, but the lower altitude at which airborne systems function allows higher spatial resolutions (Smith and Pain, 2009).

Airborne systems

Airborne systems have been widely used to account for and map the heterogeneity of soil erosion features including photogrammetric methods using stereo images (Flügel *et al.*, 2003), synthetic aperture radar interferometry (Hochschild and Herold, 2001), and airborne laser altimetry (Ritchie, 2000). Until now, most remote sensing studies are based on the use of airphoto interpretation and photogrammetry to map erosion features such as gullies (Martinez-Casasnovas, 2003; Casalí *et al.*, 2009). Recent elevation products such as LiDAR (Light Detection and Ranging) and IfSAR (Interferometric Synthetic Aperture Radar) are capable of volumetric measurements of individual gullies (Johansen *et al.*, 2012), although the technology is costly. Although airborne systems are useful for direct identification of erosion, the disadvantage of aerial photography is that it does not provide repeatable coverage over large areas that are needed for assessment of large areas for which satellite imagery is better adapted (Vrieling, 2006). Fortunately, colour digital aerial imagery at 0.5 m can now be acquired at a national scale from National Geospatial Information (NGI) between 2008 and 2012 (free of charge).

Satellite imagery

Satellite images generally provide broad coverage and long time series of data. For example, Landsat MSS and TM imagery remains a significant data source since the early 70's due to its satisfactory repeat coverage for monitoring, large scene size and low cost of entry (imagery dating back to 1972 now freely available) (Smith and Pain, 2009). The Landsat-8 carrying Operational Land Imager (OLI) was launched in February 2013 and began normal operations in May 2013. However, its potential to assess erosion and sediment yield have not been tested in peer-reviewed studies yet. Techniques frequently used include visual interpretation (Dwivedi *et al.*, 1997), correlation between spectral reflectance values (Price, 1993), automatic extraction/classification techniques (Servenay and Prat, 2003), change detection methods (Lu *et al.* 2004) and imaging radar instruments (Metternicht and Zinck, 1998). Until recently, however, coarse spatial resolutions offered by satellite imagery made it difficult to detect erosion features with required accuracy (King *et al.*, 2005). Vrieling (2006) states that most studies that have applied satellite imagery concentrate on the assessment of erosion risk factors, especially vegetal attributes (e.g. Symeonakis and Drake, 2004). In terms of erosion features, previous remote sensing studies essentially mapped large eroded areas suffering from extensive erosion. According to Hochschild *et al.* (2003), space-borne data is difficult to relate to particular processes due to the heterogeneity of the object itself as well as the environment. The spectral reflectance between individual erosion features such as gullies varies significantly over large areas and depends on vegetation cover, as well as several soil properties such as soil organic matter and soil moisture content (King *et al.* 2005, Stroosnijder 2005). An important difficulty when monitoring soil erosion by satellite is the influence of canopy cover, especially dense tree canopy concealing poor ground cover and erosion processes in temperate and humid areas.

Le Roux and Sumner (2012) based gully erosion mapping in the Tsitsa River Catchment in the Eastern Cape Province on analysis of SPOT 5 imagery acquired in 2007/8. In order to speed up the processing of data and to exclude subjectivity of manual interpretation, the study first considered different techniques of classification. However, classification techniques could not express individual gullies with acquired accuracy due to their spectral complexity, especially over such a large area. Other regional studies that utilized classification techniques in semi-arid regions of SA confirm this trend, i.e. could not

rapidly, nor accurately, define individual gullies from bare soil at a large catchment scale (e.g. Mararkanye and Le Roux *et al.*, 2012). Fortunately, with the development in sensor technology, space-borne data with improved spatial, spectral and temporal resolution is now available including IKONOS, Quickbird, WorldView and GeoEye (Smith and Pain, 2009). However, aforementioned imagery with the sufficient spatial and temporal (new, up to date) resolution are costly. Fortunately, SPOT 6 & 7 imagery at 1.5 m can now be acquired at a national scale from 2015 (free of charge by educational and research institutions). The use of imagery with high spatial resolution in object-based modelling techniques is particularly promising.

Change detection with object-based modelling

Object-based modelling, also referred to as object-based image analysis, is an important trend in remote sensing and GIScience (Blaschke, 2010). One of the most recent trends is to use object-based modelling for change detection (Blaschke, 2010). Change detection techniques by means of object-based modelling have become an important technique for mapping gully erosion activity/stability and rates. Object-based modelling first requires segmentation to generate objects with unique spectral and spatial characteristics. Segmentation can be defined as a process of partitioning an image into homogenous segments or image-objects on the basis of both spectral and spatial characteristics (Blaschke, 2010; Dey *et al.*, 2010). Segmentation is superior to conventional pixel-based classification, which is solely spectral (Benz *et al.*, 2004). After segmentation, objects can be classified into homogenous groups which involve computing the attributes of the object such as its location, size, shape, and its contextual relationships such as distance and direction to all other objects on the landscape across multiple scales (Bishop *et al.*, 2012). Therefore, object-based modelling, as opposed to individual pixels is more appropriate to address the aforementioned heterogeneity of erosion features (Shruthi *et al.*, 2011).

