THE GREEN VILLAGE PROJECT

Improving socio-economic conditions of the Tsitsa river catchment and Okhombe communities through landscape greening and integrated green innovations

Volume 1: Improving socio-economic conditions through landscape greening, a case study from the Tsitsa River catchment, uMzimvubu basin

Prepared by: Kate Rowntree, Laura Conde-Aller, Helen Fox, Monde Duma, Monde Ntshudu

WATER RESEARCH COMMISSION

TT 777/1/18

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Report to the

WATER RESEARCH COMMISSION

Prepared by: Kate Rowntree, Laura Conde-Aller, Helen Fox, Monde Duma, Monde Ntshudu

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This report forms part of a series of three volumes. The other volumes are *Improving socio-economic conditions of the Okhombe communities through integrated green innovations* (**WRC Report No. TT 777/2/18)**;

Green Village Catchment Management: Guidelines and Training (in preparation).

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EXECUTIVE SUMMARY

1. Introduction

With the increasing impacts of global climate change, depletion of natural resources and increased degradation of the world's environment, there has been a global shift in development paradigms from one that encourages resource intensive development to a more sustainable alternative (Trier & Maiboroda, 2009). The development of eco-villages, sustainable villages and Green Villages are examples of such shifts to a sustainable livelihood.

The Green Village concept is based on the premise that providing access to green technologies can improve the wellbeing of both impoverished communities and the local environment. In the context of this project, green technologies fall into two main groups: the provision of green, off the grid energy for household use and to promote small businesses and greening of the landscape through rehabilitation measures. The Green Village concept, whereby people have sustainable and affordable access to quality food, water and energy within a well-managed and functioning ecosystem, poses a significant opportunity for researchers and government to investigate rural development alternatives for the provision of basic services in remote and impoverished areas of South Africa. The "green concept" is becoming even more relevant as the impacts of climate change are beginning to be felt in the entire value chain, but in particular in marginalized rural areas. A growing response to this challenge points to the increasing interest in developing a Green Economy in the country as an approach to generate jobs, improve livelihoods and reduce vulnerability to the risks posed by climate change.

The project reported on in this document falls under the Water Research Commission's (WRC) Green Village Lighthouse. This is a long term programme that is committed to demonstrate how the green economy can be achieved in marginalised areas of rural South Africa, improving human well-being while at the same time reducing environmental risks. A green economy is thus one which acknowledges the economic value of intact ecological infrastructure. The WRC envisages that the programme will look for practical models that can be applied at a wide range of scales from the household and village to the catchment and nation. These models must address the basic needs of marginalized communities, creating economic opportunities that are integrated with the mainstream economy without negatively impacting on the ecological infrastructure that provides the support base for household economies and catchment scale resources such as water.

2. Aim and Objectives

The aim of this project is to improve socio-economic conditions of the Ntabelanga and Okhombe communities through integrated green innovations. The objectives of the project are:

1. Identify drivers of poverty, opportunities offered by natural ecosystem, and develop community-based vision of a Green Village using a bottom up approach.
2. Through integration of indigenous knowledge, green innovations, research, and technology, develop a tool box of green solutions that can address the impact of climate change and help communities or sectors to adapt to climate change.
3. Identify and develop a business (economic) framework that poor and local communities can use to improve their livelihoods without furthering land use degradation.
4. Develop and test practical and appropriate mechanisms, manuals and guidelines for landscape development and management that will protect the infrastructure and improve ecosystem services.

5. Train communities (mainly the youth) on appropriate skills/capacity necessary to sustain the businesses and ecosystem services that transform the poor community to be more self-sufficient.
6. Integrate the green solutions tool box and business framework with core line function government departments in order to ensure sustainability of the intervention and to forge partnerships with all key stakeholders.
7. Develop models on how to expand the green tool box of solutions and business framework utility, from household/village to the national or country-wide scale.

The project specified that these objectives should be applied in two catchment areas: the Tsitsa catchment above the proposed Ntabelanga dam in the Umzimvubu catchment, Eastern Cape and the upper Thukela catchment in KwaZulu-Natal. These were considered to be most suitable for implementation because the communities living in these mountainous areas experience a high level of poverty, often with little access to basic amenities. They rely heavily on the natural resources for energy, crop and livestock production. However, large parts of these areas are degraded, resulting in poor water infiltration, severe soil erosion and loss of grass and trees. Energy poverty (i.e. poor or no energy security) is a further debilitating factor to the living standard of rural people, often impacting their health and economic livelihoods. Therefore, the implementation of integrated green innovations and technologies to create entrepreneurship/jobs that improve the economic conditions of the communities living in these marginalised rural areas is likely to have a positive impact on their livelihoods. The two Green Village demonstration sites that were selected in this study were Mahlabathini and Sinxaku in the uThukela and Jo Gqabi district municipalities respectively.

The approach used by the Green Village project was a participatory action research methodology to encourage the community to actively participate in the project process. In both Mahlabathini and Sinxaku the primary research tool was to run workshops with the community groups. The detailed approach necessarily differed in the two areas. The research focus in Mahlabathini was on green energy piloted in a number of households in the village. In contrast, the Sinxaku research engaged with landscape scale rehabilitation so it was necessary to work at this broader scale. The detailed approaches and outcomes of the two projects are therefore reported in two separate volumes.

This volume (Volume 1) presents the finding of the study based in the Tsitsa catchment. Volume 2 presents the findings from Okhombe. A third volume relating to a Green Village will present the findings of the WRC project K5/2508: Green Village Catchment Management: Guidelines and Training.

3. Summary of Volume 1. Improving socio-economic conditions of the Tsitsa river catchment through landscape greening

The aim of the landscape greening programme was to address land degradation and increase land productivity in the Sinxaku villages. The primary focus of the Green Village research in Sinxaku was to identify opportunities for improved livelihoods and to develop feasible business plans to support entrepreneurship based on landscape greening activities. This required that the team work closely with community members to learn from them what their needs were and what opportunities and constraints existed to support entrepreneurship. This required a research approach based on social learning through participatory research in which learning coevolved between the researchers and the community.

Chapter 1

Chapter 1 reviews the project's aims and objectives and positions it within the WRC's Green Village Lighthouse.

Chapter 2

Chapter 2 describes the research approach used to engage with the Sinxaku communities and itemises the various activities. In total 14 workshops and meetings were held to build the capacity of the youth and women on sustainable interventions for landscape greening.

The first step was a meeting with the village headman and community members to introduce the Green Village project and obtain an agreement to work in Sinxaku. This was followed by a workshop in which the Green Village Project was introduced to the broader community. A committee was formed with the election of 18 members. Perceptions of land degradation were identified as well as historical factors responsible for degradation and possible future actions to combat erosion. Capacity building of community members was built in a rehabilitation workshop in which mapping of erosion features took place and key areas for interventions were identified.

Two key points emerged:

1. Bring back the ranger system and develop a set of rules that will protect the land and reduce erosion.
2. Work closely with the NRM to receive employment by working on reducing erosion and rehabilitating the dongas.

Due to the protracted nature of implementing the DEA-NRM's on-ground activities in the Sinxaku area it was decided to work independently of that project. In response to the articulated deed for improved grazing management we started to work with livestock owners to develop a grazing plan. This led to collaboration with Environmental Rural Solutions and Meat Naturally Pty from Matatiele. We also started to develop skills in rainwater harvesting at the garden scale to enhance the productivity of food gardens. Initially we worked with the Green Village Committee and later with two Community Works Programme (CWP) garden groups. This led to a second business opportunity of starting vetiver nurseries.

A further activity was an environmental learning programme linked to the Lower Sinxaku Primary School, described in detail in Chapter 6.

Chapter 2 also presents a list of guidelines for working with communities, based on our own experience and from a review of literature. The principles can be grouped under those which relate to engagement with the local community and those relating to the wider community. The local community engagement principles are also grouped under the procedure (what to do) and the process (how to do) that should be followed. Figure 2.5 summarises the key points. Recognising that community engagement processes takes time and patience is key to a successful project.

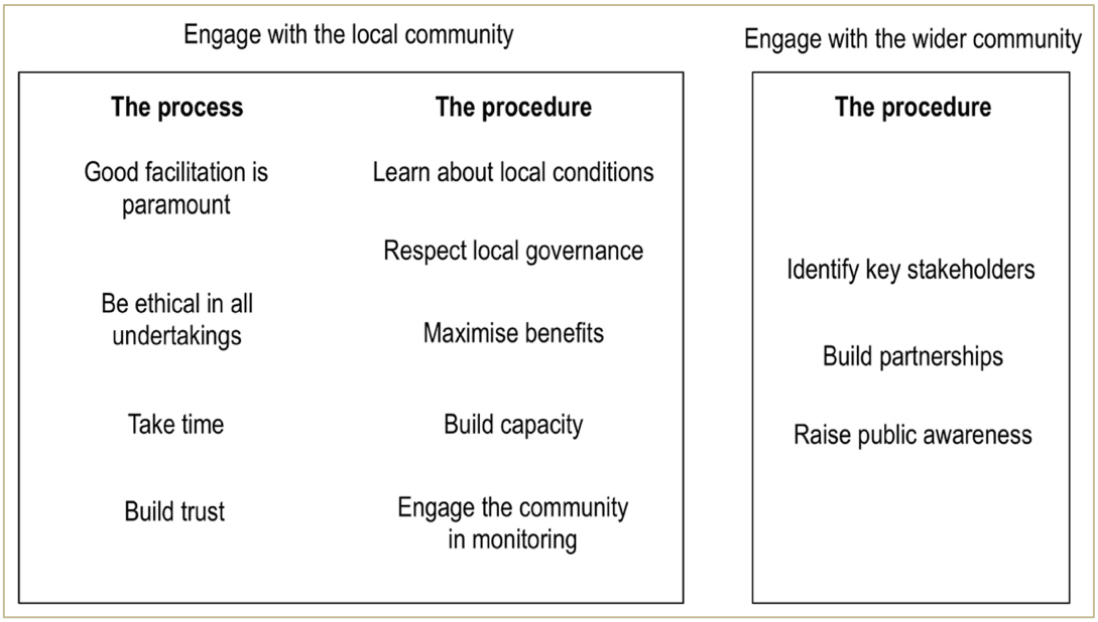

Figure 2.5 Principles of community engagement

Chapter 3

Chapter 3 describes the geographic and historic context of the Sinxaku area. According to the 2011 census the two villages comprise 1781 people living in 500 households. The population is spread more or less evenly between Upper and Lower Sinxaku. Females comprised 53% of all people in the Sinxaku area in 2011. There is a sharp drop in the age cohort for both sexes from 25 to 44, the economically most active group. Migration to cities and mines has for many years depleted the rural male working population; since 1994 women have been able legally to join their husbands in urban centres. Household income levels are low. Of the working age population, 28% was categorised as unemployed but a significant proportion (61%) stated that they had chosen not to be employed. Social grants represent a significant cash injection into the community.

The prevalence of land degradation is explained in terms of both environmental and historical factors. Steep slopes, highly variable rainfall and highly erodible, dispersive soils characterise a landscape that is highly vulnerable to erosion. Government policies, during the colonial, Apartheid and post-Apartheid period, have in turn affected how people have used the land (land use) and how this use has regulated (governance). The interconnections within the Sinxaku social-ecological systems are portrayed in Figure 3.8. Our research uncovered a strong desire among community members to reinstate an effective governance system to regulate the use of natural resources, especially grazing land. The relationship between this project and the DEA-NRM's rehabilitation project and the Ntabelanga and Lalini Ecological Infrastructure Project (NLEIP) is discussed. Our research fits well within the vision of NLEIP which is "*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.*"

Chapter 4

Chapter 4 provides background to the soil erosion processes that drive land degradation and presents an overview of remedial actions that can reduce sediment loss from the landscape. The serious erosion hazard presented by dispersive duplex soils is stressed. Warnings are given against relying on structural interventions that provide a short term solution and can, in some cases, aggravate the problem. The use of managed grazing to restore the vegetation cover is emphasised.

A simple geomorphic model based on source, pathway and sink zones is proposed as the guiding principle for rehabilitation. In all cases, the dynamic nature of the sediment system must be recognized. Rehabilitation needs to work with the direction of change that the system is undergoing, targeting areas where there is a risk of or potential for crossing a geomorphic threshold. Moderate to steep slopes with a poor vegetation cover are at risk of becoming source zones. Wide gully floors have the potential to become sink zones. Such areas are likely to give a greater return for investment than a bare surface with thin soils or an actively eroding gully.

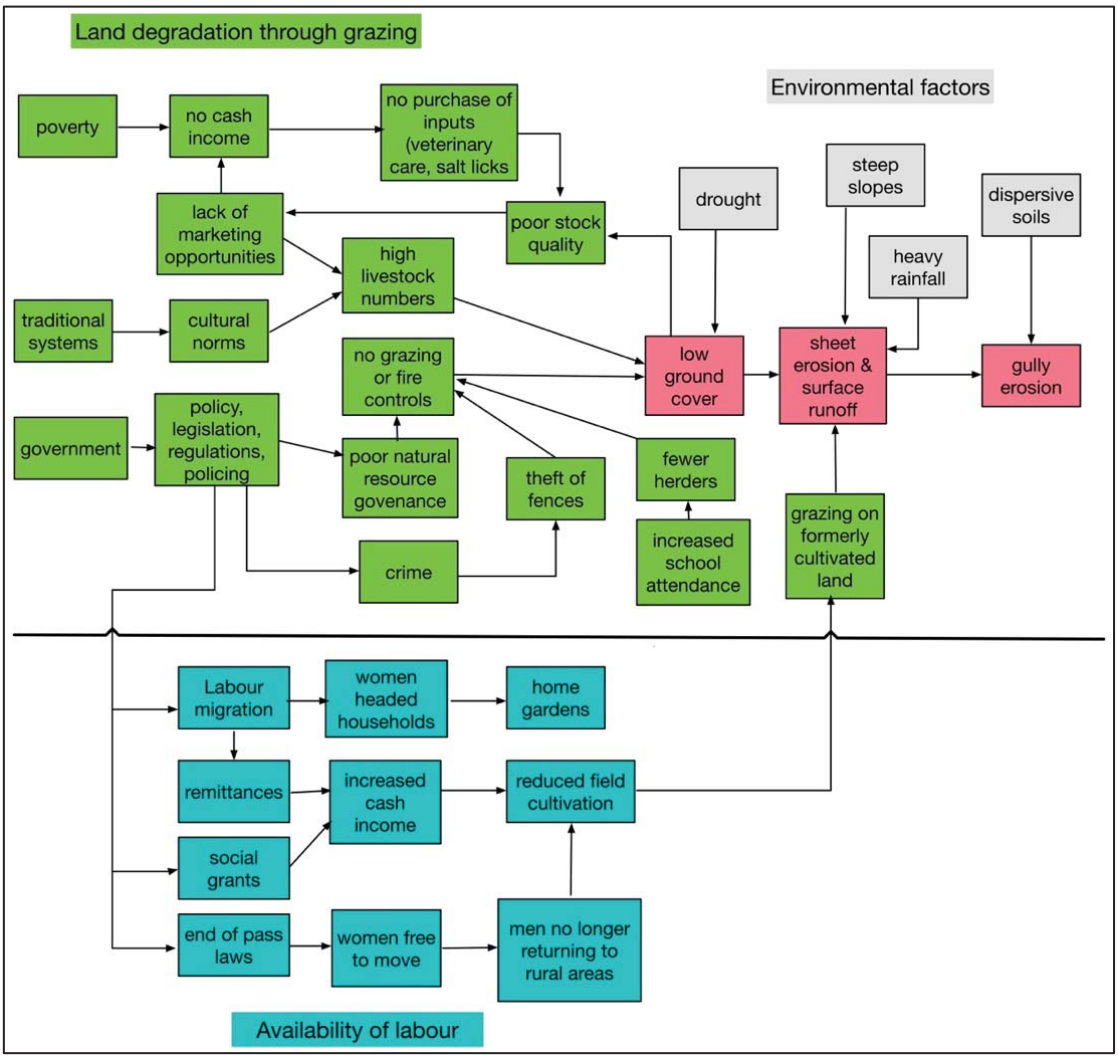

Figure 3.8 Environmental and socio-political factors leading to land degradation

Chapter 5

Chapter 5 details the outcomes of our activities in the Sinxaku area. The three main activities that were promoted in Sinxaku to build capacity, develop skills and provide opportunities for employment were (i) the catchment rehabilitation project run by the Natural Resource Management (NRM) division of the Department of the Environment (DEA), (ii) skills training in increasing food productivity through rainwater harvesting, and (iii) engagement with livestock owners to develop a more sustainable livestock industry utilising controlled grazing and marketing. All three approaches were designed to support locally-based livelihoods integrated with soil and water conservation. Figure 5.17 summarises our key recommendations as to how our proposed interventions can support the goal of NLEIP to rehabilitate the catchment through restoring the ecological ecosystem and the social system.

Business opportunities related to vetiver growing and livestock are given in Appendices A and B.

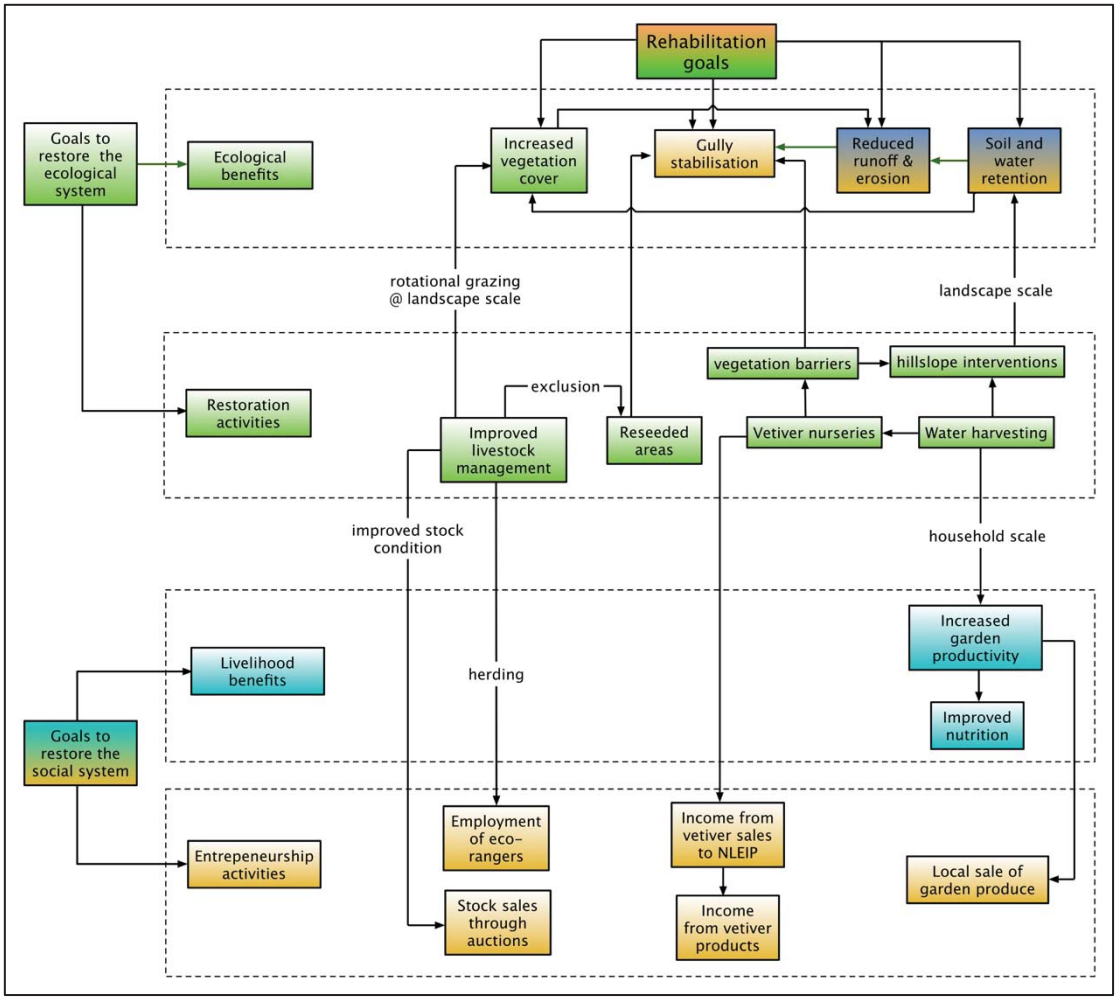

Figure 5.17 Integrated solutions to the restoration of socio-ecological systems

Chapter 6

Chapter 6 describes the education programme that was developed and implemented with the Lower Sinxaku Primary School. Learners were introduced to the basic principles of permaculture and its advantages. Further workshops and demonstrations were held at the school in which the principles of water harvesting were applied to the school vegetable garden for food provision. A litter clearing campaign was undertaken. A small group of children attended a learning programme at the Hogsback Earth School where they engaged with a farmer practicing holistic grazing, tree planting through the Hogsback Cape Parrot Project, swale building for water harvesting, as well as a number of reflective activities concerning the value of the environment.

Chapter 7

Chapter 7 addresses the two research objectives 6 and 7:

6. Integrate the green solutions tool box and business framework with core line function government departments in order to ensure sustainability of the intervention and to forge partnerships with all key stakeholders.
7. Develop models on how to expand the green tool box of solutions and business framework utility, from household/village to the national or country-wide scale.

Key government department to whom this research is relevant are detailed in Figure 7.1 The local municipalities are key role players as they already engage with and receive support from relevant provincial and national government departments. The Integrated Development plans (IDPs) of Elundini and Mhlontlo Local Municipalities already provide some potential support for our proposed business opportunities. Elundini especially recognises the need to address land degradation through their Environmental Action Plan. Both municipalities stress the need to support agriculture with the help of the Eastern Cape Department of Rural Development and Agricultural Reform (DRDAR) and the Department of Rural Development and Land Reform (DRDLR). The Eastern Cape COGTA is a key player in bringing communities and traditional authorities in to the spatial planning process and makes important input into municipal IDPs and Spatial Development Frameworks (SDFs).

The DEA-NRM rehabilitation project and the associated NLEIP provide an appropriate framework both for integration with core line function government departments and for upscaling from the village to the catchment, basin and national scale. NLEIP is designed as a research and management partnership. The DEA is its primary funder but the programme provides a platform for involvement by a wide range of stakeholders from local and national government, NGOs, research institutions and private individuals. The process of upscaling from household to national scales is illustrated in Figure 7.2.

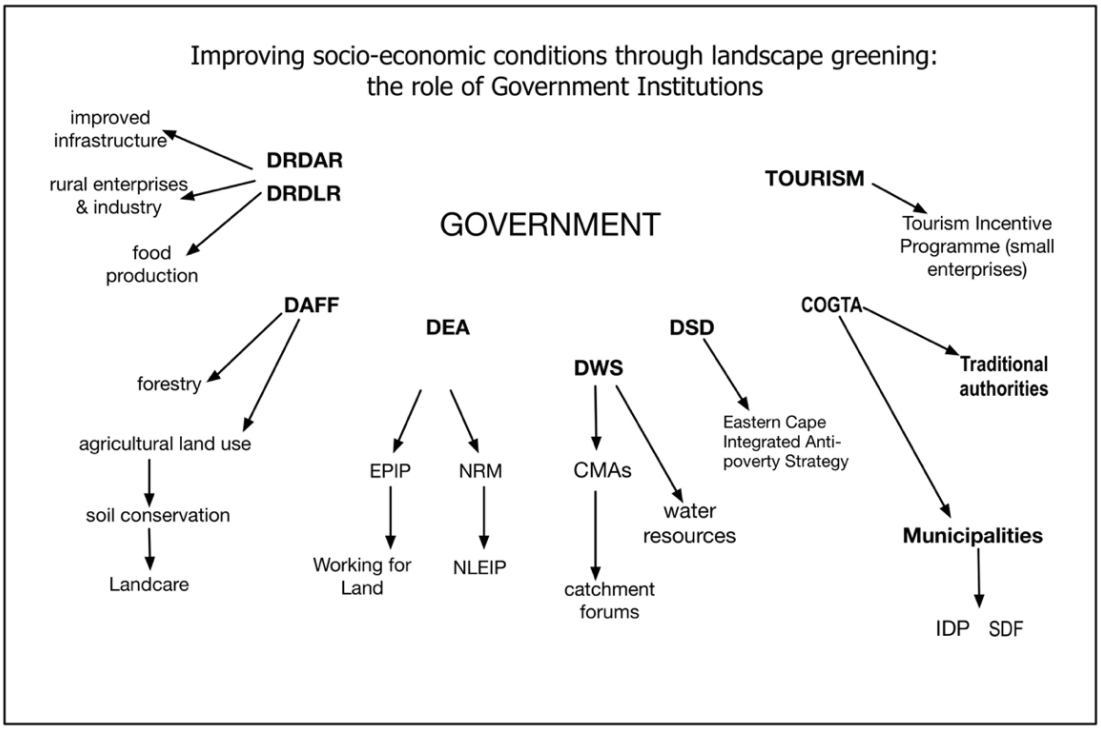

Figure 7.1. Integrating landscape greening livelihood options into government core line activities.

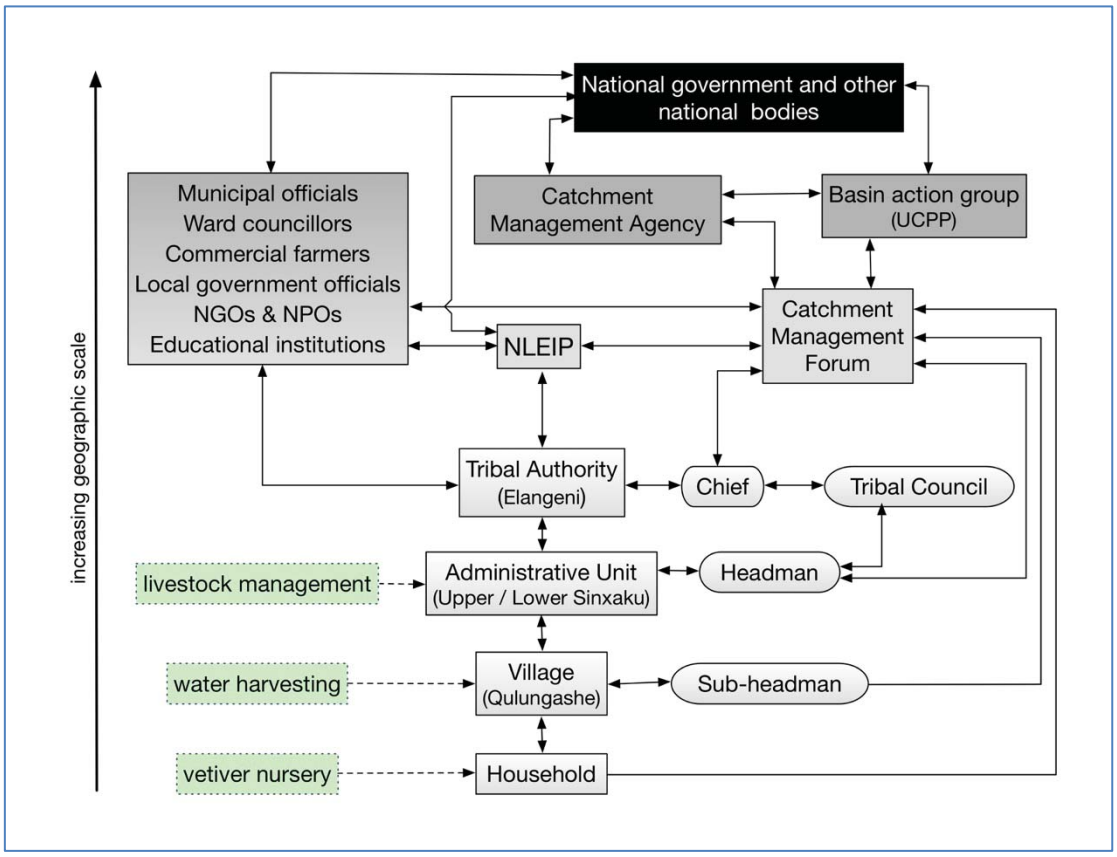

Figure 7.2 Upscaling from the household to the national scale. Local interventions are shown in green boxes. Darker shading indicates a higher level scale. Names in brackets refer to examples relevant to the Sinxaku Green Village project.

Chapter 8

Chapter 8 is the concluding chapter in which the findings are discussed in relation to the seven project objectives. The extent to which the project has contributed to the WRC's Green Village Lighthouse is also discussed. Recommendations are made for bringing together rehabilitation and livelihood opportunities. Suggestions are made for further research.

4. Review of Research Objectives

The implementation of the project achieved the following outcomes in relation to the objectives of this project:

1. ***Identify drivers of poverty, opportunities offered by natural ecosystems, and develop a community-based vision of a Green Village using a bottom up approach.***

The green village concept was introduced at Sinxaku using drama in which the different roles of the researchers, rehabilitation implementers and community members were played out. Group discussions were then held to identify what the community would like to gain from the green village project. These ideas were discussed in an open forum and feedback was given on the extent to which the Green Village project could facilitate these. The expressed need for erosion control, better livestock management and improved land productivity were all in line with the scope of the Green Village project but provision of taps and upgrading was not. It was stressed that the goal of the Green Village project was to work together with the community to achieve longer lasting sustainable practices that would contribute, in the long run, to

reduced erosion, improved soil, improved land for agriculture and livestock as well as informed and environmentally educated children.

Drivers of poverty included a landscape that is prone to erosion and at risk to drought and floods, unreliable rainfall and lack of employment opportunities.

Chapter 3 describes the findings for this objective in more detail.

2. ***Through integration of indigenous knowledge, green innovations, research, and technology, develop a tool box of green solutions that can address the impact of climate change and help communities or sectors to adapt to climate change.***

This was the focus of the Okhombe project where a tool box of green solutions was developed with the community to incorporate indigenous knowledge:

3. ***Identify and develop a business (economic) framework that poor and local communities can use to improve their livelihoods without furthering land degradation.***

In Sinxaku a proposed business framework was developed for two proposals: vetiver nurseries and livestock management and vetiver nurseries as described in Chapter 5. Although the proposals can be put to a number of funding agencies, the DEA-NRM rehabilitation project is seen as the agency through which funding should be sought. The proposals are designed to directly support the rehabilitation activities.

4. ***Develop and test practical and appropriate mechanisms, manuals and guidelines for landscape development and management that will protect the infrastructure and improve ecosystem services.***

Chapter 5 describes the land degradation process and presents recommendations for rehabilitation based on sound geomorphic principles but it does not set out to be a stand-alone guideline. The reader is directed to a number of existing guidelines, including that being developed through the WRC project K5/2508 (Volume 3 of the Green Village series).

A handbook entitled “Ukuphilisa umhlaba wethu ukwakha ikamva elingcono” (Healing our land for a better future) has been compiled as a guide to assist rehabilitation efforts in the Tsitsa catchment and other similarly degraded areas. It is aimed at community members and other stakeholders who would like to understand why land degradation occurs and to learn some of the ways that degradation can be addressed by active interventions to improve ecosystem services. The guide is in English and isiXhosa.

A similar guide to water harvesting has been prepared.

Through the Sinxaku Project a number of learning resources were developed. These include practical guidelines for landscape greening, water harvesting, integrated rehabilitation and grazing and a set of school resources linked to the primary school curriculum. These can be adopted and adapted by a wider community at all scales from individuals in household to national policy makers.

5. ***Train communities (mainly the youth) on appropriate skills/capacity necessary to sustain the businesses and ecosystem services that transform the poor community to be more self-sufficient.***

In the green landscaping project 14 workshops were held to build capacity of community members on rehabilitation techniques, water harvesting, livestock management and marketing, and establishing vetiver nurseries. These skills have the potential to increase the income earning potential of the community. The handbooks and learning resources described under 4.4 are designed to aid capacity building.

6. ***Integrate the green solutions tool box and business framework with core line function government departments in order to ensure sustainability of the intervention and to forge partnerships with all key stakeholders.***

This objective is covered in Chapter 7 as described above. For the green landscaping project there is potential to integrate the learning from this project into a number of government departments, the private sector, NGOs, NPOs and so forth.

The NLEIP project, outlined in Chapter 3, provides an appropriate framework both for integration with core line function government departments and for upscaling from the village to the catchment, basin and national scale. NLEIP is designed as a research and management partnership. The DEA is its primary funder but the programme provides a platform for involvement by a wide range of stakeholders from local and national government, NGOs, research institutions and private individuals. We have made a significant contribution to the adaptive management and restoration plan (NLEIP, 2017).

An important non-government partnership has been with ERS and Meat Naturally Pty, based in Matatiele. As core members of the UCCP this provides opportunity to share experiences with the wider Mzimvubu community.

7. ***Develop models on how to expand the green tool box of solutions and business framework utility, from household/village to the national or country-wide scale.***

This objective is also covered in Chapter 7. In Sinxaku the project initiatives (vetiver nurseries, water harvesting and livestock management) were at the scale of the household, village group and Administrative Area. To achieve sustainable livelihoods at the catchment scale and more broadly within South Africa, these need to be upscaled through formal governance structures at the Tribal Authority level, forums (in this study the Tsitsa catchment forums), basin-wide such as the uMzimvubu catchment Partnership Programme (UCPP), and at national level through relevant government departments as identified through Objective 7.

NLEIP is a catchment-wide programme so there are immediate and continued opportunities for upscaling learning from the Sinxaku project. A Catchment Management Forum (CMF) has the potential to be an effective governance structure through which local people can collaborative to contribute to decision making over the co-management of land and water at a catchment scale. According to the National Water Act of 1998 a CMF is a non-statutory body. However, it would still provide a platform for addressing local concerns and provide a conduit for information between the CMF and regional Catchment Management Agency (CMA).

All decisions on livestock management (e.g. a change in the rules for how many stock can be owned, where stock can graze and at what time) in Sinxaku, need to be sanctioned by the Tribal Council that represents all Administrative Areas in one Tribal Authority. This provides an opportunity for sharing ideas and experiences among different groups in the area and therefore of upscaling innovations. In the case of marketing cattle through auctions, many villages in the proximal area can participate even though the livestock association responsible for the auction may be from one local area.

5. Conclusions and Recommendations

5.1 Overview of project outcomes: opportunities and constraints

The underlying research question guiding this project was ‘how can village residents and the wider village community benefit from and bring benefit to the DEA-NRM’s rehabilitation project?’ The project team sought to engage with the community to explore ways in which landscape greening could enhance their livelihood well-being. Four options were explored, rainwater harvesting for food gardens, vetiver nurseries, managed grazing and auctions for livestock production and a school environmental learning programme. Given the time frame and available resources we were not able to carry any of these through the point where they were adopted fully by the community but we have been able to demonstrate their potential for

integration into a rehabilitation project. Interest has been generated and relevant skills developed. Livestock owners are at the point where they can start to engage with the broader community and external agencies in order to move forward.

A project such as this one, where we were working closely with the community to develop the research, takes considerable time to achieve its goals. Within the constraints of the project's terms of reference these goals must be adaptable, depending on the needs revealed by the community. These are not necessarily, and in fact are unlikely to be, the same for everyone. Our own goals changed from working more closely with the DEA-NRM project to working with individual community groups who were not part of the DEA-NRM project. Only in the very last stages were we in a position to bring the different strands together.

Trust is stated by many researchers to be at the core of successful community engagement. Our own experience bears this out. In the context of this research trust has been a five-way process. Firstly, there is the trust between community and researchers. This has to be built up slowly as the research proceeds. It was important from the start to be open about our agenda and not to be seen as a development agency. Secondly, there is trust between different community members and community groups. The longer we worked in Sinxaku the more we came to realise that the 'community' is not a homogenous, well-knit group and there is widespread mistrust. Some of this is probably politically inspired and seemed to get worse towards the end of the project as politics heated up at the national level. Thirdly, there is trust within the WRC project research team and, fourthly, between the local project researchers and the NLEIP community. If researchers and managers do not trust each other there will be lack of communication, miscommunication and limited progress. Our own research team came from different disciplinary backgrounds as does the NLEIP community. Finding a common jargon free language is as important as using isiXhosa in a village context. Lastly there is trust between the village community and the rehabilitation implementers. Implementers need to build the capacity of local residents to be involved in the work and to trust them to be responsible.

5.2 Recommendations to Policy, DWS, DEA, DAFF

If an externally imposed rehabilitation project is to be sustainable there must be direct benefit to both the implementers and local communities living in the rehabilitation area. In the case of the DEA-NRM rehabilitation project, the driving motivation for the government implementers is to reduce sedimentation to the proposed dams. Our research has demonstrated that a technical rehabilitation project provides opportunities improved livelihood well-being. Local communities can receive both short term and long term benefits. In the short term there are employment opportunities, which have already been welcomed by Sinxaku residents. The project was also welcomed as a means to tackle erosion, which is perceived by many as a threat to livelihoods and infrastructure. Erosion control and sediment retention can also be linked to increased spring flow and the construction of small-scale water storage areas such as sand dams. These rehabilitation outcomes address longer term benefits.

Other benefits come from integrating rehabilitation with livelihood or income generating opportunities. Those investigated in this project include improving groundcover, livestock productivity and income through controlled grazing linked to market opportunities and integrating soil and water conservation with increased garden productivity and vetiver nurseries. Vetiver is to be sold to the rehabilitation project, thus providing an income earning opportunity and directly assisting the rehabilitation project.

Recommendations regarding working at the local level are as follows:

1. The implementers work with the community at a village level to identify priorities and develop a village scale catchment management plan as recommended by Braid and Lodenkemper (in preparation).
2. Residential areas should be targeted as key source areas for storm runoff and sediment. Stormwater controls can be integrated with rainwater harvesting for food gardens.
3. It will probably be necessary to form a village catchment planning committee to represent the interests of the community. The Green Village Committee would have taken up this function if

there had been significant rehabilitation activity to engage with. Committee structures must be agreed with the Headman and Chief.

4. Identified activities that the DEA can support with immediate effect is to pledge financial and other support for the vetiver nurseries and herders. Herders are necessary to protect rehabilitated areas from livestock; livestock owners are in a position to comply with restrictions.
5. Mechanisms should be put in place to allow flexible engagement of community members in rehabilitation activities. Relying on a person-day formula is restricting.

Generic recommendations from this project can be taken up at the Tsitsa catchment scale and also by other government agencies supporting rehabilitation.

5.3 Recommendations for further research

In a short project such as this one there has been limited opportunity to take the selected options to fruition or to investigate further possibilities. Further research of a technical nature is needed to support the grazing plan. In particular, it will be necessary to do an on-ground assessment of the present grazing capacity, make an inventory of present stock numbers and ownership and develop an agreed grazing strategy. The latter two actions should only take place once there is agreement by the community that this is what they would like to do.

Economic opportunities arising from increased garden productivity can also be investigated further. Sales of vetiver to the rehabilitation project are one option but there are also other vetiver products that can be developed. Specialised skills training would be needed to enable local people to produce the baskets and mats illustrated in Figure 5.15.

Research into the integration of rainwater harvesting and micro-catchment scale rehabilitation interventions should encompass both technical and social aspects of take-up.

Whilst we have explored various options independently, it is necessary to integrate these into one catchment plan that considers how improved grazing, rainwater harvesting and other potential interventions can become a key part of the rehabilitation.

The school learning initiative aimed to develop the capacity of learners to become adults who respect the environment and have the knowledge and capacity to ensure long term sustainability of the rehabilitation and continued improvement of livelihoods in the Sinxaku villages. WRC project K5/2508 will build on this and, hopefully, extend the project to more schools in the area. There are also opportunities for the rehabilitation implementers to engage with local schools and show them nearby rehabilitation activities.

This report has not made explicit the links to climate change. However, water harvesting and improved veld condition both add to increased resilience against climate shocks. Soil carbon stocks can also be improved, mitigating increased atmospheric carbon. This presents an opportunity for entry into the carbon offset market. Payment for Ecosystem Services is another option that can be explored.

Further research is needed to uncover impediments to or catalysts for change. In a community where the young and enterprising have tended to leave for opportunities elsewhere, what can motivate those that stay behind to adopt new practices? What are the barriers within a community that prevent positive change? Are the recommended changes in fact positive? We do not want to repeat the negative consequences of Betterment Planning.