Although object-based modelling has considerable potential to improve classification accuracies, its potential to map erosion features have only been minimally tested in peer-reviewed studies. Eustace *et al.* (2011) used a semi-automated object oriented classification method to detect and map gully extent and volume within the Fitzroy Catchment of Queensland, Australia. This has been achieved by (i) using fine-resolution LiDAR transects to derive DEMs at twenty sites (limited due to cost), (ii) carrying out object-oriented classification to derive gully extent from the LiDAR transects, (iii) statistically model the relationship between gully presence, soil, topography and vegetation status, and (iv) extrapolating the model across the study area with an area of over 140,000 km^2 at the scale of 25 m pixels. Cross-validation indicated a moderate predictive ability, with an average area under the receiver operating characteristic curve of 0.62. The reasons for the modest result include the limited number of twenty LiDAR transects, the low resolution of the soil map leading to the exclusion of soil erodibility as an important causal factor in the model, and the fact that gullies may be caused by different processes at different locations (Eustace *et al.*, 2011). Other limitations include the absence of field measurements to verify the volumetric gully estimates and not assessing how gullies change through time. Johansen *et al.* (2012) extended the research of Eustace *et al.* (2011) by expanding the object-based modelling routine to include the volume estimation and assessment of multi-temporal change for three selected study sites in the Fitzroy Catchment of Queensland, Australia. This was achieved by developing an object-based approach for monitoring gully extent and gully volume based on multi-temporal LiDAR data captured in 2007 and 2010, and assessing changes in extent and volume of gullies of the three study sites. Gully extent and volume were effectively assessed, although only the gully extent mapped from the 2010 LiDAR data was validated based on high spatial resolution orthophotos (with an overall accuracy of 92%).

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Appendix 9: Participatory Monitoring, Evaluation, Reflection & Learning Framework by Botha et al. (2017)

Due to document size it is available on the TP Google Drive or request it from Mike Powell via email at m.powell@ru.ac.za

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Appendix 10: Minutes of the Sediment and Restoration COP meeting on 23 June 2016

Minutes of the Sediment and Restoration Group meeting

Held on 23 June 2016 at Rhodes University, Grahamstown

Bennie van der Waal

1) Present

Japie Buckle, Jay le Roux, Lehman Lindeque, Monde Ntshudu, Mike Powell, Dirk Pretorius, Kate Rowntree, George van Zijl, Bennie van der Waal (Chair), Margaret Wolff, Mike Coleman, Mike Powell, Pindiwe Ntloko, Ryan Anderson, Trevor Pike, Ayanda Sigwela, Nosiseko Mtati, Andrew Slaughter, David Gwapedza, Karen Milne, Johan van Tol, Nick Hamer, Alta De Vos

2) Apologies

Michael Braack, Michael Kawa, Lyndon Riddle, Heinrich Neethling, Heinz Beckedahl, Lawrence Sisitka.

3) Welcome and introduction

Bennie van der Waal opened the meeting at 09h00 and all present introduced themselves. Harry Biggs introduced the Comparative Risk Assessment (CRA) methodology.

4) Agenda

4.1 Report back on the Stakeholder Analysis - Part 1 for TP - implications and take home messages for the Sediment and Restoration Working Group

A presentation was made by Nick Hamer from the IWR and Dept. of Environmental Science (RU), and is available to the TP subscribers on the TP Google drive. There has been a significant breakdown in the communications between both national and provincial government structures and local groups. This is true for both the DWS and the DEA NRM initiatives. Major disconnections in communication in horizontal, vertical and diagonal directions within the Tsitsa catchment (T35). This will have to be addressed for all stakeholders to collaborate around the issue of sustainable land use. The absence of a well-coordinated and sustained community engagement component (both DEA and DWS) has created confusion and tensions in the catchment, specifically around the site of the proposed Ntabelanga dam. The lack of interest towards engagement from DWS towards the tribal authority structures has led to one tribal area (Elangeni) to place a ban on further research (the Green Village Project is excluded) until they get clarity from the DWS structures.

5) TP vision and Objectives

TP Vision (as at July 2015):

"**To support sustainable livelihoods for local people through integrated landscape management that**

strives for resilient social-ecological systems and which fosters equity in access to ecosystem services."

Provisional Sediment & Restoration Working Group Vision - June 2016:

"**To service the TP vision, in a socially and economically effective way that is compatible with the concept of the Tsitsa catchment as a social-ecological system (SES), with special reference to sediment erosion and its effective and responsible management through restoration efforts and good land use practice across the landscape**."