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Mr G Mguire	Project 90
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Dr W Roets	DWS

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LIST OF ACRONYMS

CAPS	Curriculum Assessment Policy Statements
CHAT	Cultural Historical Activity Theory
CMA	Catchment Management Agency
CMF	Catchment Management Forum
COP	Community of Practice
CSA	Conservation SA
CSI	Corporate Social Investment
CWP	Community Works Programme
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of the Environment
DEAT	Department of Economic Affairs and Tourism
DRDLR	Department of Rural Development and Land Reform
DST	Department of Science and Technology
DWS	Department of Water and Sanitation
EPIP	The Environmental Protection and Infrastructure Programmes (Chief Directorate of the DEA)
EPWP	Expanded Public Works Programme
ERS	Environmental and Rural Solutions
GIB	Gamtoos Irrigation Board
IDP	Integrated Development Plan
IMSC	Information Management & Sector Coordination (Chief Directorate of the DEA)
INR	Institute for Natural Resources
KZN	KwaZulu-Natal
MNP	Meat Naturally Pty
NAP	National Action Programme
NEAP	National Environmental Action Plan
NGO	Non-Government Organisation
NLEIP	Ntabelanga and Lalini Ecological Infrastructure Project
NPO	Non-Profit Organisation
NRM	Natural Resource Management (DDG Branch of the DEA)
SES	Social-Ecological System
SIP	Strategic Infrastructure Programme
SMME	Small Medium or Micro Enterprise
UCPP	Umzimvubu Catchment Partnership Programme
WRC	Water Research Commission

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CHAPTER 1. INTRODUCTION

1.1 Scope of the project

In South Africa ongoing land degradation of catchment areas is on the increase. The natural resource base, particularly in communal areas, is in decline. It is estimated that close to 18 percent of the natural land cover in the country has already been transformed (DEAT, 2008) and environmental degradation is visible in some areas impacting negatively on water resources. Poor land use management in our catchment areas can increase sediment in reservoirs, rivers and estuaries, linked to loss of topsoil. Inappropriate land use can also perpetuate changes in surface runoff and infiltration capacity of the soil leading to flood events, reduction of groundwater recharge, increasing pollution, loss of biodiversity and broadly reduce the resilience of the system and its assimilative capacity to cope with changes and uncertainty such as climate change risks. Furthermore, land degradation can have other implications such as financial costs and negative all round effects. It is estimated that soil degradation alone costs South Africa an average of nearly R2 billion annually in dam sedimentation and increased water treatment costs (DEAT, 2008). Over and above these threats, the loss of healthy catchment ecosystems impacts on rural livelihoods directly dependent on the natural resources (e.g. agriculture) and thus perpetuating the poverty cycle in these areas.

In addition to the anthropogenic land use changes and associated environmental risks described above, South Africa, with an average annual rainfall of 465 mm and a history of deep inequalities regarding the distribution of both land and water, is also faced with water scarcity risks (Kahinda *et al.,* 2008). These inequalities affect particularly the rural poor who have limited access to water (Van Koppen and Schreiner, 2014). Although measures are put in place to address these inequalities, the reality is that water supply-demand levels are not being met as most of the water in the country has already been captured, stored and allocated to users while leaving a good proportion of people as "water poor". At the same time, it is recognised in the National Climate Change Response White Paper (NCCRWP) (RSA, 2011) that increasing vulnerability to climate changes will affect agriculture and food security, particularly in smallholder farming communities heavily dependent on rain-fed agriculture as their main livelihood due to the fact that other opportunities are still limited in rural South Africa.

A growing response to this challenge points to the increasing interest in developing a Green Economy in the country as an approach to generate jobs, improve livelihoods and reduce vulnerability to the risks posed by climate change. Green economy strategies can not only boost a country's economic growth, but also improve socio-ecological resilience, transformation and ultimately contribute to a more equal state. A move from current green economy practice to one of fostering a developmental state is required (Death, 2014).

The project reported on in this document falls under the Water Research Commission's (WRC) Green Village Lighthouse. This is a long-term programme that is committed to demonstrate how the green economy can be achieved in marginalised areas of rural South Africa, improving human well-being while at the same time reducing environmental risks. A green economy is thus one which acknowledges the economic value of intact ecological infrastructure. The project envisages that the programme will look for practical models that can be applied at a wide range of scales from the household and village to the catchment and nation. These models must address the basic needs of marginalised communities, creating economic opportunities that are integrated with the mainstream economy without negatively impacting on the ecological infrastructure that provides the support base for household economies and catchment scale resources such as water. To quote the WRC's web site "The GV goal is that of a knowledgeable rural community in which a

healthy ecological infrastructure is maintained, which practises sustainable and productive agriculture, and utilises renewable energy." (Water Research Commission 2017).

In their web site (Water Research Commission 2017) the WRC provide a list of strategic objectives (see Box 1.1), envisaged outcomes (see Box 1.2) and actions (see Box 1.3) designed to achieve the goal of the programme. These have informed and guided the research as set out in this report. The WRC stress that the focus of research is on the generation of new knowledge, testing and providing knowledge to the implementers (Government/society).

Box 1.1 Strategic objectives

- Develop an integrated framework for rural development that benefits communities with minimal risks to environment
- Improve livelihoods through measurable healthy living conditions
- Improve water ecosystems, and food and energy security
- Improve human health and dignity through adequate sanitation and solid waste management
- Build a knowledgeable society with improved competency for integrated catchment management and development
- Support job creation, local economic empowerment and development.

Box 1.2 Outcomes

- A community receiving basic needs, transformed and greatly self-sufficient living in harmony with the environment
- Adaptable framework outlining how community traditions, government policies, and business principles in collaboration can result in improvement of livelihoods
- Tested guidelines for the integration of research products, and green technologies leading to economically viable job creation and markets
- Social, economic and environmental learning which leads to resilient systems and green rural societies

Box 1.3 Actions

- Initially focus on the research portfolio and analysis level in an attempt to establish needs/possible tools for solutions
- Secure developmental models and scenarios
- Identify possible science and technology interventions
- Demonstrate what the integrated approach can achieve, and market the idea to implementers/funders
- Develop models for up-scaling the framework for implementation
- Look for innovative solutions at a small scale with potential for IP/beneficiation
- Support entrepreneurship and green job creation

1.2 Objectives and aims

The aims of this project were to:

1. Identify drivers of poverty and opportunities offered by natural ecosystems, and develop a community-based vision of a Green Village using a bottom up approach.
2. Through integration of indigenous knowledge, green innovations, research, and technology, develop a tool box of green solutions that can address the impact of climate change and help communities or sectors to adapt to climate change.
3. Identify and develop a business (economic) framework that poor and local communities can use to improve their livelihoods without furthering land use degradation.
4. Develop and test practical and appropriate mechanisms, manuals and guidelines for landscape development and management that will protect the infrastructure and improve ecosystem services.
5. Train communities (mainly the youth) on appropriate skills/capacity necessary to sustain the businesses and ecosystem services that transform the poor community to be more self-sufficient.
6. Integrate the green solutions tool box and business framework with core line function government departments in order to ensure sustainability of the intervention and to forge partnerships with all key stakeholders.
7. Develop models on how to expand the green tool box of solutions and business framework utility, from household/village to the national or country-wide scale.

Together, these aims were to meet the more general goal of demonstrating how integrated green innovations and technologies can be utilised to create entrepreneurship/jobs that improve the economic conditions of communities living in marginalised rural areas. The location of the research was stipulated as Okhombe in KwaZulu-Natal and Ntabelanga (Tsitsa catchment) in the Eastern Cape, within the uThukela and Jo Gqabi District Municipalities respectively.

1.3 The Green Economy and the Green Village concept

The DEA views the green economy as a sustainable development path based on addressing the interdependence between economic growth, social protection and natural ecosystems. Green economy programmes should be supported by practical and implementable action plans. The DEA defines the Green Economy in the South African context as a "system of economic activities related to the production, distribution and consumption of goods and services that result in improved human well-being over the long term, while not exposing future generations to significant environmental risks or ecological scarcities" (DEA, 2017 About Green Economy). Their definition of green jobs includes those in agriculture that contribute to preserving or restoring environmental quality, protect ecosystems and biodiversity as well as reduce energy, materials and water consumption. The National Strategy for Sustainable Development and Action Plan (NSSD 1) approved by Cabinet in 2011, built on the previous South Africa National Framework for Sustainable Development of 2008. NSSD 1 has the following five strategic objectives:

- Enhancing systems for integrated planning and implementation
- Sustaining our ecosystems and using natural resources efficiently
- Towards a green economy
- Building sustainable communities
- Responding effectively to climate change.
- (DEA 2017 National Strategy for Sustainable Development and Action Plan)

The name of the WRC's Green Village Lighthouse implies that these objectives are to be achieved at the scale of the village (a Green Village). Internationally, the term Green Village has been used synonymously

with Eco-village, which often has rather different connotations than those promoted by the DEA and The Green Village Lighthouse. It is therefore appropriate to situate the research in this project in the international literature on green villages so as to compare differences and similarities.

Much of the Green Village literature advocates sustainable living that is detached as far as possible from the main stream economy (Takeuchi *et al.*, 1998; Garden, 2006; Siracusa *et al*., 2008; Kasper, 2008; Trier and Malboroda, 2009). Green Villages or Eco-Villages tend to be a developed world concept and often have an urban base. The models presented in the literature are therefore not directly applicable to rural villages in the former homelands of South Africa. The general principles, however, can be adapted so that researchers and entrepreneurs can address society's urgent challenges in these areas.

A more relevant model is provided by Agarwal and Narain (1992) who discuss the role of Green Villages in promoting participatory rural development in India. Their focus is on improving the productivity of the land through ecologically sound farming practices. They explain the destructive impact that environmental degradation has had on poverty stricken communities in India and stress the need for an integrated approach that involves the rural communities in more sustainable land management. Agarwal and Narain (1992) explain that, in order to achieve ecological sustainability, one cannot use the methods of developed western countries and stress the importance of Indigenous Knowledge in designing new agricultural systems. Agarwal and Narain (1992) advocate that the most effective path for rural Indian villages to achieve sustainable development and fight poverty is through the increase in production of biomass using sustainable, highly productive systems, "not technological innovations which give bumper yields today but diminish the future by degrading the natural system on which biomass production depends" (Agarwal and Narain, 1992, p. 53).

There are a small number of Eco-Village / Green Village projects underway in South Africa. Most of these have an urban context: the Rainbow Homestead Sustainability Commons located close to Cape Town (retrieved from: http://genoa.ecovillage.org/), the Gqunube green eco-village project near East London and the Lynedoch eco-village in Stellenbosch. The Tsilitwa eco-village project, located near Qumbu in Mhlontlo Local Municipality in the Eastern Cape, is the only one in a rural setting comparable to either Sinxaku or Okhombe. Tsilitwa is typical of an ill-resourced, impoverished community situated in the degraded landscape of the former homeland of the Transkei. It is therefore worth examining this case study in some detail as it provides useful lessons for the WRC's Green Village Project.

The Tsilitwa Sustainable Village was set up by Sustainable Villages Africa (Pty) (SVA) with R9.5m funding from the Department of the Environmental Affairs and Tourism (DEAT) and the Dutch Government (Holmes, 2006). Sustainable Villages South Africa put a strong emphasis on the importance of providing access to electricity and improved water supply in order to revitalise the economy. They recommended that human and animal waste be used to generate energy for local use. The Tsilitwa project targeted home gardens for food crops using permaculture techniques. Training in conservation farming concepts and techniques was facilitated by the Tsolo Agricultural Development Institute. A cooperative was established so that farmers could share equipment and other facilities. Holmes (2006) concludes that the early success of the project depended both on external intervention and funding and the adaptation of traditional farming methods to ensure community acceptance. Holmes (2006) also believes that a truly successful eco-village or sustainable village, "includes a strategy to place vulnerable communities in the position where they can fund their own development with the minimum of infrastructure," (Holmes, 2006, p. 16) and this is what the Tsilitwa sustainable village strove to achieve.

A rather different picture of the Tsilitwa Sustainable Village Project is painted by Qotywa (2011) who visited the village after DEAT funding had stopped, four years after the start of the project. His aim was to investigate its long-term sustainability. He found that of the four project activities that had been initiated –

the cooperative, a guest house, improved water supply and garden cultivation – only gardens were still in operation. There was suspicion over the management of the cooperative, the guest house was dysfunctional, Eskom had cut off the electricity supply to water pumps due to non-payment and water had to be fetched from the river three kilometres away. It became increasingly difficult to get people to come to meetings. Despite these drawbacks the project was seen to have some positive outcomes: short-term job creation, skills development including better husbandry, increased food availability, with a greater range of food crops grown, increased unity within the community and an increased sense of personal responsibility. A post office was also built in the village. Some unintended negative consequences were also noted. These include jealousy within the village over the selection of pilot households and jealousy from surrounding villages regarding the project as a whole. Short-term employment also had its negative aspects, with the repossession of furniture, increased house break-ins and an increase in the number of taverns. There is no mention by Qotywa (2011) of the renewable energy initially advocated by SVA so one can only assume that this never got off the ground.

The main problem identified by stakeholders interviewed about the project was insufficient funding. Reasons given included a genuine shortfall of funds but also mismanagement. There was concern that the implementing agency took a disproportionate share of the funds in consulting fees. Both the DEAT and the Community Development Forum believed that continued funding is needed to sustain the project. Jacobs (1997) pointed out that a village on its own cannot provide basic infrastructure such as roads, reticulated water and sewerage, electricity and so on. He therefore concludes that sustainable communities must have state support to be viable.

A lack of cooperation between different government departments was also cited as a reason for poor project performance. There was minimum involvement, if any, of Agriculture, Water, Energy or Trade and Industry and a lack of commitment from the local municipality.

A third problem identified by some interviewees was that the role of community members in the project was not made clear. The implementation was top-down, with the community being beneficiaries and wage earners rather than real decision makers. They also saw the project as being a “one-man show” run by the ward councillor. Clearly this is not a good recipe for a sustainable community led project.

Through his research Qotywa (2011) also gained insight into how the community of Tsilitwa perceived a sustainable community. The three components seen to be most important were, first and foremost, productive agriculture and accessibility to local markets followed by basic services in the form of water and electricity and good health and education facilities. Missing from all responses was any concern for the environment.

The residents of Tsilitwa do not, on the whole, choose to live there. They are there as a result of historical forces and settlement by their forebears. The need to work together as a forum and community, employing sustainable food production techniques, was not driven by ethical choices but by desperation (Holmes, 2006). By adopting the interventions and practices recommended by outside agencies they hoped to improve their living standards.

Trier and Maiboroda (2009) note that there are many different models of eco- or green villages that are context specific and “a single sustainability blueprint does not exist, and each community has to find its own way” (Trier & Maiboroda, 2009, p. 819). There are, however, a number of commonalities that include:

1. The village must be a coherent entity within which a sense of community or belonging can develop.
2. Community members, including youth, should be integral to decision making.

3. Economic and social development should not be at the expense of the natural environment.
4. The community should be self-reliant as far as is practical, with their activities having a minimum ecologic footprint. This can be achieved by:
    a) sustainable living in terms of renewable energy, waste recycling, rain water harvesting, energy efficient building;
    b) ecologically sound permaculture practices that promote local food production.
5. Health and education programmes should be an integral part of development.

As discussed by Qotywa (2011) for the Tsilitwa village case study, funding is an important issue. Clearly in the long-term a sustainable village should be self-sufficient and should not rely on external funding, but to kick start the process investment is required over a considerable time period, especially in poor communities.

The WRC Green Village initiative can be critiqued against the criteria listed above. As noted by Holmes (2006) village communities in rural South Africa act out of a basic survival need rather than an ethical desire for sustainable living. South African rural villages traditionally may appear to have a strong sense of community that can be used to build a participatory basis but underlying tensions may thwart a common vision. We are not working with wealthy consumers who have a desire to "get back to nature"; the Tsitsa and Okhombe communities are well aware of the vagaries of nature and would rather find ways to buffer its effects on their livelihoods. Improved livelihoods in the villages depends on increased connectivity with the outside world, not less. We therefore need to find an acceptable balance between facilitating sustainable practices within the villages and the need for village communities to engage with external agencies and markets. As noted in their web site the WRC states that a Green Village must create economically active communities that are integrated into the mainstream economy.

1.4 The research villages

Villages in the former homelands of the Transkei and Zululand are characterised by high unemployment, low household incomes and limited access to basic services such as piped water and reliable energy for heating, cooking and lighting. Reliance on locally produced food has declined as soils have become impoverished and income from social security provides an alternative, and possibly more reliable means to access staples. There is therefore great potential for improving living standards through the adoption of green technologies and greening of the landscape through soil and water conservation.

The research in this project was carried out in two villages in the headwater catchments of the uThukela and uMzimvubu rivers, specifically the Tsitsa river above the proposed Ntabelanga Dam. Both villages are located in former homelands. The village selected in the Tsitsa catchment comprised the two tribal Administrative Areas of Upper and Lower Sinxaku, hereafter referred to as the Sinxaku villages. They are situated in the Elundini Local Municipality (ELM) of the Jo Gqabi District Municipality (JGDM). The village is located in the foothills of the Drakensberg escarpment at an altitude of ~1000 masl. The catchment is badly degraded as evidenced by widespread soil erosion and the spread of alien invasive vegetation in the upper Tsitsa catchment.

Research into soil conservation and water harvesting has been ongoing in the uThukela catchment (Everson *et al.* 2011). Green technology research by members of the project team has also been carried out in the area. Everson and Smith (2015) developed guidelines on how biogas could be generated using livestock manure and rainwater harvesting. The Green Village project provided an opportunity to extend this research; the project focus in this area was therefore the identification, development and testing of green technologies in the Okhombe community.

In response to anticipated sedimentation problems in the Ntabelanga dam, the Department of the Environment (DEA) initiated a rehabilitation project through their Natural Resource Management programme (NRM) to combat soil erosion in the Tsitsa catchment. This NRM led project aims "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." This is in line with the vision of the Southern Drakensberg Sustainable Development and Conservation Strategy, developed for the Elundini and Senqu Local Municipalities: "Improving the quality of life for all by facilitating sustainable economic opportunities in balance with the environment" (Elundini Municipality, 2016 p. 124). This long-term developmental vision is based on the key principles of improving the quality of life and creating opportunities for local economic development in a manner that is in balance with the environment.

As the Green Village project was to work closely with the DEA-NRM project, the focus in this area was linking improved livelihoods to restoration of ecological infrastructure through soil and water conservation. The two Sinxaku villages lie in the immediate basin of the proposed dam, which was a priority area for the DEA-NRM's rehabilitation. This 'village' was in fact made up of six small settlements, several of which are adjacent to each other and physical boundaries were difficult to discern. The study unit comprised ~500 households, more or less evenly distributed between Upper and Lower Sinxaku.

The research team had no previous engagement with the community and were generally unfamiliar with the area. However, Dr Johan van Tol from the University of Fort Hare, an advisor on the team, had already established a good relationship with the lower Sinxaku community and was able introduce us to the headman. Despite Van Tol's earlier work in the village, it is significant that the Eastern Cape project was not building on any concerns already identified by the community.

Most houses in Sinxaku have a connection to electricity and there were no reports of it being unreliable. According to the Elundini Municipality Integrated Development Plan (IDP) for 2016-17, 94% of households have an electricity connection. Access to water is a bigger problem. There have been a number of funded projects in the two villages: e.g. a poultry project and a Community Works Programme (CWP) garden project. The villages are relatively close to the main tarred road between Maclear and Tsolo (c. 7 km) with taxi service to the two towns, a further 25 km and 28 km respectively. A significant threat or promise to Sinxaku is the Ntabelanga dam, which can bring both benefits and disadvantages. It was generally beyond the scope of this project, however, to take this into consideration.