6) A preliminary list of Principles for the Sediment and Restoration Working Group

a) Address the drivers of landscape degradation (too frequent fire, no grazing system, etc.) as soon as possible as rehabilitation under ongoing causative pressures is likely to fail.
b) All areas upstream of existing reservoirs/dams, regardless of dam size, to be excluded from rehabilitation efforts for the short to medium term. Secure dams that are vulnerable to erosion.
c) Prioritise degraded or incised wetlands.
d) Target active erosion (e.g. gully head erosion) as soon as possible
e) Maintain existing interventions
f) From a rehabilitation aspect, reduced runoff velocity, increased palatable vegetation cover and rooting mass are very important factors to address ongoing erosion (Russell et al., 2009). Use methods that will contribute to all three these aspects.
g) Protect vulnerable areas not yet eroded.
h) Start rehabilitation in the low angled upperparts of the landscape (catena) as this will reduce flow energy and retain water and sediment higher up in the landscape, ultimately reducing energy downstream and allowing downstream areas to stabilise to some extent. Once the upper parts are stable, move rehabilitation to lower parts.
i) Prioritize interventions on low angled slopes as flow energy is less and sediment trapping volume will be optimised.
j) All interventions to fall outside the full inundation levels (1:100 year flood level) of the proposed dams.
k) Dispersive soils are a special case and can't be treated in a standard way. Dispersive soils will erode at any hydraulic gradient (even at a centimetre scale), thus important not to disturb or accumulate water in dispersive soils where possible (Russell et al., 2009).
l) Russell et al. (2009) developed a decision tree for the various gully interventions in wetlands (Figure 1 and 2). The principals are similar for dryland rehabilitation, but the cost effectiveness of large structures on much steeper slopes (compared to low angled wetlands) could render the option non feasible. Assess the cost effectiveness of various options.
m) Prototyping (tinkering) is crucial and can guide adaptive management. Get community to understand that it might fail.
n) Monitoring plan on the prototyping – need a dedicated person to process the monitoring data and relay

it to management and scientists

7) Comparative Risk Assessment

Harry Biggs led the CRA assessment, comparing 4 scenarios/narratives (Table 1). The four scenarios are summarised below.

Social Approach (Presented by Kate Rowntree as local resident living in the Green Village area in 2025)

Researchers came 10 years ago. Some help in the form of a Green Village (GV). TP was around for a while and gave some jobs. Lots of education about SLM and restoration. TP has gone now. All the fences are gone and things have gone back to what they were. Lots of emigrations. Lots of cattle from outside. Degradation is even worse now. Where was the ongoing communication? Some school education happened, but the people with skills have left.

Hard structures (Presented by Dirk Pretorius and Trevor Pike)

What happened: 3 000 gullies – only 1 000 were attended with soft structure. People are happy with the social component, but 80% of the sediment is still entering the dam. Too much sediment in the water and dam silting up. We didn't increase the lifespan of the dam. Ecotourism of the dam will be affected by the dredging. The dam is expensive and its lifespan needs to be increased.

Definition: weirs, check dams, earth dams.

Problem: Sediment volume is so large – we have to use logic. Sediment removal from small structures is cheaper than removing from the dam. Building big structures gives us time to work upstream. Diluted resources = low impact. Costs are high and EIAs are needed. Need to prioritise where to put the hard structures as there are too many locations that need interventions. Large volumes of sediment coming through the Tsitsa River, need to build a trap in the main river.

Turkey case study – rationale is that you need hard structures to prevent sediment because up stream interventions may fail.

Trevor Pike: Prime focus should be on hard structures in the lower regions of the catchment where you have a greater opportunity to trap larger amounts of sediment- so putting in some key structures in those areas making sure they are formed on suitable foundations so you can maximise the sediment trapping capacity. The rest of the structures would be stabilisation structures so the sides of your gullies can start stabilising. Obviously in the sediment trapping structures you have to take into account the fact that with dispersive soils you want to keep all your flow in your gullies, so you can't push water out of your gullies. These sites for hard interventions would have to be carefully chosen. These sites should have multiple entry points and working back up those areas putting in structures can trap sediment or stabilisation structures to stop dongas getting deeper and wider - sediment and stabilisation structures in dongas to stop them from degrading further. Limited options for soft structures and also have a risk of failure.

Soft options (presented by Bennie van der Waal)

20 years later: The texture of the landscape has changed due to the many soft options that were implemented.

Vegetation pockets have established on former bare slopes. Sediment is trapped at the source and water is infiltrating on the hillslopes. Hillslope-channel connectivity is reduced and the slow release of water allows gullies lower down to stabilise and revegetate.

REHAB is defined reinstating ecological process. Trap sediment where energy low = high infiltration. Change the way sediment is moving. Big major assumption is that sediment is from gullies = wrong. Start at the top of the hill slope. Increase grass cover. Start to create vegetated gullies. Need to have ongoing maintenance. Silt fences and ponding has life spans so need to be checked regularly. The interventions will create 'islands of fertility' for further vegetation establishment and 'island' expansion.

If we DON'T:

1. Higher runoff
2. High sediment transport
3. High erosion on slopes
4. Sedimentation in the dam
5. Less water in the soils available for vegetation growth.