1.5 Research approach and structure of the reports

The approach used by the Green Village Project applied a participatory action research methodology (Mapfumo *et al.,* 2013). It was important from the start to mobilise and encourage the community to actively participate in the project process as this is likely to cause the community to develop pride and ownership of the project. In both Mahlabathini and Sinxaku the primary research approach was to run workshops with the community groups. The detailed approach necessarily differed in the two areas. The research focus in Mahlabathini was on green energy piloted in a number of households in the village. In contrast, the Sinxaku research engaged with landscape scale rehabilitation so it was necessary to work at this broader scale. The detailed approaches and outcomes of the two projects are therefore reported in two separate volumes:

Volume 1.	Improving socio-economic conditions through landscape greening, a case study from the Tsitsa River catchment, uMzimvubu basin
Volume 2.	Improving socio-economic conditions of the Okhombe communities through integrated green innovations

A third volume will be based on the WRC project K5/2508: Green Village Catchment Management: Guidelines and Training.

CHAPTER 2. THE RESEARCH PROCESS

2.1 Introduction

The primary focus of the Green Village research in Sinxaku was to identify opportunities for improved livelihoods and to develop feasible business plans to support entrepreneurship based on landscape greening activities. This required that we work closely with community members to learn from them what their needs were and what opportunities and constraints existed to support entrepreneurship. We used a research approach based on social learning through participatory research in which learning coevolved between the researchers and the community. Our aim was to co-learn about possibilities with the community, to investigate livelihood and entrepreneurship options that met their needs and to develop agency for sustained change. Agency is the human ability to act for an intended outcome, it has a causal effect on the world, and indicates the human capacity to transform situations (Harvey, 2002). Forms of agency can influence the sustainability or degradation of cultural-ecological systems depending on the motivations, reflexivity, knowledge and power dynamics influencing action.

The main research method used was to workshop co-learning and planning for change. A number of participatory tools were used to draw out information and to build agency for change. These included group discussions, participatory mapping and transect walks. Examples are given below. Skills were developed through more formal talks, demonstrations and hands on practice. A list of the 14 workshops held in Sinxaku is provided in Table 2.1.

The prospect of the Ntabelanga dam and the ongoing NLEIP project attracted a number of other research projects to the area. Notable among these was the WRC project on 'The Mzimvubu Water Project: baseline indicators for long-term impact monitoring 'that was led by Dr Johan van Tol from the University of Fort Hare (WRC project no. K5/2433). Lower Sinxaku was one of five villages selected for study in this project. Data sharing with this project gave additional insight into garden productivity and soil quality, use of local plants, soil erodibility factors, rangeland condition, livestock ownership and socio-economic profiles. Honours students from the Departments of Environmental Science and Geography collected data on governance of natural resources (Shannon Herd-Hoare) and analysed rainfall data (Jessica Drewett and Natasha Moore). Dylan Weyer, from Environmental Science undertook participatory mapping workshops and household surveys in Sinxaku and four other villages to identify the location of resource areas and to understand their use over time. In the wider catchment, Margaret Wolff from The Institute for Water Research is engaged on researching institutionalising catchment management forums in the Mzimvubu Catchment.

Table 2.1/...

Table 2.1: Sinxaku meetings and workshops

Date	Purpose	Outcome
12 March 2015	Meeting with Headman and community members to introduce the Green Village project	Agreement in principle for project to be based in Lower Sinxaku
29-30 July 2015	Introduction of the Green Village Project to the broader community, including Upper Sinxaku.	Good buy-in to the project; election of committee of 18; identification of perceptions of land degradation, historical factors responsible for degradation and possible future actions to combat erosion.
15-16 October 2015	Rehabilitation Workshop	Mapping of erosion features; identification of key areas for interventions; introduction of community members to the implementers from the Gamtoos Irrigation Board (GIB) and explanation of how the rehabilitation project works.
19 January 2016	Sinxaku Green Village meeting with committee	Feedback on progress of employment on rehabilitation activities; introduction to basic principles of water harvesting and its advantages; introduction to principles of holistic grazing.
6 April 2016	Sinxaku Green Village meeting with committee – water harvesting workshop	Explanation of water harvesting techniques within a catchment context.
27-28 June 2016	Sinxaku Green Village meeting with committee – water harvesting workshop	Further explanation of water harvesting including visit to garden to see its effectiveness
17-18 August 2016	Sinxaku Green Village open community meeting	Revisited and confirmed project aims and discussed way forward. New smaller committee elected (6 members), agreement reached on the responsibilities of committee members. Workshop on developing business plans. Activity with Sinxaku Primary School
29-30 November	Sinxaku Green Village meeting with committee	Visit to rehabilitation sites; field visit to identify possible home-based vetiver grass nurseries
23-24 January 2017	Workshops with (1) CWP garden group and (2) livestock owners.	Workshop with the Community Works Programme regarding water harvesting. Workshop with livestock owners in Sinxaku lead attended by three representatives from the uMzimvubu Catchment Partnership Programme. Feedback from Lower Sinxaku Primary school regarding learning resources.
26-29 March 2017	Workshop with CWP garden group	Follow up workshop with the Community Works Programme re water harvesting. Three community members attended an auction in the Matatiele area.

Date	Purpose	Outcome
May	Workshop with livestock owners and sharing workshop with ERS in Matatiele. GIB manager attended first day of workshop.	Explanation of rehab practice and links to livestock management;
June/July	Workshop with CWP garden group; meeting with key livestock owners	Follow up workshop with the Community Works Programme re water harvesting. Household identified for first vetiver nursery; discussion on way forward for livestock planning.
November 2017	Sharing workshop	Sharing between communities from Sinxaku and Port St Johns; focus on water harvesting for food growing; initial work in vetiver garden.
November 2017	Final project workshop. Vetiver nursery planning workshop, livestock workshop, CWP workshop	Follow up workshop with livestock owners - commitment to hold meetings to seek support for managed grazing and auctions; Feedback from CWP group.

Due to the significant number of aligned research projects occurring in the Sinxaku area since 2015 the Green Village team decided that not to undertake its own household surveys; there was a real danger of research fatigue developing in the Sinxaku communities. The University of Fort Hare, Dylan Weyer and Shannon Herd-Hoare all carried out their own surveys so these provided us with data relevant to our own research. In addition, the National Census of 2011 provided statistics on all the enumeration areas within Sinxaku. As this is supposed to be a comprehensive survey of households it was thought to be sufficiently reliable for our purposes. Clear changes since 2011 observed in the field were noted.

Project resources were spent mainly on field visits to the Sinxaku community. The research was also supported by literature reviews to ground general principles, web searches to gain practical information and conversations with key partners as described below. Conversations with NLEIP researchers and managers were key here as they are guiding rehabilitation in the Tsitsa. Bi-annual project meetings enabled interactions with representatives from the Department of the Environment (DEA), Department of Water and Sanitation (DWS) and other research organisations. A second group that we have worked with since the beginning of 2017 is the uMzimvubu Catchment Partnership Project (UCPP), Environmental Rural Solutions (ERS), a non-government organisation (NGO) based in Matatiele, and their associates Meat Naturally Pty. Rolo Nöffke from Hydromulch (Brakpan) has provided valuable advice on planting vetiver.

2.2 Selection of the study area

The choice of community within which the research takes place has many ramifications for the direction and success of the project. These cannot always be seen in advance. In the case of the WRC Green Village project in the Tsitsa we were mandated to work in an area where land degradation would have a direct impact on siltation of the dam. At the start of the project the DEA-NRM's focus was on the Elangeni Tribal Authority that lies directly to the south of the dam's inundation area. Some rehabilitation work had already started in the western portion of this area under the implementing agent, the Gamtoos Irrigation Board (GIB). During meetings in January and February with research team members and NRM personnel it was agreed that the Green Village project should be located within this area at a site which was visible to government personnel visiting the site of the proposed dam. The Sinxaku villages were an obvious choice.

It lies on the road that links the tarred road to the road crossing over the Tsitsa River and is the most accessible of the Elangeni villages.

Dr Johan van Tol from the University of Fort Hare had worked previously in Lower Sinxaku and recommended that we should approach this community to see if they would host the project.

A meeting with the headman was held in Lower Sinxaku on 21 March 2015. Several community members also attended. The purpose of the WRC's project was explained and permission sought to work in Lower Sinxaku. The leaflet distributed at the meeting is given in Figures 2.1 and 2.2. There was some scepticism about "another project" coming to the village but it was agreed that Lower Sinxaku would host the research. The scope of the project was later extended to include Upper Sinxaku. The two villages are adjacent to each other, occupy a distinct topographic area, enclosed in a basin extending down to the Tsitsa River and share common erosion problems which should be addressed through an integrated erosion control plan. Working with both villages was also intended to limit the potential for inter village jealousy that could threaten the project.

A group of researchers from Rhodes University visited the area in May to investigate possible linked research projects that would support the aims either the Green Village specifically or NLEIP in general. They met with village leaders and carried out a focus group mapping exercise to identify boundaries and other features of local interest. The field trip provided an opportunity to recce the area and establishes its potential for future research.

A significant outcome of these preliminary interactions with village leaders was that the headman was introduced to us as the chief – Chief Jongibandle (he who looks after us). Only later did we discover that the true chief, Mathandela Mbandla, lived in Bokolweni village, further to the west. This created some tensions later and careful negotiation was required to ensure the successful continuation of the project.

Figure 2.1/...

Ukwakha Ilali Eluhlaza (Green Village) ukuze kubekho ubomi, umhlaba namanzi asempilweni kwindawo yaseNtabelanga

Uhlala kwintlambo yoMlambo iTsitsa. Le nto ke ithetha ukuba lomhlaba uhlala kuwo okwaxhasa isilimo nemfuyo yenu ukhuphela konke okwenzeka kuwo kuMlambo iTsitsa. Inxenye yamanzi omlambo iTsitsa ivela kumhlaba wenu. Umhlaba obangela amanzi alo mlambo abe mdaka uphuma kule ndawo yenu nakwezinye ilali ngasentla. Izinto ezingcolisa amanzi alo mlambo nezenza ukuba nigule xa nisela amanzi awo zivela kule lali yenu, ilali ezingasentla kunye needolophu ezisemantla omlambo.

Umhlaba ongqonge lomlambo iTsitsa ukhukuliseke gqitha. Umphezulu womhlaba ovelisa okulinyiweyo unciphile kwaye awunamveliso, uzele ziindonga ezinqumleza emasimini. Xa imvula inetha amanzi ahamba phezu komhlaba athi arhuqe nomhlaba ukuyotshona emlanjeni. Imvula ayihlali emhlabeni ize iwenze uthambe ukhulise izityalo kakuhle

iSebe Lezemicimbi Yendalo (DEA) lifuna ukuyitshintsha le ndlela izinto ezime ngayo kule ndawo yalo Mlambo iTsitsa. Bafuna ukuninceda ukuze nilungise lomhlaba, kunqandwe lamanzi nalo mhlaba ungaka uphelela emlanjeni nokuze kwenziwe amasimi negadi zibe ngcono ekuveliseni okutyaliweyo ze nikwazi nokondla imfuyo. Eli Sebe lixhasa ngezimali i*project* ezakunceda ukulungisa umhlaba wenu. Le nkqubo ibizwa ngokuba kukubuyiselwa komhlaba empilweni.

Eli sebe lenza le *project* yokubuyiselwa komhlaba empilweni lisebenzisa isicwangciso Sokulawula Okuxabisekileyo Kwemvelo/ ndalo(Natural Resource Management). Lisebenzisa esi sicwangciso,eli sebe lifuna ukusebenza nani, nina bahlali, ukuze kuncitshiswe ukhukuliseko

lomhlaba, kuphuculwe ubomi benu, kuziswe amathuba omsebenzi kuze kwandiswe imveliso yomhlaba. Sifuna ke yonke le nkqubo ibe yi *project* yenu ngoko sifuna ukusebenza nani.

Sifuna ukuqala kwilali enye ukuze sibone eyona ndlela yokubuyisela umhlaba empilweni ezakuthi incede umhlaba kunye nani ngokufanayo. Ngoko sizakuyibiza le lali Ilali Eluhlaza (Green Village) kuba sifuna ukufumana indlela yokuba niqhubeke niphila kulo mhlaba kwangaxeshanye ningawonakalisi. iKomishoni YoPhando Ngamanzi iye yaxhasa ngezimali iYunivesiti yese*Rhodes* neyase *Fort Hare* ukuze incede thina sincede nina ukwenza oku kule minyaka mithathu izayo.

Ungathanda na ukuba yilali yethu yokuqala Eluhlaza? Bona apha ngezantsi oko kulindelekileyo kuthi, thina baphandi, nani bantu bakule lali. Sonke, thina kwakunye nani sinoxanduva ekufuneka siluthwele size silufezekise.

Uxanduxa Lwabanphandi Belali Eluhlaza (Green Village)
Ukunxibelelanisa phakathi kwabahlali kunye ne *project* Yokuphatha Okuxabisekileyo Kwemvelo/ndalo (Natural Resource Management) ebuyiselwa umhlaba empilweni
Ukuphanda ngezona ndlela ziphucukileyo zokulwa nokhukuliseko lomhlaba.
Ukuyila iindlela zokuhlola impumelelo yemilanganiselo ebekiweyo yokulawula ukhukuliseko lomhlaba
Ukuhlola impumelelo yemilanganiselo yokulawula ukhukuliseko lomhlaba
Bazakuphuhlisa *iproject* yokufunda ngendalo (eco-learning) kwisikolo sasekuhlaleni
Baza kuseka *iproject* yegadi kwimizi ethile ekuhlaleni
Bazakusebenza nabahlali ukuphuhlisa isicwangciso soko kumele kwenziwe kwixa elizayo izinto ezinokuthanani `nobuhlaza` njengokuqhubeka nokugcina izinto zikwimeko entle, ukuqokelela amanzi emvula, igesi yemvelo, amandla elanga aguqulwa asebenze njengombane, namandla omoya aguqula asebenze njengombane
Baza kwenza baze baxhase *iiworkshop* ukuze bancede abahlali bazuze kangangoko banako kule ne *project* Yokuphatha Okuxabisekileyo Kwemvelo/ndalo ebuyisela umhlaba empilweni

Uxanduxa Lwamalungu Elali Yasekuhlaleni
Azakusebenzisana nabaphandi Belali Eluhlaza ukwalatha iingxaki zokhukuliseko lomhlaba nezicombululo ezinokusetyenziswa
Azakunceda abaphandi kwimibuzo abanayo\kwindawo abafuna ukuya kuzo : Ukufikelela nokuya kwindawo zophando ngaphandle kwengxaki Basebenze njengabancedisi nabatoliki
Aza kwenza isicwangciso sabahlali belali ukuze bakwazi ukulawula oko kuza kwenziwa xa kubuyiselwa umhlaba empilweni
Azakuphuhliso isicwangciso sezinto abafuna ukuzenza ukuze bakwazi ukucela inkxaso-mali *yeproject* zexesha elizayo *Develop* a business plan to apply for funding for a future project.
Aza kukhuthaza isikolo ukuba sizibandakanye nale *project* yokufunda ngendalo
Aza kwalatha imizi ethile ezakubandakanyeka kule *project* yegadi
Azakuphuhliso isicwangciso sezinto abafuna ukuzenza ukuze bakwazi ukucela inkxaso-mali *yeproject* zexesha elizayo *Develop* a business plan to apply for funding for a future project.
Aza kulungiselela abize iintlanganiso elalini: Ukufuna indawo yentlanganiso, okusiwa phantsi kwempumlo kwaziswe abahlali *ngeeworkshop* nokukhuthaza abantu baze kuzo
Anxulumane nezinye iilali eziselumelwaneni ukuze zixelelwe ngale *project* Yelali Eluhlaza (Green Village)

Figure 2.1: Leaflet distributed at the first meeting in Lower Sinxaku to introduce the project

Creating a Green Village for healthy lives, land and water in the Ntabelanga area.

You are living in the valley of the Tsitsa River. This means that the land on which you live and which supports your crops and animals drains into the Tsitsa river. Some of the water in the Tsitsa comes from your land. The soil that makes the Tsitsa brown during a flood comes from your land and from the land of other villages higher up the river. Pollutants in the Tsitsa river that make you sick when you drink the water come from your land or the land of other villages and towns higher up the river.

The land around the Tsitsa river is badly eroded. The soils have become thin and infertile and deep dongas cut across your fields. When it rains the water runs over the surface, taking the soil down to the river. The rain does not soak into the soil where it can make your crops grow well.

The Department of the Environment (the DEA) wants to change how these things work in the valley of the Tsitsa River. They want to help you to heal the land, to stop so much water and soil being lost to the river and to make your fields and gardens better able to grow crops and feed your animals. The DEA are funding a project to help your land to heal. This process is called rehabilitation.

The DEA is running their rehabilitation project through the Natural Resource Management programme. Through this programme the DEA wants to work with you, the local people, to slow down the erosion process and improve your lives, bringing employment and increased productivity from the land. We want this to become your project so we need to work with you.

We want to start in one village so we can find out how best to do the rehabilitation so that it helps the land and helps you. We will call this village a Green Village because we want to find a way that you can continue to live off the land without harming it. The Water Research Commission has given funding to Rhodes University and the University of Fort Hare to help us to help you to do this over the next three years.

Would you like to be our first Green Village? You can see below what it will mean for us, the researchers, and for you the people from the village. We will both have certain responsibilities that we must try to honour.

Responsibilities of the Green Village Researchers	Responsibilities of the members of the Village Community
Liaison between the village residents and the Natural Resource Management rehabilitation project.	
Research the best ways to tackle erosion problems.	Work with the Green Village researchers to identify erosion problems and possible solutions.
	Assist researchers with surveys: enable safe access to research sites act as field assistants and interpreters.
	Put together a plan for the village community to manage the rehabilitation activities.
Devise methods to monitor the success of the erosion control measures.	
Monitor the success of the erosion control measures.	Assist with monitoring activities - collecting data to monitor the success of the rehabilitation.
Develop an eco-learning project at the local school.	Encourage the school to join the eco-learning project.
Implement a food garden project in selected households.	Identify households for the food garden project.
Work with the village community to develop a business plan for future 'green' activities such as further restoration, water harvesting, biogas, solar energy, wind turbines.	Develop a business plan to apply for funding for a future project.
Facilitate and fund workshops to help village residents to get the most out of the Natural Resource Management's rehabilitation project.	Organise village meetings: find a suitable venue, organise refreshments advertise the workshop and encourage attendance.
	Network with neighbouring villages to tell them about the Green Village project.

Figure 2.2: English version of the leaflet in Figure 2.1

2.3 First steps

The first workshop was held in Lower Sinxaku on the 29th and 30th July with the aim of, firstly, building relationships between the broader villager community and the Green Village researchers and, secondly, coming to a common understanding between the local residents and the Green Village research team around the desired outcomes of the Green Village project.

People were invited from Lower and Upper Sinxaku as both villages share common problems of erosion. An open invitation in English and Xhosa was distributed two weeks before hand (Figure 2.3). The Ward Councillor was also invited but he delegated Ward Committee members in his place. Between 150 to 160 people arrived on the first morning. The background to the project was presented using drama in which the different roles of the researchers, rehabilitation implementers and community members were played out. Group discussions were then held to identify what the community would like to gain from the project. These ideas were discussed in an open forum and feedback was given on the extent to which the Green Village project could facilitate these. The expressed need for erosion control, better livestock management and improved land productivity were all in line with the scope of the Green Village project. Provision of taps and upgrading was not. It was stressed that the goal of the Green Village project was to work together with the community to achieve longer lasting sustainable practices that would contribute, in the long run, to reduced erosion, improved soil, improved land for agriculture and livestock as well as informed and environmentally educated children.

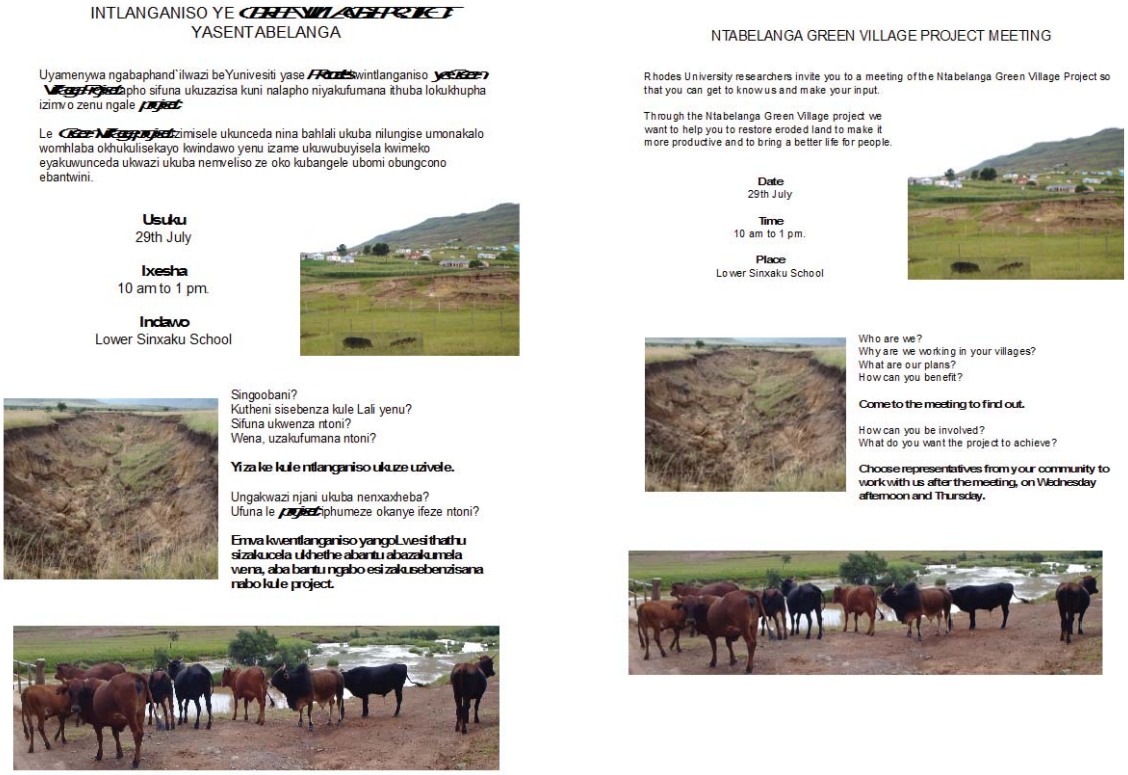


Figure 2.3: The invitation to the first Green Village community workshop

In order to achieve these project goals, it was necessary to work with a smaller group who could represent the Sinxaku community to work with us to develop village-level plans. It was agreed that three people would be elected from each of the six smaller settlements. The Green Village Committee was comprised of nine people representing Lower Sinxaku and nine Upper Sinxaku. The Upper Sinxaku headman and a Ward Committee member from Upper Sinxaku were among this representative group. The Lower Sinxaku headman did not attend the meeting although he had given it his support.

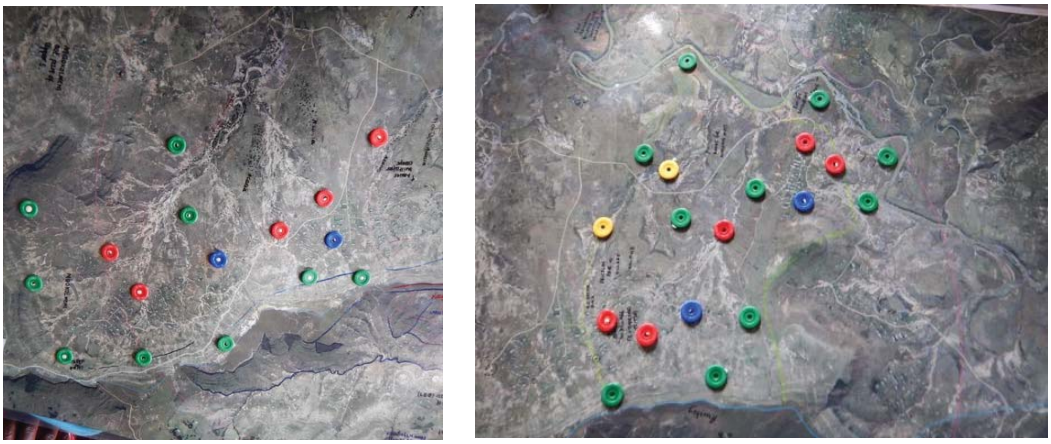
We worked with this smaller group for the rest of the workshop. Activities included the construction of a time line of events that could explain the present state of erosion, a transect walk through the village during which village members showed the research team examples of erosion features and an erosion control feature and small group discussions to identify ways in which erosion problems could be tackled. Two key point emerged:

1. Bring back the ranger system and develop a set of rules that will protect the land and reduce erosion.
2. Work closely with the NRM to receive employment by working on reducing erosion and rehabilitating the dongas.

Project logistics, such as provision of accommodation for researchers and employment of research assistants, was also discussed.

2.4 Engaging with the DEA-NRM's rehabilitation project

The second workshop held in Sinxaku on the 15-16 October 2015 specifically addressed the land degradation issues and the means to control erosion. There was the possibility that GIB would employ work teams in the Sinxaku area so it provided an opportunity to plan the way forward with the Green Village Committee. The first activity was an exercise in which groups demonstrated their understanding of the erosion process. They were asked to show what happens to raindrops when they hit the soil surface by placing counters on a simple diagram. This led to discussions on the importance of a good vegetation cover, the interactions between vegetation and livestock and the role of fire. The importance of controlling livestock and fire were continuing themes. A demonstration of different erosion control structures was presented using slides. The group then walked to nearby sites where small structures could be built in gullies and used to trap both water and sediment. This was followed by a mapping exercise in which participants mapped the location of priority sites for various different types of structures using a large map derived from Google Earth indicating houses, roads and gullies and other landscape features (Figure 2.4). Sites included (1) structures that could include a sand dam for water supply (2 sites per village), (2) priority areas for erosion control (5 sites per village) and (3) grazing areas.



(a) (b)

Figure 2.4: Rehabilitation priorities identified by committee members from (a) Upper and (b) Lower Sinxaku. Blue disks = water points, red disks = erosion control priority points, yellow disks = fencing areas, green disks = grazing areas.

On the second day of the workshop the meeting was joined by Mr Justice Ngcengane who was the regional Manager for GIB and Mr Brian Fortuin, who was the local manager. The community members gave feedback on the previous day's activities. Mr Ngcengane then explained how the rehabilitation project worked. Funding comes through the government's Extended Public Works Programme (EPWP) so it is necessary to comply with that programmes guidelines regarding employment criteria. A site visit was made to two of the priority sites identified on the previous day.

Mr Ngcengane recognised the Green Village Committee as an authentic structure with which to engage with respect to rehabilitation activities. The committee was given the task of selecting two teams from Sinxaku to begin rehabilitation work. These teams were subsequently trained later in the year. This was a positive move for the Green Village Project as it gave committee members a direct responsibility and created the potential for the committee to become effective partners in the rehabilitation. Two circumstances, however, militated against this happening. Firstly, it transpired that Chief Mbandla was not pleased with the process by which the Sinxaku teams were selected. The previous practice had seen people

employed from across Elangeni ensuring that employment opportunities were spread between all villages. It took considerable persuasion from both the researchers and, more importantly, the Upper Sinxaku headman, to allow the two Sinxaku teams, who had already received training, to continue working. This was the research team's first encounter with Chief Mbandla and, although it nearly had serious negative consequences for the project, it also served to inform the chief further about the project and consequently proved to have positive outcomes. The second circumstance that prevented the Green Village Committee from effectively partnering with the rehabilitation efforts was that employment of any teams stopped almost as soon as work had started in Sinxaku. It continued intermittently through 2015 and 2016 and only resumed again in earnest in late 2017. This interrupted work programme was due in part to financial constraints and in part to the realization by the DEA-NRM that a more structured approach to rehabilitation was required, based on a clear plan that met scientific, technical and social needs.

2.5 New directions

By early 2016 it had become clear to the Green Village Project research team that a different approach was needed if the project aims were to be achieved. With limited rehabilitation activity we needed to identify landscape greening opportunities that were not dependent on external agencies. We therefore turned our focus to two further lines of investigation. The first was to demonstrate how garden yields can be improved through rain water harvesting, and the second was to promote improved livestock management in order to bring back a better ground cover and hence reduce runoff and erosion. A series of workshops were held with the Green Village Committee to explain the concepts behind water harvesting and to provide in-garden demonstrations. During these meetings the benefits of holistic grazing were also explained. Three workshops were held in the first half of 2016.

In August 2016 an open meeting was held so that the Sinxaku community could revisit the aims of the Green Village Project. It also gave a space for open discussion about project governance. As a number of the elected committee members no longer attended meetings and there was some dissatisfaction with the leadership, it was decided it was an appropriate time to elect a new committee. It was agreed by the meeting that a smaller committee would be more effective, made up of four members from each of Upper and Lower Sinxaku. The roles and responsibilities of the committee were discussed at the meeting and agreed on as follows.

1. Committee members must be committed and attend all scheduled meetings with the researchers.
2. Committee acts as a conduit between community and researchers; need effective feedback in both directions.
3. Decisions should represent the wishes of the broader community
4. Committee members should encourage others to come to relevant workshops
5. Committee members do not receive a stipend; membership is voluntary.

The meeting participants were not forthcoming about how they themselves saw the project progressing but agreed that we should continue with plans for holistic grazing and rain water harvesting. The need to develop business plans to improve household income was also included.

Although we had held a number of workshops on water harvesting techniques, enthusiasm for uptake by individuals was lacking. Effective water harvesting requires manual labour for work such as digging swales and may of the workshop attendees had been elderly people. We were not in a position to use WRC project funds to employ people to do this work. In November 2016, the newly elected Green Village Committee therefore recommended that we work with a group of gardeners who are paid through the Community

Works Programme (CWP). Two teams of twelve people were already working in Lower Sinxaku. We approached the supervisor who welcomed the idea that we should work with the CWP teams and use one of the gardens as a demonstration site. Subsequent workshops brought together the two Lower Sinxaku teams to learn together.

Our initial engagement with the Green Village Committee had aimed to develop village scale initiatives that could evolve into a rehabilitation plan that would also support sustainable livelihoods. Our focus shifted after August 2016 as we began to work at the scale of the livelihood activity or project.

Rain water harvesting was promoted as a way to increase the effectiveness of rainfall as a source of water for gardens, thus increasing food security, at the same time supporting rehabilitation through soil and water conservation. Although increased produce could result in a surplus for sale, this was not the primary focus of this component of the Green Village Project. A related business venture was to establish vetiver nurseries in home gardens, using water harvesting to secure sufficient soil moisture to establish plants. Once established, plants could be sold to the NLEIP rehabilitation project. At a workshop in November 2016, seven households were identified that were interested in starting nurseries. The present plan is to trial the process with one household.

Livestock management was a recurring theme through many of the early workshops and workshop participants had concurred with the benefits of better controls on livestock. However, buy-in from the broader community was necessary as livestock is grazed on communal land. Interest had been generated at village meetings attended by committee members. In January 2017 an open meeting for livestock owners was held in Upper Sinxaku at which the principles of managed grazing were explained. Concurrently we had begun to engage with Environmental Rural Solutions and the uMzimvubu Catchment Partnership Programme (MCPP) based in Matatiele. Three people from the MCPP attended the meeting and explained how better livestock management could be linked to livestock auctions. This led to representatives from the Upper Sinxaku livestock owners visiting an auction in a village near Matatiele and, later, attending a learning exchange workshop run by ERS in Matatiele. The response was highly positive, leading to an acceptance by at least some of the community of the benefits to be gained from a programme to improve livestock management. Key community members have been inspired to extol the potential benefits to other livestock owners in the hope of establishing a system acceptable to the community.

Improved livestock management based on controlled grazing has been promoted as a way to improve income from overstock while also combatting land degradation through an increased ground cover. A second reason for control is to protect rehabilitation sites so that the ground cover can recover. At many sites further up the valley, it was observed that livestock had been allowed to graze immediately after the rehabilitation structures have been put in place, negating many of their positive effects. A rehabilitation manual has been produced that gives simple explanations of the causes of erosion and possible control measures being used in the area. This is to help community members understand the purpose of erosion control interventions and therefore be more likely to protect them from grazing or vandalism. Photographs, mainly from the Sinxaku area, are used to illustrate the different methods and text is provided in both English and Xhosa. A first draft of the manual was distributed to livestock owners at a workshop in May 2017 and was used to explain the basic principles of erosion and its control. A copy was also given to the GIB manager. It is hoped that the final version, now completed, will be distributed more widely among both livestock owners, headmen and sub-headmen, rehabilitation supervisors, rehabilitation team members and other key individuals in the community. It is hoped that it will be a useful resource for other rehabilitation projects in the country.

2.6 Practical Issues

2.6.1 The Green Village Committee

At the first community workshop held in July 2015 it was agreed that the Green Village Project would work with an elected committee of 18 people who represented the broader community. This initially worked well but interest waned once it became clear that we were not there to provide employment. There was also jealousy from non-committee members who thought that the committee, and the Chairperson in particular, were being paid, although we had made it clear that the work would be voluntary. It also became apparent that the committee members were not necessarily the ones who would be most involved in our proposed activities.

After the election of the new, smaller committee a number of circumstances acted to further weaken its effectiveness. Firstly, younger people had been elected, which in itself could have proved positive as there is a clear need to empower the youth and integrate them more fully in to local decision making. Unfortunately for the project several of the young people left the area shortly afterwards to find work in urban centres. Secondly, with the new approach of working directly with the CWP garden group and a separate livestock group the previous function of the Green Village Committee was lost.

One committee member, who is also a livestock owner, serves as our contact person, arranging meetings and accommodation but otherwise the committee plays no role.

2.6.2 Workshop venues

The nature of the venue in which a meeting is held has an influence on the outcome of a workshop. It determines how comfortable people area, how easy it is for participants to communicate with each other, and whether or not a computer can be used to share visual information. Workshop venues were arranged for us by a committee member.

The first two meetings were held in a class room in Sinxaku Primary School (Figure 2.5a). The advantages were that furniture could be moved around to allow small group discussions and electricity was available to allow a computer to be used. There was wall space and chalk boards to present feedback. We were also provided with a room where lunch was prepared by local cooks. Disadvantages were the small size of furniture that was not designed for adults, the difficulty in darkening the room to allow projected images to be seen, and the need for a screen. In the first open community meeting the class room was also too small to accommodate over 150 people so that much of the meeting was held outside in the school yard (Figure 2.5b). Using two class rooms for a two-day workshop was also disruptive to school activities although it did give the project team the opportunity to interact with the head mistress and other teachers, who were supportive of the project.

The venue for our next two meetings was a rondavel attached to the lower Sinxaku headman's house. This had the advantage of causing all participants to be seated in a circle that was small enough to encourage interaction. A disadvantage was the lack of adequate seating and no tables to work on. Subsequent meetings with the Green Village Committee and the CWP garden group were held in the Church Hall (Figure 2.5c). This had the advantage of sufficient chairs, a large space and access to electricity. The white walls allowed projection of visual material from a computer and, although light and airy, the projection area was dim enough for images to be seen. A disadvantage of this space was the larger size and the lack of tables. Chairs initially set in rows imparted a more formal atmosphere so care had to be taken to achieve the best seating arrangement to achieve effective small group discussions and free interactions between the community participants and the research team. Food was prepared in a neighbour's house.

The livestock meetings were held in Upper Sinxaku at the crèche (Figure 2.5d). We used the open veranda area which was a large enough space but offered little shelter, no access to electricity and seating was limited. The crèche was also undergoing renovations so we were in effect meeting in a building site. Food was cooked in the original crèche building adjacent to the new one.

Learning also took place where possible at field sites, interacting with more successful gardeners and investigating erosion sites (Figure 2.5).

The location of a meeting venue effects participation by the community because wherever it is placed some people will have to travel long distances, probably by foot. It was over 5 km from the furthest settlement in Upper Sinxaku to meeting venues in Lower Sinxaku and about 3 km to Qulungashe. Conversely, the crèche in Upper Sinxaku is over 3.5 km to Maxisibeni and over 6 km to Qulungashe. Where possible we helped with vehicle transport.

(a) Workshop discussions in the Lower Sinxaku Primary school

(b) Large group discussions outside the school

(d) Meeting about livestock management in the veranda of the Upper Sinxaku creche

(c) A meeting in the Church Hall

Figure 2.5: Meeting places

2.6.3 Accommodation

Accommodation for the Green Village research team was provided by village households, arranged for us by the committee. This brought income into the village and helped to build relationships between ourselves and the community. It also gave more time to get to know the local area through direct observation.

All houses that we stayed in had electricity for lighting, fridges and charging equipment. We had access to the kitchen and a gas cooker. Sufficient hot water was always available for washing.

Arranging accommodation and employing cooks for a workshop were the two areas where a committee member could benefit directly from the project if family members were used. This may have been one source of jealousy. The intention was always to use a range of households for accommodation but we were normally given the same two or three places.

Although we never experienced problems relating to personal safety we are aware that it can be an issue at times of festivals and political tension. We avoided holding workshops close to public holidays.

2.6.4 Project location and workshop frequency

Sinxaku village is situated over 500 km from Rhodes University in Grahamstown where the project is based. Travel times varied between 5 and 7 hours depending on road works and other conditions. This meant in effect that any visit to the field area required two days of travel and significant expense in vehicle hire. It was our experience that two days was the maximum length for a workshop, with interest waning on the second day. A two-day workshop therefore required four days of researcher time, plus additional time for planning. The resources required in time and travel costs meant that our visits to the area were less frequent than optimal to build momentum in the community.

2.7 Working with the Sinxaku communities – lessons for community engagement

When working with communities in Sinxaku we did our best to follow best practice with regard to the principles of community engagement that engender sustainable natural resource practice. Resources consulted are listed in Box 2.1. The principles can be grouped under those which relate to engagement with the local community and those relating to the wider community. The local community engagement principles are also grouped under the process (how to do) and the procedure (what to do) that should be followed (Figure 2.6).

i. Engaging with the community

The most important principle that is 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 and allow them to take responsibility and be part of decision making. A technical and scientific focus runs the risk of side lining the required social process by offering limited opportunities for effective local participation of local resource users (Fox and Cundill, unpublished). Fox and Cundill (unpublished) also warned against naïve or romantic notions of rural communities – communities are not homogenous, nor are they necessarily living according to traditional norms that may once have been in harmony with nature.

Box 2.1 Guidelines for practicing land rehabilitation

Bryson, L. and Braid, S. 2016. *Deliverable 3: Lessons learnt report* (Draft). Green Village: Catchment Management Guidelines and Training. WRC project K5/2423.

Bunning, S., McDonagh, J., Riuox, J. 2011. Land degradation assessment in drylands. Manual for local level assessment of land degradation and sustainable land management. Part 1. Planning and methodological approach, analysis and reporting. Food and Agriculture Organization of the United Nations, Rome.

Denison, J., Smulders, H., Kruger, E., Houghton, T. and Botha, M. 2011. *Water Harvesting and Conservation – Volume 2 Part 2: Facilitation and Assessment Guide for the Technical Manual.* WRC Report No. TT 494/11 ISB No. 978-1-4312-0132-7

Denison, J., Smulders, H., Kruger, E., Houghton, T. and Botha, M. 2011. *Water Harvesting and Conservation – Volume 2 Part 3: Facilitation Manual.* WRC Report No. TT 495/11 ISB No. 978-1-4312-0133-4

Denison, J., Smulders, H., Kruger, E., Houghton, T. and Botha, M. 2011. *Water Harvesting and Conservation – Volume 2 part 4: Facilitation and Assessment Guide for the Facilitation Manual*. WRC Report No. TT 496/11 ISB No. 978-1-4312-0134-1

Fox, H.E. and Cundill, G. (unpublished). Toward more community-engaged ecological restoration: A review of current practice and future directions.

Motteux, N. 2001. The development and co-ordination of catchment fora through the empowerment of rural communities. Water Research Commission.

Rowntree, K.M. 2006: Integrating Catchment Management through LandCare in the Kat Valley, Eastern Cape Province, South Africa. *Physical Geography*. 27 (6), 435-446.

In Sinxaku we actively sought community support from the start of the project and engaged at least some community members throughout the project. We relied on the various committees or working groups to relay information back to other community members. This was not as effective as we had hoped.

It is also important to engage with the wider community who have a vested interest in the project. NLEIP undertook an extensive stakeholder engagement exercise in both areas above and below Ntabelanga Dam. Key stakeholders were identified and informed about the rehabilitation project.