Averted degradation (presented by Jay le Roux)

Properly map the susceptible areas and then to negotiate with communities to fence of land and protected it until they can take care of it or manage it. If we do not take care of these areas which all have dispersive soils, then when they will erode and possibly increase the sediment yield from the catchment.

Identified areas must be protected (e.g. fence with policing), or these areas will contribute 300 000 t of soil per annum) and will reduce the life expectancy of the proposed Tsitsa dams by 30%.

If this is not followed then:

- more than 30% more sediment per annum will land up in the dam
- Instead of silting up in 50 years it will silt up in 35 years (foot note – at current driver pressure – excludes massive immigration + increased frequency and size of episodic extreme flooding events)
- Irrigation on dispersive soils will cause major erosion
- Hard and soft structures will silt up quicker and be less effective

Soil scientists will need to make the soil maps to guide this process.

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Table 1. CRA Scores and comments for the four scenarios.

Scenario	Likelihood	Impact	RAWSCORE	How well abated @ what cost	Risk Appetite	How ELSE abated @ what cost	Comments	Rating key
Socially Orientated Approach	3	2.5	7.5	Hardly (Dirk felt that TP was doing). @ Medium	NO	Partly @ High cost and long term	AS - people will not be depressed if no interventions take place. Role of sheep, and plough is very important in avoiding further degradation. There is a concern that the 50-year time horizon is just as NB. Key risk are that partnerships are essential	IMPACT – 1 = minor 2 = intermediate 3 = major 4 = catastrophic
Hard Structures	3	3	3-9	Hardly @ almost zero		15 years well @ high cost. 50 years well to medium @ high cost	Inflated Sediment retention %. Wetlands vs dredging key issue. We need to keep scale in context	Likelihood: 1 = low 2 = med 3 = probable 4 = pervasive
Soft Structures	3	3	9	Partly @ medium @		Well @ high	Needs to be strongly linked to No 1. Lots of abatement happening in private lands	Abatement H = Hardly P = Partly W = well
Averted Degradation	3.5	Local = 3, overall = 1	Local = 10.5 Overall = 3.5	Not being dealt with		Not easy but worth considering - Matatiele a good example	More areas can be defined as "avoided degradation" e.g. Non-Gullies of dispersive soils.	Overall cost: L = low M = Medium H = high

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Harry summarised the conflicts and key ideas that emerged from the meeting below:

If it were ever in doubt, the CRA (and importantly, the concurrent discussion) should have made it quite clear that all 4 approaches have merit, and will have to somehow be intertwined.

In contradiction to some CRA's this one had similar scores, BUT note:

- There was wide disagreement about hard structures – not that some won't be needed (they will) but that perceptions of overall effectiveness vary so widely that the "raw score" actually diverges sharply – meaning this has uncovered a key uncertainty. This seemed in the discussion to be linked to another key uncertainty – that of the necessity of dredging (and belief that this is sustainable) as compared with the need for vegetating the area behind these. These uncertainties seem to suggest some early prototyping and experimentation is needed.
- The averted degradation option has lower wide-geography (catchment scale) risk but if not implemented in the vulnerable area, extremely high risks.

Further key issues that came out in discussion were that

- Fitting in with "bureaucratic" decision-making cycles is a reality rather than some optional choice to be considered after the "facts" are determined. The whole sequence and mix of implementation, as it gets figured out, must take these cycles into account BUT the respective bureaucracies will also need to take note of the obvious benefits of where possible introducing more agility and flexibility into what are otherwise pretty rigid schedules tending to preclude effective adaptation as the group learns. This will be an ongoing tension so start working at it from both ends.
- Rather than "ideologically" trying to dominate the plan with mainly one strategy, the pragmatic option seems, in the light of the scores and the discussion, to allow enough space for prototyping (in one sense there is time to do so, and even if there appeared not to be, the opposite strategy of "pre-decided domination" obviously carries very high risks indeed) Experimenting provisionally on a smaller than "domination" scale (i.e. where all options play a role), and sensible ways with some carefully thought-through sub-options, will produce some of the initial key results wanted AND at the same time allow wider buy-in in the TP group, as you discover and learn pros and cons of each (and their combinations) in at least in the shorter term (1-2 yr.) till the next cycle of deciding. This could continue "telescoping" forward in time as some longer results become available and other shorter-term ones from new decisions start becoming apparent. I.e. the adaptive approach with more connected group decision-making.
- Apart from (or actually including) the above prototype "experiments" (hopefully some at least turn out to be meaningful early interventions, from the others you will at least learn valuable lessons) across a range of types of actions, a really useful plan would be to set up a group-derived catchment sediment and rehab plan, itself a growing "telescoped" product but actionable at key defined points. This will build further buy-in and is a good goal anyway.