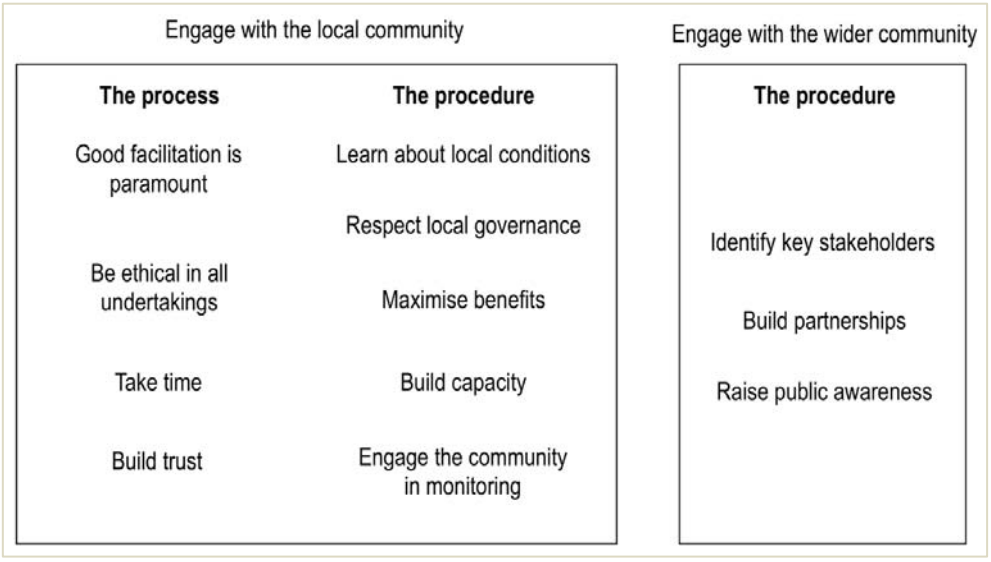


Figure 2.6: Principles of community engagement

ii. 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;
- 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.

The Sinxaku Green Village Project was fortunate to be able to employ the same facilitator that we worked with in the Kat Valley in the late 1990s and early 2000s and with whom we have developed a solid working relationship over the years. This contributes greatly to our ability to enter into a working partnership with a community.

iii. 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.

In Sinxaku we explained the roles and responsibilities of the research team and the community at our first meeting with the headman. Thereafter we went through a phase of adaptively developing the project in light of the response from the community. We always tried to be clear as to what we could or could not offer through the project.

iv. Take time

Rehabilitation of landscapes often requires a new way of doing things. Introducing new concepts requires a significant amount of research and engagement and takes time. There should be freedom to make mistakes. Do not hurry the process and build capacity among the community to make a meaningful contribution. Pilot projects can be used to demonstrate possible outcomes. De Groot *et al.* (1992) warn that proceeding with rehabilitation works without adequate information can lead to disaster.

Progress in achieving project objectives in Sinxaku has been slow. At the end of the project we have started to engage effectively with the two groups that can in separate ways work towards achieving benefits from rehabilitation. Even now it is a slow process as the community leaders attempt to get agreement from others. According to one livestock leader, who is championing the process, we must proceed "step by step".

v. Build trust

Time is 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.

Certainly on the surface our relationships with the Sinxaku community appear to be good. A related element is identifying the level of trust between community members and possible barriers to sharing new knowledge and capacity. It may be necessary to find ways to build trust between community members before a project can move forward. We encountered problems on this account at a number of stages through the project. One example is the jealousy felt by some people regarding the first Green Village Chairperson. A second example arose when working with the CWP garden group who openly stated that a lack of trust between members of the group prevented them from working effectively. Other underlying tensions were also perceived though not always articulated. These tensions seemed to have increased in line with the progress of national politics. Weyer (in preparation) has also identified a certain level of jealousy amongst Lower Sinxaku residents that hindered cohesion within the community.

vi. Learn about local conditions

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, income opportunities and available labour.

In Sinxaku, some of this information was gained at the first community workshop and through the activities of other researchers. We continued to be better informed about local conditions through the course of the project.

vii. Respect local governance

To be successful any project must work within existing institutions of local governance. It is importance to create an institutional space that allows a free flow 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.

Working, or not working, with local governance could have caused the downfall of the Sinxaku Green Village Project. As new comers to the village we followed the normal protocol of asking to speak to the local leader. We were introduced to the Lower Sinxaku headman as the chief. Early in the project we asked for clarification about governance structures and again were advised that the Headman is the person who we need to work through. It seems that this holds true as long as a project does not include distribution of funds, a change to land access or to the rules governing how land is used. These become the provenance of the chief. Employment through the EPWP is therefore a concern of the chief rather than a village matter.

The Ward Councillor becomes involved when there is external funding aimed at development. This did not apply to our project, though it would become important if proposed business plans resulted in external funding being forthcoming.

viii. Maximise benefits

Local people need to see the benefits of rehabilitation. 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. There should also be a minimum risk to the community from project failures. Although it is imperative that rehabilitation is linked to improved livelihoods in both the short and long term, top- down job creation programmes that do not engage communities in an effective way should be avoided. Many South African government-funded projects are under pressure to create employment as a primary outcome. A short coming of the Sisonke LandCare project in the Kat Valley was the Department of Agriculture's insistence that most of the funding go into job creation rather than capacity building for empowerment, environmental awareness and long-term sustainability (Rowntree, 2006). Fox and Cundill (unpublished) suggest that restoration projects that focus solely on the ecology of landscapes to the neglect of their productivity for livelihoods can negatively impact restoration outcomes. Morgan makes the point that "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).

The DEA-NRM's rehabilitation project in Sinxaku offers short term benefits of employment but this is not sustainable in the long term. The aim of our project was therefore to look for sustainable long term solutions that would benefit people from the local community and support rehabilitation. This principle is at the heart of this project.

ix. Build capacity.

A training programme aimed at building skills is an essential part of any sustainable initiative.
In the Sinxaku Green Village Project co-learning and skills development was a central part of the research. We also implemented a school's programme to engage pupils in environmental learning through action.

x. 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. These and other tools are reviewed in Chapter 4. In Sinxaku we have not engaged in a monitoring programme because of the slow start to rehabilitation activities in this area.

2.7.1 Engaging with the wider community

i. Identify key stakeholders

In the Tsitsa catchment two stakeholder analysis exercises have been carried out to capture the stakeholders in the catchment. Separate exercises were completed for the areas above the proposed Ntabelanga dam and the Lalini Dam. This required identifying community leaders among both municipal and traditional authority structures as well as NGOs, NPOs, farmer support structures among others.

ii. 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.

There are various actual and potential partners working with the Sinxaku Green Village project. Many of these fall under the umbrella of NLEIP. They include the Universities of Rhodes, Fort Hare and Free State, the Institute of Natural Resources (INR), Pietermaritzburg, the DEA's division of Natural Resource Management (NRM) who are responsible for the NLEIP, and the DWS who is a key stakeholder regarding the Ntabelanga Dam. Aurecon are a further partner through their WRC project K5/2500. An important partner is the uMzimvubu Catchment Partnership Programme (UCPP) and the NGO Environmental Rural Solutions, based in Matatiele.

Opportunities for further partnerships are given in Chapter 7.

iii. 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, regional and national scale.

To date the main public awareness raising has been through the NLEIP forum, through an ERS learning exchange and from presentations at conferences. Catchment Forum meetings provide a forum where community members can share their experience. Two 'Green Village' people have attended meetings of the Mzimvubu Catchment Management Forum.

2.7.2 Further reflections

Where appropriate it is advisable to work with local groups that are already established and adequately funded. Although a number of people were interested in water harvesting they were not prepared to invest the extra effort required to get it going in their own gardens. Many householders are old and do not have access to labour for heavy manual work. Young people who remain in the area are less interested in gardens unless it provides employment. Working with the CWP we had a 'captive' group who were happy to work with us as they were already being paid to be there. They expressed an interest to apply the techniques learnt in their own gardens.

Do not expect people to volunteer to do work unless there is a clear incentive to do so. Even if unemployed, most people are occupied in some way. Be aware of events that keep people away from meetings and plan around these when possible. Meeting times should fit into the daily schedule of work activities.

Capacity building for agency is a long process that requires continued input, plus an understanding of what capacity already exists. Developing skills requires training via specific activities. Jobs (employment) cannot be created in a vacuum. They require an employer and a need to get something done.
The importance of building trust between the external facilitators and the local community is stressed as a priority for successful community engagement. A related element is identifying the level of trust between

community members and possible barriers to sharing new knowledge and capacity. It may be necessary to find ways to build trust between community members before a project can move forward.

Through this project we are contributing to capacity development for landscape greening and have gone some way to develop new 'green' skills among a selected number of people. Working through the CWP we aimed to improve the skills and productivity of those already employed and thus enhance their work experience. Improved livestock management has the potential to provide both market and employment opportunities in the future.

CHAPTER 3. THE SINXAKU ENVIRONMENT

3.1 Location

The Sinxaku Green Village Project in the Tsitsa catchment is located close to the proposed Ntabelanga dam (Figure 3.1). The total area of the catchment above the dam is ~2000 km^2. It is comprised of five quaternary catchments (T35A-E); Sinxaku lies within the most degraded quaternary, T35E.

Land is owned communally under the Tribal Authority of Elangeni and typifies much of the former Transkei. As noted by Hoffman and Ashwell (2001) in their survey of land degradation in South Africa, land degradation is considerably worse in communal areas than commercial farming areas and land use types and land tenure systems are important predictors of soil erosion, though not necessarily the direct cause. Moreover, their findings showed that the rate of degradation is decreasing in commercial areas but increasing in communal areas.

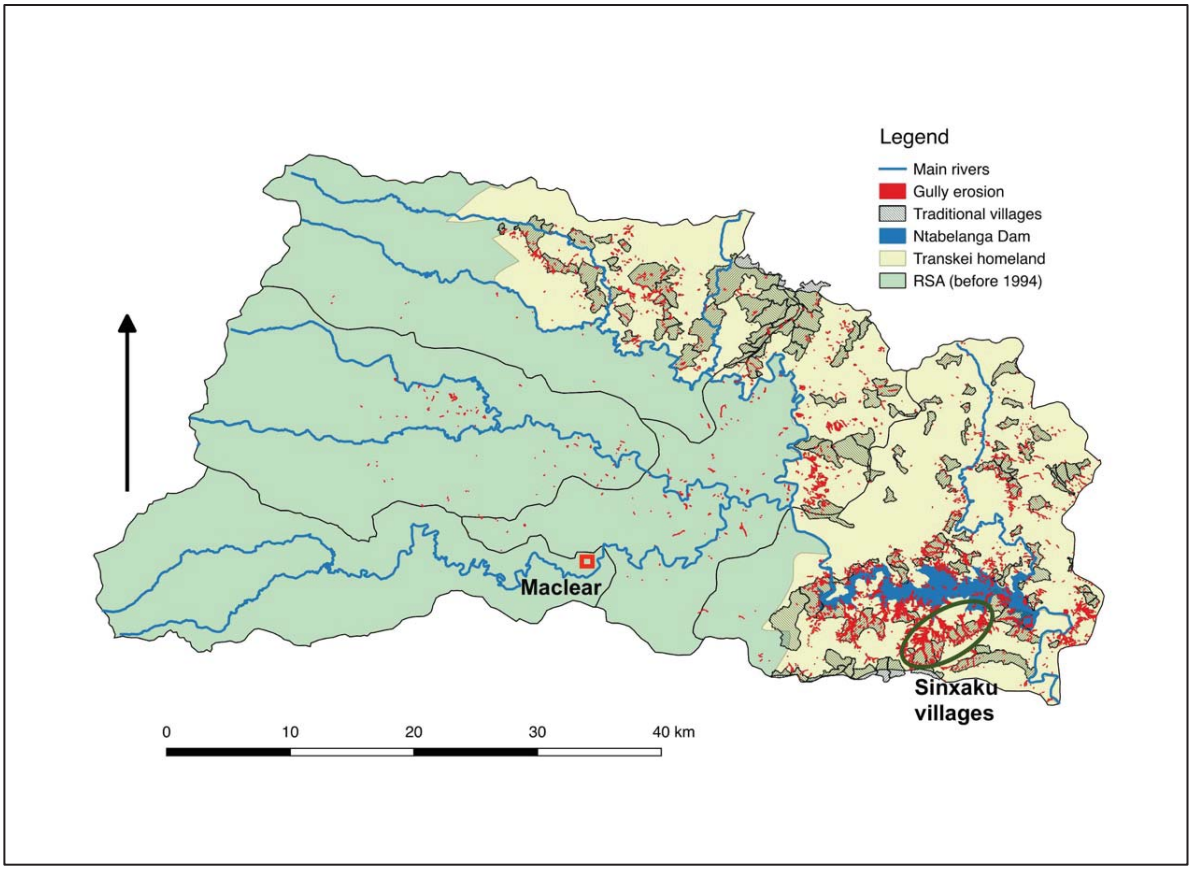


Figure 3.1: The location of Sinxaku villages within the catchment of the Ntabelanga dam

The severe land degradation and prospects of excessive siltation of the proposed Ntabelanga dam was the catalyst for the DEA-NRM's rehabilitation project through their Natural Resource Management Chief Directorate. The rehabilitation is guided by the multi-institutional Ntabelanga and Laleni Ecological Infrastructure Project (NLEIP) that brings together managers, implementers and researchers under one umbrella as described in Section 3.6.

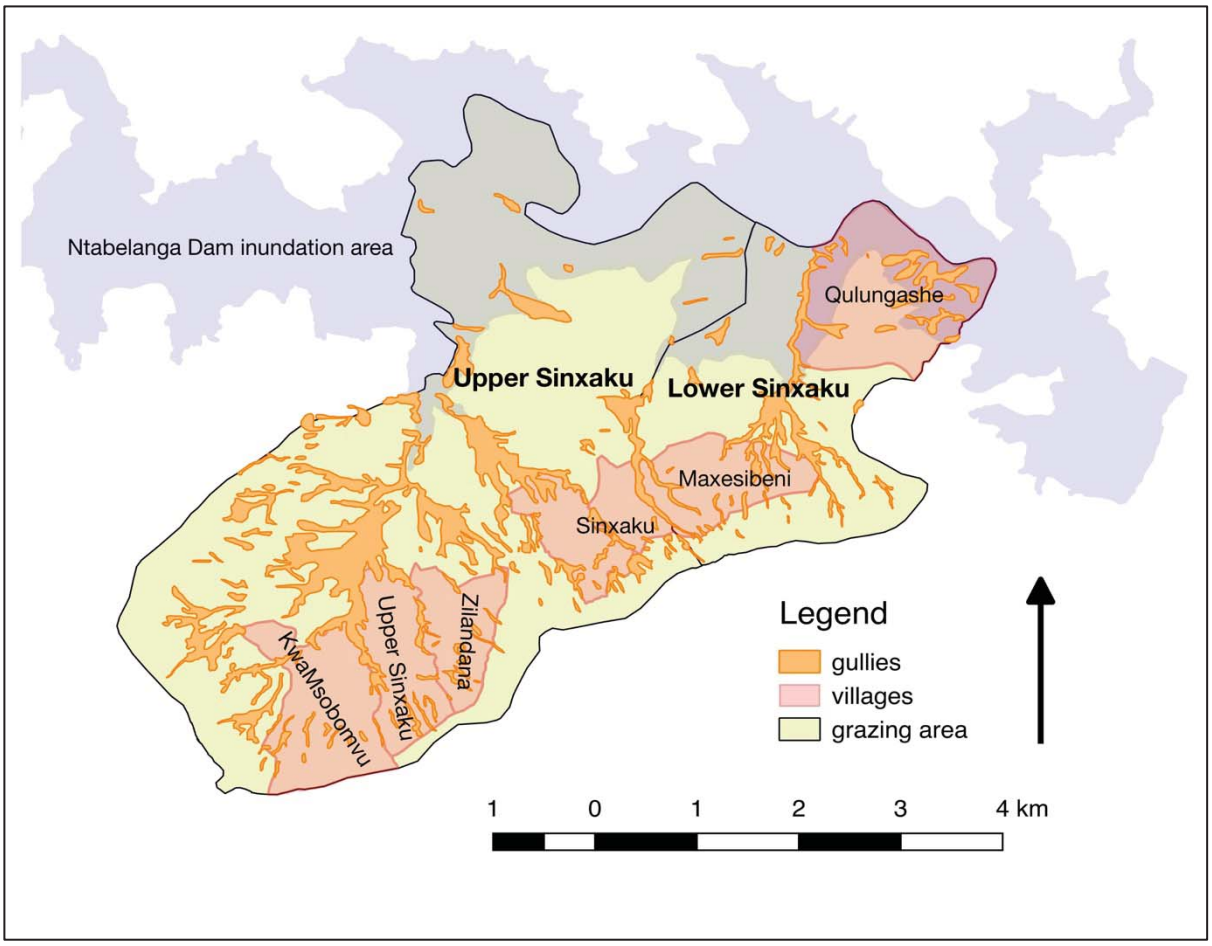


Figure 3.2: The Sinxaku Administrative Areas showing the extent of villages and gullies.

3.2 The Sinxaku landscape

The Sinxaku villages lie within a basin that drains to where Tsitsa river will eventually be inundated by the Ntabelanga dam (Figure 3.2). Within the Sinxaku basin there are a number of small catchments draining into the main gully networks. These small catchments, and micro-catchments within them, comprise suitable scales for planning water harvesting activities. The settlements lie at the break in slope between steep backslopes and gentler slopes that extend to the river.

The Sinxaku villages are located in the two Administrative Areas of Upper and Lower Sinxaku (variously spelt Sinxago, Sinxako, eSinxako) in the Tribal Authority of Elangeni. Their combined area is ~4000 ha, of which Upper Sinxaku makes up 3000 ha and Lower Sinxaku 1000 ha. The two Administrative Areas are comprised of six 'villages' (Figure 3.2). Each administrative area falls under one headman and several sub-headmen. We have been working across all scales from the household to the combined Upper and Lower Sinxaku areas. For the purpose of this report we will refer to the WRC project in the Tsitsa catchment as the Sinxaku Green Village Project and the area as the Sinxaku villages.

Figure 3.3 shows the distribution of annual and mean monthly rainfall for Maclear, some 18 km distant from Sinxaku. It has a mean annual rainfall of 824 mm and a coefficient of variation of 18%. Rainfall is concentrated in the months between October and March when, on average, 81% of the rainfall is received. The high inter-annual variability means that drought can be a problem (Table 3.1). Residents see unreliable

rainfall as the major constraint on cropping. Exacerbating low rainfall is the high rate of summer evaporation potential which reaches 6.5 mm in December (Van Tol *et al.*, 2017). The lowest evaporation potential occurs in June (3 mm). Van Tol *et al.* (2017) summarise future predicted trends. While rainfall amounts are likely to increase, so is the rainfall intensity, leading to more frequent flooding and erosion. An increase in temperature will intensify evaporation losses. Effective soil and water conservation practice will become a priority.

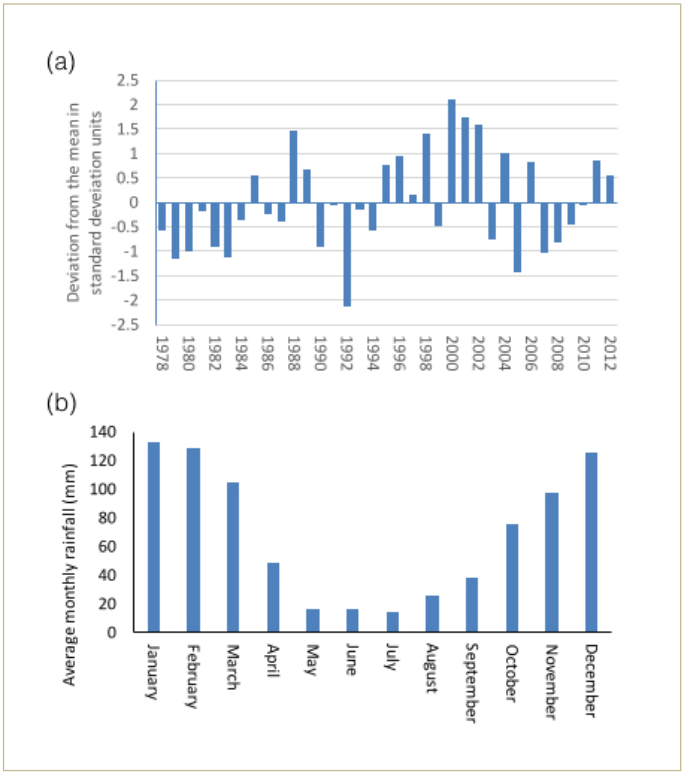


Figure 3.3: Annual and monthly rainfall distribution, Maclear

Much of the Sinxaku area is underlain by Beaufort Group mudstones of the Tarkastad Formation, which gives rise to relatively shallow, dispersive, duplex soils that are highly erodible and susceptible to gullying (Figure 3.4). They have given rise to the ubiquitous deep gullies that dissect the colluvial deposits on the lower slopes. Tunnel erosion is often a precursor to surface gully formation. The difficulty of managing these soils is widely acknowledged (Laker, 2004; Beckedahl *et al.,* 1988; Pawardsa and Van Tol, 2016).

The vegetation of the Sinxaku area is described by Mucina and Rutherford (2006) as East Griqualand Grassland, with Drakensberg Foothill Moist Grassland on the higher slopes and mountaintops. East Griqualand Grassland is a characteristic vegetation of the mudstones and sandstones of the Beaufort Group. Erosion status is described as ranging from low to moderate, clearly not applicable to the Sinxaku area. East Griqualand Grassland consists of grassland with patches of bush clumps of *Leucisidea sericea* on wet sites and *Diospyros lycioides*, *Acacia karroo* and *Ziziphus mucronata* in low-lying and very dry sites. In Sinxaku *Acacia karroo* is the most common woody shrub.

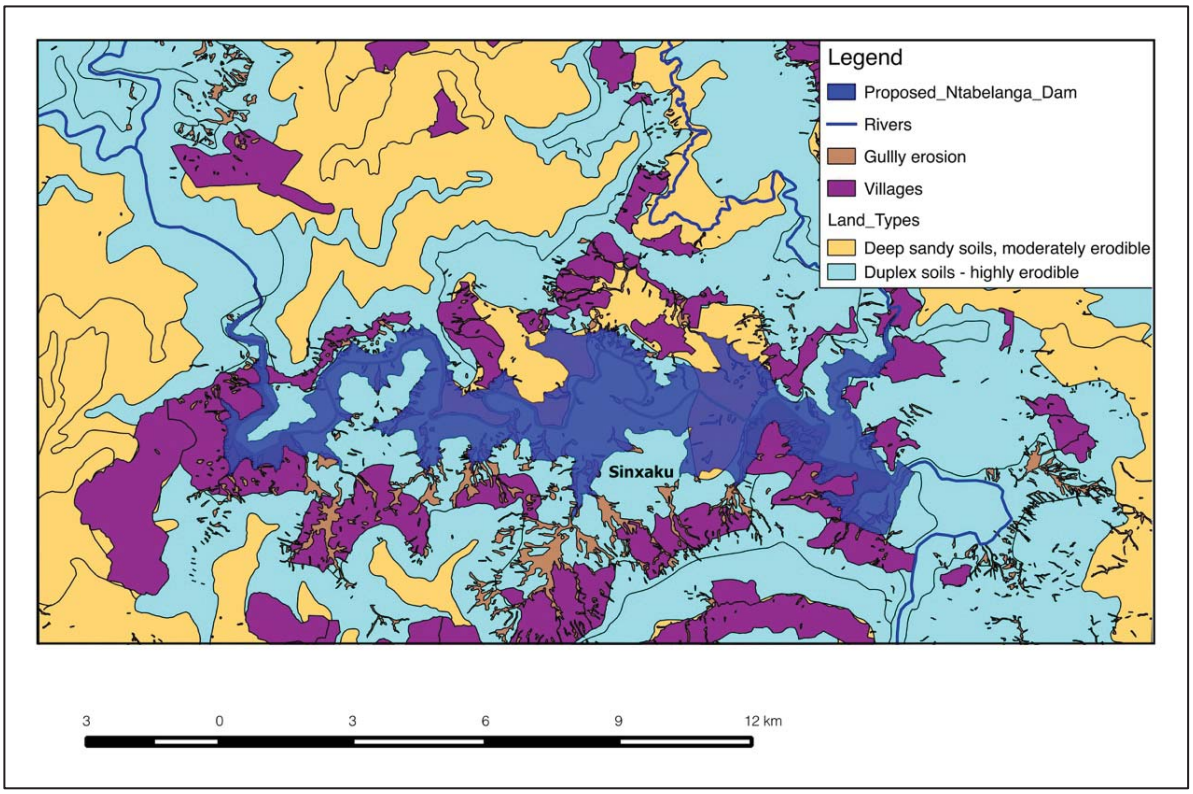


Figure 3.4: Land types and soil erodibility in the Ntabelanga dam basin

Vegetation surveys were carried out in March and November 2016 by researchers from the WRC project K5/2433 (Van Tol *et al.,* 2017). The two most common plant associations, found on slopes of 6% and 14%, together contributed to 68% of the 19 sampled sites. The vegetation cover was reported to be between 80% and 82% and litter cover between 5% and 4.4%. Only one site was sampled on the steep backslopes. This site on a 70% slope had a cover of 65% and litter cover of 2%. These are relatively high cover values for a degraded landscape. It may be that better vegetated sites were surveyed so as to capture a full range of species. The pH of all sites was found to be acid (5.0-5.17).

Land use must be carefully planned to take account of the highly erodible soils in the area. At the present day the main land uses are garden cultivation and livestock grazing. Following Betterment Planning on the 1960s fields were established on the lower slopes, with some contouring, but these have largely been abandoned. These show evidence of poor vegetation cover and sheet erosion. Van Tol *et al.* (2017) note that formerly cultivated lands are frequently eroded by gullies, even on the deeper, freely draining soils that have a lower soil erodibility.

3.3 The historical context

Land degradation and the potential for rehabilitation is evaluated here through a political ecology lens. A basic premise of the political ecology approach to understanding land degradation is that it is the result of external policy decisions that disempower land users and stop them using land sustainably (Blaikie, 1985). It is important to understand this context if rehabilitation strategies are to be successful. 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 can either 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 Sinxaku area lies within the former homeland of the Transkei so it is important to look at the history of homeland policies and legislation. 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 on behalf of the community by Tribal Authorities, while private commercial farms are 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.

Table 3.1 presents a time-line of events in the Sinxaku area as related at the first workshop with community members. This is set alongside historic events at a national scale as summarised below. As indicated above, drought, and less often floods, were an environmental hazard acknowledged by the community.

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. It is discussed in detail by Fox (2000), Lester (2000), Simon and Ramutsindela (2000). Beinart (1984) presents an insightful and detailed analysis of how colonial and Apartheid policies impacted on rural people and exacerbated land degradation between 1900 and 1960. 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 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 taken 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 affected people's reliance on the land.

Table 3.1: A time-line of local and national events

Colonial and Apartheid era			
Date	Event as told by community members	Date	National event
1883	Resettlement because of Trust, followed by cutting of trees for building and farming. People came from Thabathi village, close to Tsolo. "The landscape used to be a very green with intact soils and nice forests."	Late 1800s 1890s	European settlement extends to the area Rinderpest outbreak and quarantine controls
1916	Resettlement into mountains, cutting of forests	1913	Native Land Act
		1930s	Betterment Planning initiated
1947	Drought that killed livestock, caused soil erosion	1948	Apartheid legislation
1956 1950s	Drought & famine which was accompanied by a fever that killed people Tornado, loss of crops	1951 1953 1959	Black Authorities Act Bantu Education Act Promotion of Black Self Government Act
1960 Early 1960s	Resettlement; houses on top of mountains moved to lower slopes; regulations to reduce livestock numbers so that veld could recover; Veld fires contributed to soil erosion Bad erosion started	1960s 1965	Betterment Planning in Elangeni Increase in pensions granted to Black Africans
1970 Late 1970s 1979	Drought accompanied by a disease that killed cattle Still planting fields. Floods – wet year		
1983	Drought	1983	National level drought caused by El Niño
1990 1993 1994	Floods that destroyed housing and roads but brought about the school that the workshop was held in. Drought that killed livestock and crops Drought and veld fires. Migration of women to urban centres; men no longer returning to villages to help with ploughing and planting.	 1994	 End of Apartheid with democratically elected government

Post-apartheid			
1997	Tornado	1994	RDP (Reconstruction & Development Programme)
		1996	GEAR (Growth, Employment & Redistribution)
		1995/1997	
		1998	Land Reform policies
1999	Child grant contributed negatively to planting fields – easier to buy from shops	1998	National Water Act National Environment Management Act Child support grant introduced
2000	Floods and veld fires		
2003/2004	Fences stolen, completely stopped farming; increased poverty	2005	ASGIS (Accelerated & Shared Growth Initiative for South Africa)
2010	Tornado	2010	New Growth Plan
2013	Mass death of cattle due to lack of grazing land and dry conditions; flooding – mudslide blocked road.	2012 2013	NGP (National Development Plan) State Land Lease and Disposal Policy
2015	Dongas widened more than before	2014	Mzimvubu Water Project launched

Urban labour and Influx controls

Many able bodied men were taken to work in the mines in the Johannesburg area. Influx controls meant that women could not join their husbands as 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 and1983 over 400 000 isiXhosa were forcibly removed from white areas to the Transkei (Simon and 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 the1950s and 1960s in response to widespread erosion in communal areas (Beinart, 1984; 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 cultivated lands, decreased control over livestock, a concentration of roads and track 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 (Herd Hoare, 2015).

Farmer support

Farmer 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). 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 the 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 and 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).

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 owners. Despite the land reform policies instigated in the late 1990s (RSA 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 Hall and Kepe (2017), the most recent government policy on land reform (State Land Lease and Disposal Policy of 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 IMF, the World Bank and GATT and the move in South Africa towards a neo-liberal growth policy. The short lived Reconstruction and Development Programme 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 2012 (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 and 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 and 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 on commercial farms.

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. 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 since 1994 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 further reduced the areas cultivated, including home gardens.

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.

3.4 The people of Sinxaku

3.4.1 A democratic analysis of Sinxaku

A demographic analysis was conducted for the Sinxaku villages based on data extracted from the 2011 Census using SuperCross by Danuta Hodgson. Updated information is available from Weyer (in preparation) and Van Tol *et al.* (2017). Here we present our findings on the demographic profile, employment status and household services.

According to the 2011 census the two villages comprise 1781 people living in 500 households. The population is spread more or less evenly between Upper and Lower Sinxaku. Females comprised 53% of all people in the Sinxaku area in 2011. The age-sex distribution demonstrates some interesting dynamics of population movements (Figure 3.5). From the 2011 distribution (Figure 3.5a) it can be seen that that from the age of 35 the male population declines relative to females. There is a sharp drop in the age cohort for both sexes from 25 to 44, the economically most active group. Migration to cities and mines has for many years depleted the rural male working population; since 1994 women have been able legally to join their husbands in urban centres. Figure 2.5b compares population figures for 2001 and 2011. It is apparent that many of those who were aged between 5 and 20 years in 2001 (now 15 to 30) have left the area. There was a small influx of people older than 45.

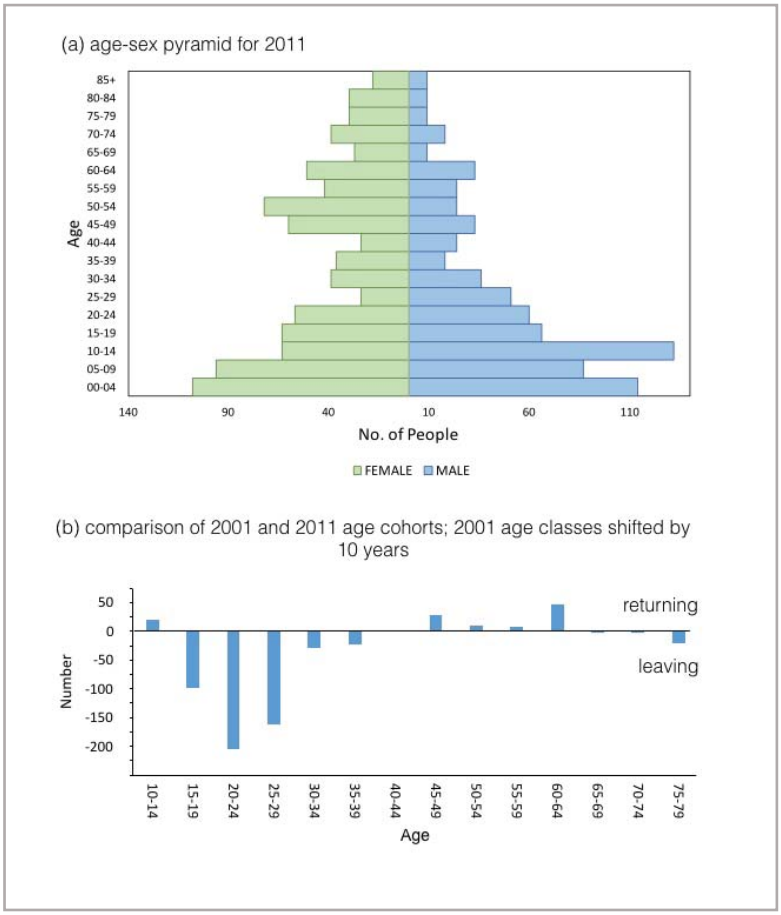


Figure 3.5: Demographic profile of Sinxaku

Table 3.2: Employment status of Sinxaku residents

Total people	% employed	% un-employed	Employed	Un-employed	Discouraged work seeker	Chose not to work	Not applicable
1701	5	34	45	246	54	534	822

Of the working age population, 28% was categorised as unemployed but a significant proportion (61%) stated that they had chosen not to be employed (Table 3.2). Social grants represent a significant cash injection into the community. Old age grants were increased significantly in 1994 and child support grants introduced in 1998. They were again adjusted in 2017. On average there are 1.4 children under 18 years and 0.5 pensioners (60 years and older) per household, equating to a total grant of R1332 per household (2017 figures). Weyer (in preparation) reports slightly higher figures. Of 20 randomly selected households surveyed in Lower Sinxaku, he found an average monthly income from social grants of nearly R2000 and a maximum of R4500. Only two households did not receive a grant. Others received between two and six grants. Thirty percent relied on social grants for their income, a further 55% received grants but also sold livestock, crops or natural resources harvested from the area. Remittances were not a major source of income. Weyer (in preparation) found that when parents moved to urban areas the child support grant was not received by carers in the village. Similar figures were reported by Van Tol *et al.* (2017) for five villages

studied in the wider area around the Ntabelanga dam in 2016. Nearly 50% relied entirely on social grants, a further 20% supplemented grants with piece jobs and 11% received income from relatives.

Household energy use, access to water and sanitation facilities are given in Tables 3.3 to 3.5. These are all aspects that can have an impact on the local environment. According to information gained during a workshop in July 2015, most houses were electrified in 2007, only those built after this time are not on the grid. Electricity is therefore by far the most favoured form of lighting but, due to expense and unreliability, is used by fewer households as the main energy source for cooking and only a few use electricity for heating. Wood, followed by paraffin, is the most favoured fuel. It is surprising that so few households reported gas as their preferred cooking fuel. All houses we stayed in used gas; they may have been anomalies or conditions have changed since 2011.

Table 3.3: Household Energy Use

COOKING							
Total House-holds	**Electricity**	**Gas**	**Paraffin**	**Wood**	**Solar**	**Coal**	**Animal dung**
492	252	21	72	144	3	0	0
HEATING							
Total House-holds	**Electricity**	**Gas**	**Paraffin**	**Wood**	**Solar**	**Coal**	**Animal dung**
489	78	0	84	291	0	0	3
LIGHTING							
Total House-holds	**Electricity**	**Gas**	**Paraffin**	**Candles**	**Solar**		
492	459	0	6	27	0		

Most of the wood used in households on an everyday basis is purchased from a plantation and brought in by the bakkie load. Wood for ceremonial purposes is collected from the local environment (Weyer, in preparation)

Very few households use renewable energy. Three houses in lower Sinxaku use solar power for cooking. The use of animal dung for heating is also very limited (three households in Upper Sinxaku).

Table 3.4: Access to water

(a) ACCESS TO PIPED WATER							
Total House-holds	**Inside dwelling**	**Inside yard**	**< 200 m**	**200-500 m**	**500-1000 m**	**> 1000 m**	**No access**
501	0	0	135	54	63	24	204

(b) MAIN SOURCE OF WATER								
Total House-holds	**Water scheme**	**Bore hole**	**Spring**	**Rain water tank**	**Dam/ pool**	**River**	**Water vendor**	**Water tanker**
492	108	3	0	36	24	186	69	24

Access to a clean and reliable water supply has been repeatedly mentioned as a major concern of village residents. Statistics describing access to water are given in Table 3.4. No households reported having piped water linked to their dwelling and, unless they have a rain water tank, have to travel a significant distance to get water. The statistics say nothing about the functionality of piped water schemes. Since we first visited the area in July 2015, taps in Upper Sinxaku have been dry due to malfunctioning pumps. According to one resident, surface water is preferable to borehole water because of the taste. River water is by far the most common source of water used in Lower Sinxaku. According to the 2011 census, rainwater tanks supplied 36 houses but this number has since increased significantly (informal field observations). Weyer (in preparation) found that 40% of his sample had rain water tanks, mostly bought at their own expense. When these dry out during prolonged dry spells the owners use an alternative source of streams from the mountain, the Tsitsa River or water trucks brought from the Ntywenka Planation. The cost of transporting bulk water is said to be R250 for 250 litres.

Statistics on sanitation and refuse disposal facilities are given in Table 3.5. It can be seen that there are limited toilet facilities and no formal refuse collection. Over half the households reported no rubbish disposal facilities. Together this points to a high potential for pollution of the local landscape by faecal matter and household waste.

Table 3.5: Sanitation Facilities and Refuse Disposal

(a) REFUSE DISPOSAL					
Total House-holds	**Removal by Local Authority or private company**	**Communal refuse dump**	**Own refuse dump**	**No rubbish disposal**	**Other**
501	0	0	228	261	12

(b) SANITATION							
Total House-holds	**None**	**Flush toilet**	**Chemical toilet**	**Pit toilet (VIP)**	**Pit toilet (other)**	**Bucket toilet**	**Other**
486	294	0	66	3	87	0	36

The statistics presented in Tables 3.2 to 3.5 were derived from the 2011 census. From our observations while staying and working in the area it is apparent that, in some aspects, conditions have improved. While census figures provide a useful starting point for describing conditions in an area it is recommended that a survey is taken to capture up-to-date information for both Upper and Lower Sinxaku if it is required for planning and implementing rehabilitation.

3.4.2 Local governance structures

The two Sinxaku communities fall within the tribal authority of Elangeni. The traditional leadership structure is shown in Figure 3.6. The Chief has authority over this area through a tribal council. The tribal council is made up of the headmen from each of the Administrative Areas, two of which are Upper and Lower Sinxaku. Under the headman are several sub-headmen, each responsible for a small settlement comprising around 15 households. Households must take their concerns to the sub-headman who will either deal with them directly or take them higher up the chain. Tribal leaders are hereditary in nature, though the length of time a family has held a leadership post varies. Some chiefs and headmen were put in place by the British colonial authority and are still felt to be less authentic, commanding less respect from the community. Chiefs are responsible for matters relating to land issues including access and communal use.

The boundary of the Elangeni Tribal Authority approximates that of the Municipal Ward which comes under an elected councillor. The Ward Councillor is responsible for bringing externally funded development projects to the area. Community members were sometimes wary about engaging with the councillor because of the political nature of the appointment.