8) The immediate way forward after this meeting

- Need to work on the key uncertainties related to intervention effectiveness.
- Prototyping/experimentation is needed. Need to monitor the tinkering but must be done systematically and recorded (especially with students).
- We need to agree that T35E is the lowest common denominator for spatial planning.
- Group to draft a framework for implementation plan.
- Kate to send out comments on the GV Guidelines for Greening the Landscapes.
- Jay offered to make a rule-based model for predicting gully prioritisation.

9) Next meeting on 15 July 2016 at Rhodes University

Proposed agenda for the 15th July, in Grahamstown

- Framework for the Integrated Catchment Management Plan
- Committee to work on the Integrated Catchment Management Plan
- Vision for the S&R Working Group
- S&R WG Guidelines
- Develop TORs and responsibilities and reporting channels
- Discuss prototyping

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- Summarise outputs
- Prototype the S&R GP – Policy to Practice for TP Governance

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Appendix 11: Examples of Potentially Suitable Ruderal Plants for Rehabilitation Consideration, and Related Notes.

By Ralph Clark

The following is a selection of ruderals that can be considered for the Project, based on site observations and extensive knowledge and experience of plants in this regional context.

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Indigenous ruderals:		
Berkheya carlinifolia (drier areas)	Wild Thistle/African Thistle/Dissel.	
Berkheya heterophylla (drier areas)	Wild Thistle/African Thistle/Dissel.	
Berkheya maritima (wetter areas)	Wild Thistle/African Thistle/Dissel.	
Nidorella podocephala (perennial trailer)	No common name that I could find.	
Non-native ruderals:		
Bidens formosa (=*Cosmos bipinnatus*)	Cosmos	
Bidens pilosa	Common Blackjack	
Chenopodium spp.	Goosefoots	
Cichorium intybus	Chicory	
Melilotus alba	White Sweet Clover	
Plantago lanceolata	Narrow-leafed/Ribwort Plantain	
Schkuhria pinnata	Dwarf Marigold	
Tagetes minuta	Khakibos	
Indigenous Karoo-Type Shrubs for Semi-Arid/Highly Denuded Areas:		
The following tough karroid shrubs could be considered for rehabilitating west- and north-facing and semi-arid areas, by planting in contoured rows. They are often the natural consequence of prolonged overgrazing and the accompanying 'Nama-Karoo-ification' of Grassland. They can be used to kick-start recovery in areas where it would be futile to start with planting grass first – e.g. areas that are virtually barren and on which sheet erosion is very high; steep denuded slopes; hot, dry areas where grasses will struggle as the pioneers; and highly degraded areas that will remain under unacceptable grazing risk indefinitely if planted to anything vaguely palatable. These plants also have strong root systems to help bind what soil is left, and will help accumulate organic matter to slowly create a viable seed-bed for other, more palatable plants. They have no grazing value, and so would be left alone where any other form of rehabilitation would be nullified by selective grazing.		
Aloe ferox	Bitter Aloe	
Aloe striata	Coral Aloe	
Artemisia afra – potentially an excellent nursery plant for grass rehabilitation as livestock appear to avoid it.	Wormwood	
Chrysocoma ciliata	Bitterbos	
Cotyledon orbiculata	Pig's Ears	
Eriocephalus spp.	Kapokbosse	
Felicia filifolia	Fine-leaved Felicia	
Helichrysm rosum	no common name that I could find	
Kalanchoe spp. (e.g. *K. thyrsiflora*)	Geelplakkie	
Lycium spp.	Honeythorns	
Indigenous Montane Shrubs for Steep Slopes, Gullies Etc.		
These would be suitable for higher rainfall, steep, rocky slopes that are fire refugia. They naturally occur along the base of cliffs, in rock screes, along boulder-strewn riverlines, along cliff-tops in the eastern Great Escarpment, and as a forest and thicket margins.		
Buddleja auriculata	Weeping Buddleja	
Buddleja salviifolia	Sage-leaved Buddleja	

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Euclea undulata	Common Guarri	
Leucosidea sericea	Ouhout	
Myrsine africana	Cape Myrtle	
Rhamnus prinoides	Dogwood, Blinkblaar	
Searsia divaricata (high altitude i.e. >1,600 m)	Rusty-leaved Currant/Mountain Kuni-bush	
Searsia dregeana	No common name that I could find.	
Nutrient-Deficient Bare Gully Slopes, Bare Steep Slopes & Rock Shelves		
These would be suitable for high rainfall slopes with highly leached soils (subsoils if heavily eroded, and even on bare rock). They typically form dense colonies in such habitats, and their dense growth-forms create valuable silt-traps. They can occur on highly degraded soil, overgrazed land, on cliff-edges, rock sheets, and in eroded gullies and dongas.		
Cliffortia linearifolia	no common name that I could find	
Helichrysum anomalum	no common name that I could find	
Metalasia densa	White Bristle Bush	
Stoebe vulgaris (=*Seriphium plumosum*)	Slangbos, Bankruptbush	
Plants suited for wetlands		
These would be suitable riparian or wetland pioneer plants for revegetating denuded but seasonally or perennially wet areas. Most wetland species are naturally pioneer species and colonise available habitats easily (provided there is some sense of 'stability', i.e. no subject to flash floods, sediment inundation, etc.).		
Cyperus congestus	Dense flat-sedge	
Cyperus dives (e.g. behind weirs/donga reclamation devices)	Giant Sedge	
Cyperus marginatus	No common name that I could find	
Helichrysum aureonitens	Golden Everlasting	
Juncus inflexus	Blue Rush	
Nidorella spp.	Common Reed	
Phragmites australis	No common name that I could find	
Pseudognaphalium luteo-album	Bulrush	
Pycreus polystachyos	Jersey Cudweed	
Typha capensis		
Plants suited for gulley bottoms		
These would be plants suitable for planting in deep gullies that have been stabilised, to increase organic matter in them and to increase roughness from woody debris so that water-flow is slowed. They would be safe from fire, given the *de facto* fire refugia formed by the gullies. Not all of these are necessarily ruderal, but all can occupy lower successional levels successfully.		
Asclepias fruticosus	African Milkweed	
Buddleja auriculata	Weeping Buddleja	
Buddleja salviifolia	Sage-leaved Buddleja	
Gymnosporia buxifolia	Common Spike-Thorn	
Leonotis spp.	Wild Dagga	
Leucosidea sericea	Ouhout	
Myrsine africana	Cape Myrtle	

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Phragmites australis	Common Reed	
Rubus rigidus	Wild Bramble; not to be confused with numerous invasive species	
Salix mucronata	Safsaf Willow	
Typha capensis	Bulrush	
Vachellia karroo	Sweet-thorn	

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Appendix 12: Recorded & probable Alien Invasive Plant Species present in the Ntabelanga Dam Catchment area.

By Ralph Clark

Due to the large size of Appendix 12 it available on the TP Google Drive or request it from Mike Powell via email at m.powell@ru.ac.za

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Appendix 13: Proposed spatial distribution of implementation based on a hypothetical funding scenario of R26 Million per year.

This budget is implementation focussed and excludes the development of training materials, HR costs of researchers, a catchment coordinator, high level stakeholder meetings, etc.

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	Interventinons	nodes	Check	T35A	T35B	T35C	T35D	T35E	N/P/Team	Participants	W/days	p/ds	P/d cost	Assumed Cost	
Herding		30	30	9	0	0	9	12	4	120	240	28800	235	R 6,768,000	26%
monitoring															0%
Social Engagement		50	50	10	10	10	10	10	1	50	200	1000	170	R 1,700,000	7%
remunerated Science		50	50	10	10	10	10	10	1	50	120	6000	170	R 1,020,000	4%
plug preneur		50	50	10	10	10	10	10	1	50	60	3000	170	R 510,000	2%
Fire		4	4	1	0	0	1	2	12	48	120	5760	300	R 1,728,000	7%
Risk Dams	35		35	8	8	2	10	7					50000	R 1,750,000	7%
Wetlands	70		70	20	8	7	15	20					50000	R 3,500,000	13%
Alien Clearing															0%
WOF teams		4	4	1	0	0	1	2	12	48	120	5760	300	R 1,728,000	7%
Alien Clearing		6	6	1	1	2	1	1	12	72	240	17280	235	R 4,060,800	16%
Forest Restoration		2	2	1	0	0	0	1	12	24	200	4800	235	R 1,128,000	4%
Hillslope Erosion Control		4	4	1	0	0	1	2	12	48	200	9600	235	R 2,256,000	9%
														R 26,148,800	100%

Units per Quat	R 6,172,831.48	R 4,029,487.21	R 3,515,084.59	R 5,829,896.39	R 6,601,500.33
Total Units	R 287.35				
% per Quat	R 1,188.58				
Budget per Quat	R 6,172,831.48	R 4,029,487.21	R 3,515,084.59	R 5,829,896.39	R 6,601,500.33
p/d/cost	R 287.35				
220000 ha	R 1,188.58				

82000	

Glossary of terms

With inputs from Jessica Cockburn and Margaret Wolff

Agency - "the capability or power to be the originator of acts". [Agency] "does not exist in a vacuum but is exercised in a social world in which structure shapes the opportunities and resources available to individuals, in which appropriate ways of being and behaving are not simply a matter of individual choice". (Cleaver 2007:226)

Betterment planning - A South African government program implemented in the former bantustans/homelands, officially to conserve the natural environment, to improve agricultural production and to provide services. It involved the compulsory movement of many people into new concentrated villages throughout the former homelands.

Biodiversity stewardship -"An approach to securing land in biodiversity priority areas through entering into agreements with private or communal landowners, led by conservation authorities. Different types of biodiversity stewardship agreement confer different benefits on landowners, and require different levels of restriction on land use. In all cases the landowner retains title to the land, and the primary responsibility for management remains with the landowner, with technical advice and assistance provided by the conservation authority." (SANBI, 2016: 11)

Catchment management agency (CMA) - The CMA is responsible for protection, conservation, development and management of a delineated water management area (WMA) in South Africa.

Catchment management strategy (CMS) - Management of the water resources in the WMA is detailed in the catchment management strategy which must be developed (as per legislation) for each of the WMAs.

Catchment management forums (CMFs) - Catchment management forums are identified as the non-statutory institutions for civil society participation in water resources management

Collaboration - "The pooling of appreciations and/or tangible resources, e.g., information, money, labor, etc., by two or more stakeholders, to solve a set of problems which neither can solve individually." (Gray, 1985: 912)

Complex social-ecological systems - "In essence, the social-ecological systems approach emphasizes that people, communities, economies, societies, cultures are embedded parts of the biosphere and shape it, from local to global scales. At the same time people, communities, economies, societies, cultures are shaped by, dependent on, and evolving with the biosphere. Social-ecological systems, are complex adaptive systems, where agents often interact in unplanned and unpredictable ways. These interactions underlie the emergence of broader scale patterns that feedback on the system and influence the interactions of the agents. Hence, the properties of complex adaptive systems change because of the interplay between the adaptive responses of the parts (or agents) and the emergent properties of the whole. Causation is often nonlinear in complex adaptive systems with the potential for chaotic dynamics, multiple basins of attraction, and shifts between pathways or regimes, some of which may be irreversible. The dynamic interaction of variables of slow and fast change makes it difficult to know when such dramatic changes may occur and to pinpoint cause-and-effect mechanisms...." (Folke et al. 2016:1,2)

Critical complexity - Critical complexity is a perspective on research in complex SES which foregrounds the normative or value-based nature of framing practices (Audouin et al. 2013)

Ecological Infrastructure – "Naturally functioning ecosystems that deliver valuable services to people, such as water and climate regulation, soil formation and disaster risk reduction. It is the nature-based equivalent of built or hard infrastructure, and can be just as important for providing services and underpinning socio-economic development. Ecological infrastructure does this by providing cost effective, long-term solutions to service delivery that can supplement, and sometimes even substitute, built infrastructure solutions. Ecological infrastructure includes healthy mountain catchments, rivers, wetlands, coastal dunes, and nodes and corridors of natural habitat, which together form a network of interconnected structural elements in the landscape" (SANBI, 2016)

Ecosystem services - "the capacity of natural processes and components to provide goods and services that satisfy human needs, directly or indirectly." (de Groot et al., 2002: 394)

Epistemic injustice - Epistemic injustice is the "wrong done to someone specifically in their capacity as a knower" (Fricker 2007:1)

Ethics - A systematic concern with the principles by which human beings seek to distinguish between right and wrong in our behavior towards other people and towards the natural environment

Framing - "the capability or power to be the originator of acts". [Agency] "does not exist in a vacuum but is exercised in a social world in which structure shapes the opportunities and resources available to individuals, in which appropriate ways of being and behaving are not simply a matter of individual choice". (Cleaver 2007:226)

Governance - "Political and institutional relationships including those of power and knowledge." (Leach et al., 2010: xiii)

Interdisciplinarity - Research that cuts across disciplines, beyond the addition of results from different disciplines (multidisciplinary research), but does not extend beyond the practices of academic researchers (Castán Broto et al., 2009)

Community of practice - Groups of people who share a passion about a topic and who want to grow their knowledge by interacting on an ongoing basis (from Wenger 1998). TP seeks to expand this definition by closing the "knowing-doing-gap" and include *activity* **and** *implementation* to make it truly PRACTICE. All too often a COP gets trapped in the academic realm and does not translate into real change on the landscape. We want to invoke COMMUNITIES OF PRAXIS (COPraxis)

Hill slope seep wetlands - A type of wetland located on gently to steeply sloping land and dominated by colluvial (i.e. gravity driven) unidirectional movement of water and material down slope.

Landscape approach - "A conceptual framework whereby stakeholders in a landscape aim to reconcile competing social, economic and environmental objectives. It seeks to move away from the often-unsustainable sectoral approach to land management. A landscape approach aims to ensure the realisation of local level needs and action (i.e. the interests of different stakeholders within the landscape), while also considering goals and outcomes important to stakeholders outside the landscape, such as national governments or the international community." (Denier et al., 2015: 10)

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Monetary land restitution award - The Land Restitution Act of 1994 provided for the restitution of their formerly held land to people who had been forcibly expelled from it due to a racially discriminatory law or act under Apartheid, or for financial restitution if it was no longer possible to return their original land to people

National Water Act (NWA) - Water act governing water use, licensing and protection in South Africa

Natural resource management (NRM) - A collective process of sustainable use, conservation, and protection of renewable natural resources (including for example forests, grazing land, wildlife, fisheries, river catchments, irrigation systems etc.) by diverse actors (including governments, farmers, business, communities, and NGOs) so that improvements in the condition of natural resources can be achieved (after Lockwood et al. 2010 and Kumar 2005).

Normalized difference vegetation index (NVDI) - An important vegetation index (a measurement parameter that is an indication of the vegetation cover over the earth's surface in remote sensing field), that has been widely applied in research to monitor changes in vegetation cover and effects of drought on agricultural lands at national and global level. It is calculated as a ratio difference between measured canopy reflectance in the red and near infrared bands respectively.

Polycentric governance - is characterized by an organizational structure where multiple. Independent actors mutually order their relationships with one another under a general system of rules (V. Ostrom 1972)

Praxis - is the process by which a theory, lesson, or skill is enacted, embodied, or realized. "Praxis" may also refer to the act of engaging, applying, exercising, realizing, or practising ideas

Reflexivity - "A collaborative process of acknowledgement, critical deliberation and mutual learning on values, assumptions and understandings that enables the generation of ''new meanings, new heuristics, and new stakeholder identities'' (Lenoble and Maesschalck, 2010: 199) ...the role of such reflexive processes is to encourage processes of critical assessment and social learning on the background values and assumptions guiding research, and on the socio-institutional structures supporting particular norms and practices." (Popa 2015: 47)

Resilience - Social-ecological resilience is the capacity to adapt or transform in the face of change in social-ecological systems, particularly unexpected change, in ways that continue to support human well-being. Adaptability refers to human actions that sustain, innovate, and improve development on current pathways, while transformability is about shifting development into new pathways and even creating novel ones. Shifting pathways or basins of attractions do not take place in a vacuum. Any transformation draws on resilience from multiple scales and diverse sources. It recombines experience and knowledge, learning with change, turning crises into windows of opportunity, and governing transformations for innovative pathways in tune with the resilience of the biosphere. Resilience thinking explicitly focuses on understanding how periods of gradual change interplay with periods of rapid change in intertwined social-ecological systems confronted with true uncertainty and what that means for people and the planet.

Scale - "The spatial, temporal, quantitative, or analytical dimensions used to measure and study any phenomenon." (Gibson et al., 2000: 218)

Social-ecological systems (complex) - An integrated perspective of humans-in-nature (Berkes & Folke, 1998)

which posits that human systems are embedded in, and entirely dependent, on the biosphere (Folke et al., 2016). SES are complex adaptive systems, and are characterised by nonlinear feedbacks, dynamic interactions, individual and spatial heterogeneity, and operate over varying time scales (Levin et al., 2012)

Social justice - Social justice is both a process and a goal (Bell 2016) and it is achieved when people have equal access to goods, opportunities and institutions needed to develop their capabilities for human functioning and when people have both the power and the resources necessary to decide how they will use their capabilities (Donaldson and Daughtery 2011)

Social learning - "A change in understanding that goes beyond the individual to become situated within wider social units or communities of practice through social interactions between actors within social networks." (Reed et al., 2010: 6)

Stewardship (environmental) - "Environmental stewardship is the responsible management of human activity affecting the natural environment to ensure the conservation and preservation of natural resources and values for the sake of future generations of human and other life on the planet, together with the acceptance of significant answerability for one's conduct to society" (Welchman 2012: 303)

Strategic Adaptive Management (SAM) - Strategic Adaptive Management (SAM) is a fundamentally stakeholder-centered approach that facilitates the iterative development of shared rationalities and future-focused objectives, as the basis for adaptive cycles of consensual decision making (Rogers and Luton 2011)

Sustainability - "A normatively explicit form of the general term, referring to the capability of maintaining over indefinite periods of time specified qualities of human well-being, social equity and environmental integrity." (Leach et al., 2010: xiii)

Subsidiarity The principle of subsidiarity holds that a larger and greater body should not exercise functions which can be carried out efficiently by one smaller and lesser, but rather the former should support the latter and help to coordinate its activity with the activities of the whole community.

Sustainability science - Science that seeks to understand the fundamental character of interactions between nature and society. Such an understanding must encompass the interaction of global processes with the ecological and social characteristics of particular places and sectors, as well as society's capacity to guide those interactions along more sustainable trajectories (after Kates 2000)

Sustainable and just natural resource management (NRM) - Sustainable and just natural resource management is natural resource management conducted in a manner which recognizes the interconnectedness of social and ecological systems. It therefore works towards interlinked outcomes which benefits the social-ecological system as a whole. Such outcomes can be achieved through sustainable management and protection of natural systems, in ways which ensure equitable access to the benefits of natural resources. Furthermore, facilitation of processes and spaces for knowledge production and exchange, and management and governance of natural resources, should be guided by principles of justice, fairness and democracy.(drawing on Agyeman et al. 2003, Ribot 2006 and George and Reed, 2017).

Transdisciplinarity research - is defined as research efforts conducted by investigators from different disciplines working jointly to create new conceptual, theoretical, methodological, and translational innovations that integrate and move beyond discipline-specific approaches to address a common problem

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Values - What specific individuals or groups of people believe to be good or bad; for example, corruption.

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