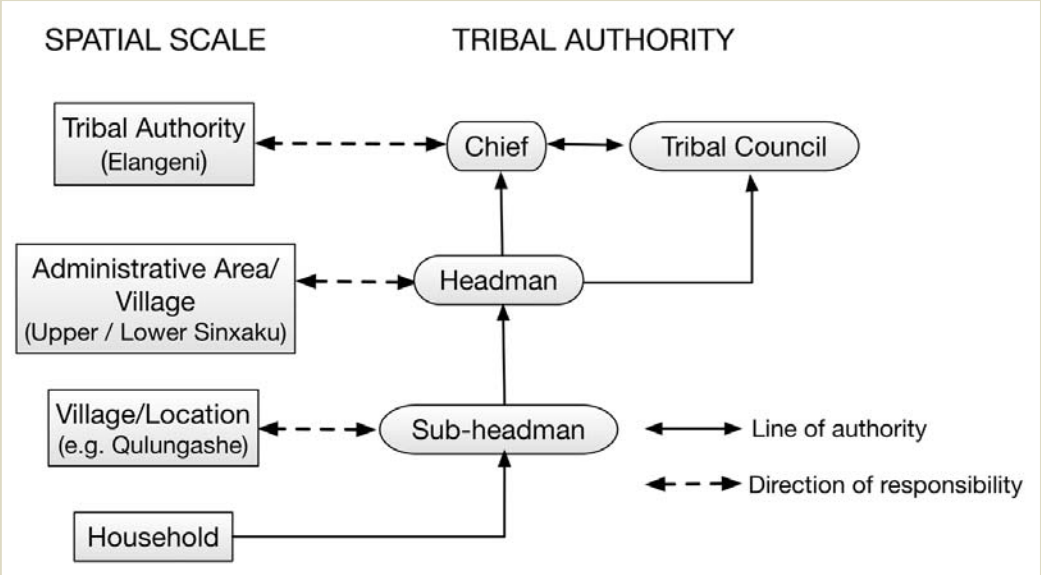


Figure 3.6: Traditional leadership structure in Elangeni

3.4.3 Land use practice and use of natural resources

Livestock are an important household asset in the Sinxaku villages and we were told that most households would own some animals. Typical numbers of livestock and age of owners, derived from a sample of twenty people who attended a livestock workshop in Upper Sinxaku, is illustrated in Figure 3.7. Given the wide range in numbers presented, the sample, although small, is probably representative of the range of numbers owned by households in the villages. Weyer (2015) found that for the twenty house-holds surveyed in Lower Sinxaku the average numbers per households were cattle: 4, goats: 11, sheep: 7. These are similar to but lower than for Upper Sinxaku (cattle: 6, goats: 15, sheep: 20). However, his sample did not include owners of large herds. Three large sheep farmers from Lower Sinxaku were interviewed by Green Village researchers. They all owned more than 100 sheep, one over 200. Two owned 10 and 11 cattle each and 30 and 64 goats. The third farmer did not own cattle but had over 100 goats in addition to over 100 sheep. These are sizable numbers.

Livestock are left free to range with little control, but are brought back to the village at night for safety. Herd-Hoare (2015) surveyed community members about their use of livestock. She found that they place a high value on the ownership of livestock, with cattle being the most important, followed by sheep and goats. Cattle have multiple uses: traditional purposes, a food source, and sale. Wool is an important commodity. Weyer (in preparation) reports that in 2015 a 50 kg bag of wool would fetch between R300 and R700 if sold in Maclear. The sale of livestock within the local area makes a significant contribution to the household income. Goats are important for traditional ceremonies amongst the youth.

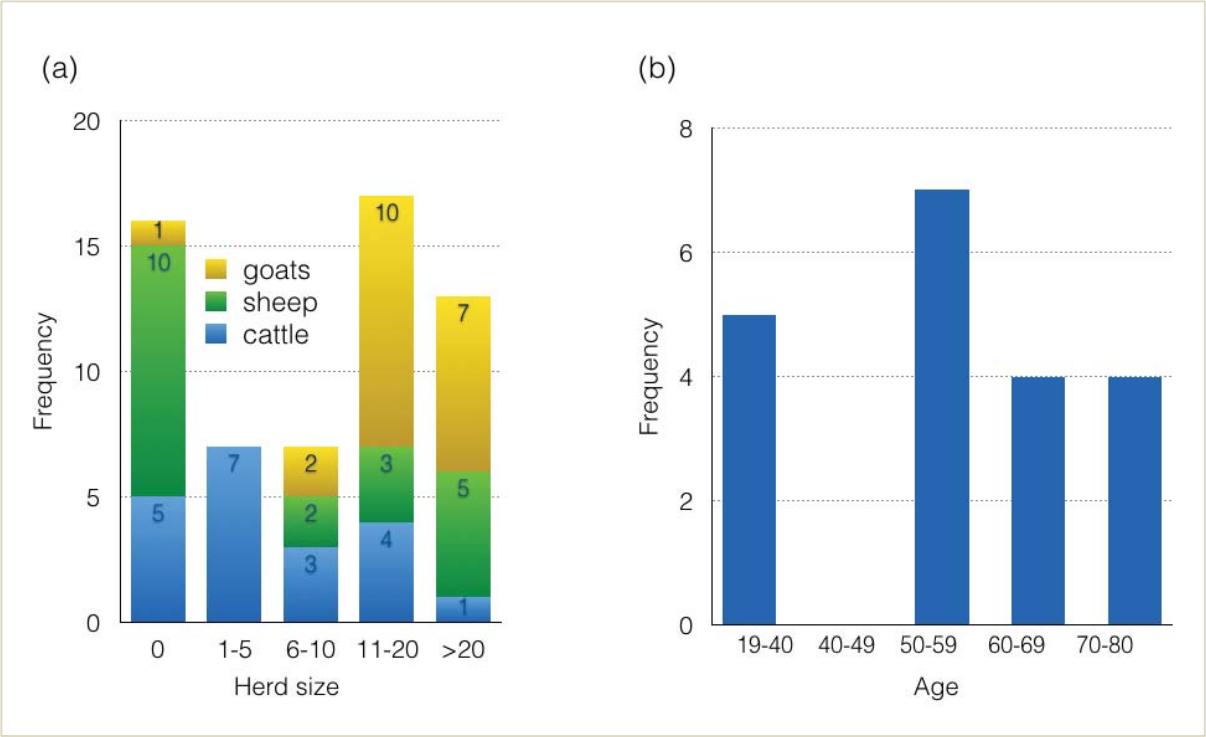


Figure 3.7: Livestock numbers for twenty households in Upper Sinxaku

The perception of some householders interviewed by Herd-Hoare is that livestock numbers have decreased over time. There was a sharp reduction in 1965 following Betterment Planning imposed by the government. Severe loss of livestock due to drought in 2013 is indicated in Table 3.1 above. Following the change in government on 1994, the migration to the cities leaves fewer to people to look after stock. Stock are also owned by people living in urban areas, looked after by a local resident. Theft is also a problem. The growth of Christianity has reduced the important of livestock for traditional ceremonies. Other householders interviewed intimated that livestock numbers had increased due to the breakdown of controls on the number that can be owned.

Cultivation was once widespread on the lower areas of both villages but has now almost ceased entirely. The main reasons given are drought, lack of manpower to plough, lack of access to tractors and machinery, theft of fences, soil erosion and reduced fertility and a lessened need to grow crops due to the introduction of child subsidies in 1999 (workshop outputs this project, Weyer (in preparation), Van Tol (2017)). Cultivation is now confined to gardens next to the homesteads. These are securely fenced. Although most households have a fenced garden not all are cultivated. It was reported that home gardens had been reduced in number due to lower soil productivity and increased social grants. Gardens are used to grow vegetables, including wild spinach, and fruit: peaches, oranges, lemons, prickly pear. A wide variety of crops grown including maize, cabbage, spinach, wild spinach, peas, beans and beetroot. Peach trees are also found in most gardens and are said to bear well. Oranges, lemons and prickly pear are other fruit mentioned by workshop participants. One householder practices a form of water harvesting and is able to sell his crops to others in the village. The Community Works Programme (CWP) is also responsible for helping older people with their gardens. The employees are able to use or sell crops surplus to the needs of the elderly beneficiaries.

Soil health in gardens in Lower Sinxaku was investigated by Nqandeka. Soil was analysed for ten gardens and ten sites sampled in the vegetation survey. A soil health index was derived from the measures including

nitrogen (N), phosphorus (P), sodium (Na) and potassium (K) concentrations, soil organic carbon (SOC), aggregate stability. Soil health values for gardens ranged from a high of 97.8% to a low of 70.9%. For vegetated sites the range was 82.4 to 53.8%. Low values in gardens were attributed to low soil organic carbon (2 sites), low phosphorus (3 sites), low potassium (1 site) and poor aggregate stability (nine sites). The vegetated sites scored more poorly with respect to SOC, BC, P and K but better for aggregate stability. It can be concluded that in general applications of manure (the main fertilizer) maintains soil fertility but frequent tillage breaks down the fine aggregate structure.

Garden maize yields were measured at the end of two seasons and compared to the optimal yield for the area in the absence of fertility and water constraints. Despite generally favourable soil conditions, yields in all gardens were well below the optimum. The best garden had a yield of 2.15 tons/ha against an optimum of 5.6 tons/a. Nqandeka suggested that the yield gaps of between 0.73 t/ha and 4.38 t/ha can be explained by unreliable rainfall, lack of labour, lack of external inputs and poor quality seed.

Social benefits were given by Sinxaku residents as one reason why cultivation had stopped. Other reasons given were that after 1994 women were legally allowed to migrate to urban areas and did so to join their husbands. This meant that men no longer returned to the villages in the ploughing and harvesting season, so manpower became a problem. By 2004 fences were in disrepair and in 2004 many were stolen. Fields were no longer protected from cattle and field cultivation ceased. Limited access to tractors was also seen as an impediment to crop farming.

When asked about use of natural resources, firewood collection was an overwhelming response but little wood is in fact collected from the local area. The main source of fuel wood is wattle and eucalypt from the Ntwenka Plantation on the southern edge of the area. This is brought to the villages by bakkie and sold to households. The river provides fish and medicinal plants as well as sand for building. Thatch grass (also used for brooms) is collected from the mountains and old fields. Rabbit, small buck and jackal are all hunted for food.

3.4.4 Community perceptions of erosion

The time-line in Table 3.1 illustrates the community's perception of erosion. Although the largest dongas have been present for the lifetime of the oldest residents, erosion was thought to have worsened in the 1960s and is worsening today. Widening of dongas threatens houses, gardens and roads. Tunnel erosion was perceived to be localised and presented an additional hazard because livestock could fall through the eroded holes in the veld. Open dongas were not seen to present a hazard to livestock; rather they could provide watering points and sheltered grazing.

Workshop participants reported that serious erosion began in the early sixties, attributed to drought, veld fires and clearing trees from waterways. Until the 1990s Rangers, formerly employed by the Transkei Government, were responsible for controlling fire and wood collection. Rangers stopped working sometime after 1994. Livestock were not blamed for erosion. There had been some attempt in the early '90s to stabilise dongas using gabion type structures. The breakdown of governance systems since 1994 is apparent, as was also found by Herd-Hoare (2015).

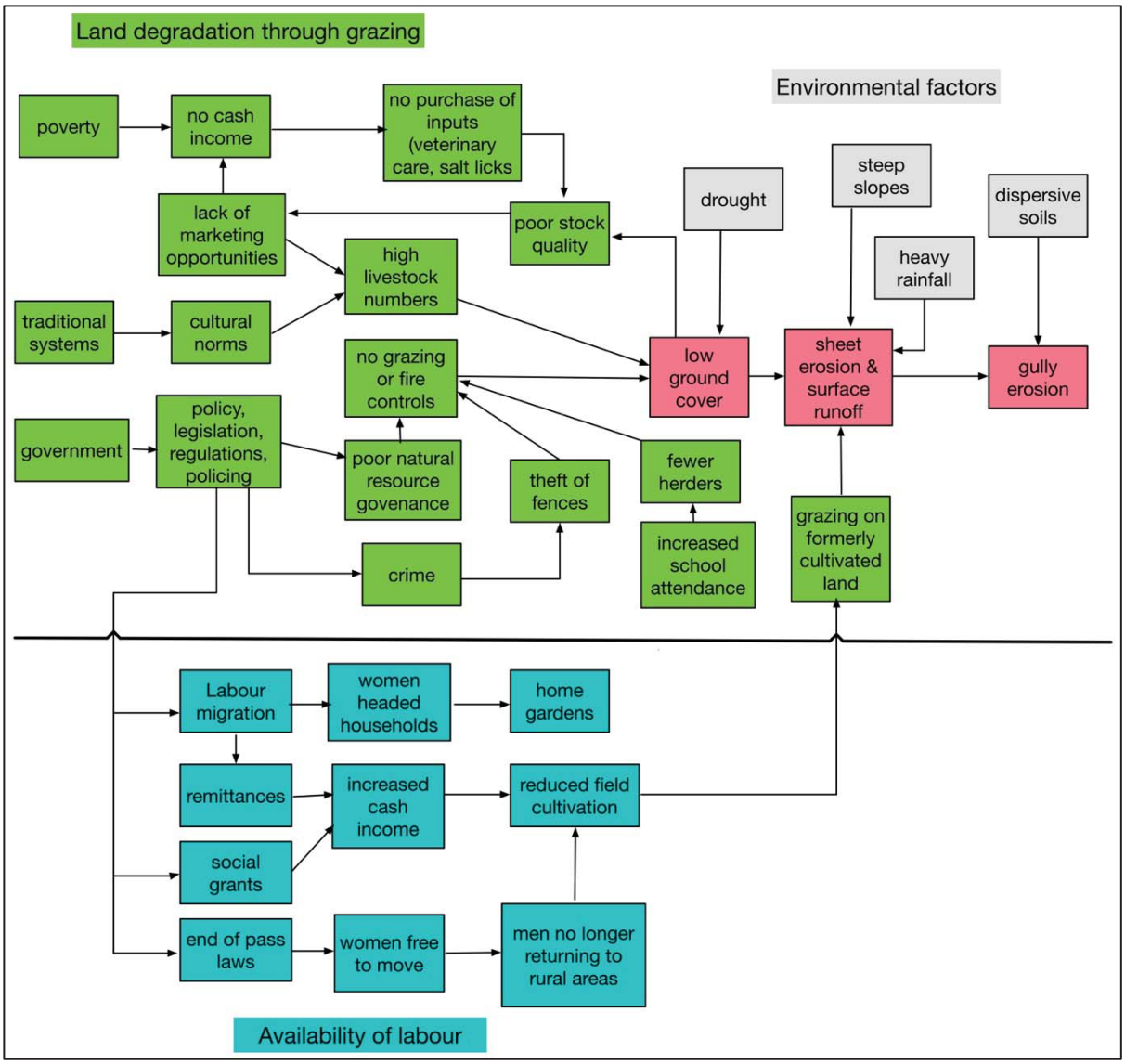


Figure 3.8: Environmental and socio-political factors leading to land degradation

The severe erosion in Sinxaku and other areas lying adjacent to the proposed dam's inundation area is clearly the result of environmental factors (steep slopes, dispersive soils, drought and floods) and socio-political factors that have limited the potential for local people to use land sustainably and to counteract erosion. The complex relationship between these factors as played out in the former homeland area of the Tsitsa catchment and Sinxaku is illustrated in Figure 3.8. Poverty, traditional systems and government policies have together determined land use patterns and resulting degradation. Government policies have had a significant impact on the availability of labour for agricultural activities which also has had a direct impact on land use and, ultimately, land degradation. The relationships shown are based on understanding gained from literature reviewed in Section 3.3, often confirmed by our own research in Sinxaku. Figure 3.9 illustrates the impact of poverty and health on an individual's capacity to engage in rehabilitation activities. Although rehabilitation may offer the incentive of paid labour, constraints on time, poor health and physical strength and low skills attainment act as disincentives. It is clear that improved livelihood incentives and government policies that are empathetic to the conditions and culture of these rural areas are both important conditions for future rehabilitation efforts leading to landscape greening.

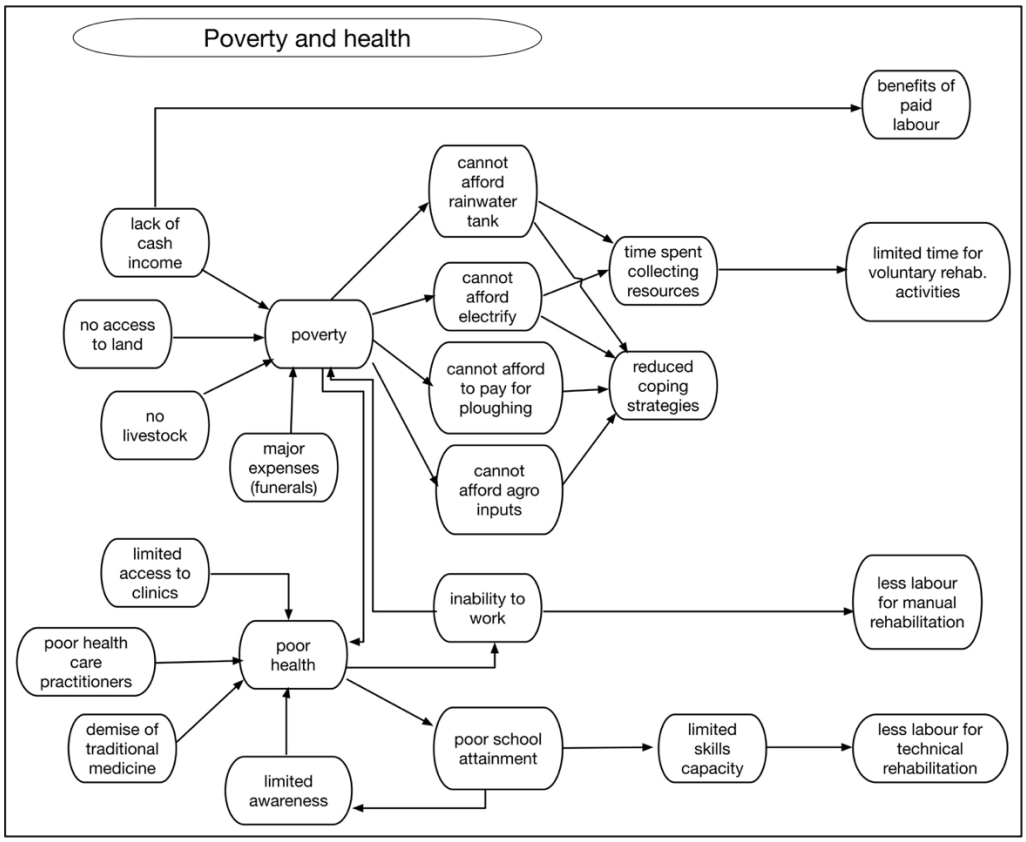


Figure 3.9: Impact of poverty and health issues on capacity for undertaking rehabilitation work

3.5 The DEA-NRM's rehabilitation project and NLEIP

The DEA has three Chief Directorates under their Environmental Programmes, namely: the Environmental Protection & Infrastructure Programme (EPIP), Information Management & Sector Coordination (IMSC) and Natural Resource Management (NRM). There is some overlap between the EPIP and the NRM as both are concerned with the protection of ecosystem function but, according to the DEA website, an important difference is that the EPIP focusses on creating work opportunities whereas the NRM focuses on meaningful livelihood opportunities. Both work with the Extended Public Works Programme to employ labour. The EPIP is responsible for, among other things, the Working for Land programme. This supports local scale rehabilitation at the village level in a number of South African provinces. The DEA-NRM is the key department active in the Tsitsa catchment where they have instigated a rehabilitation project. The Ntabelanga and Lalini Ecological Infrastructure Programme (NLEIP) serves as a forum that brings together researchers, managers and implementers and provides guidance to the DEA-NRM's rehabilitation process.

The Ntabelanga and Lalini Ecological Infrastructure Project (NLEIP) is a catchment scale rehabilitation and sustainable land use management programme funded primarily by the DEA in collaboration with the Department of Science and Technology (DST) and the Water Research Commission (WRC). It embraces a large and varied group of research and catchment management partners and links to many different stakeholders. The Sinxaku Green Village Project is one contributor. NLEIP (2017) presents the strategic thinking behind the adaptive management plan for rehabilitation and sustainable land use management in the Tsitsa catchment above the proposed Ntabelanga and Lalini dams.

The catalyst for NLEIP was the proposal to build the two dams on the Tsitsa River – Ntabelanga and Lalini – through the Mzimvubu Water Project of the DWS. High rates of soil loss from the catchment threatens the feasibility of these dams. Le Roux et al. (2015) estimated that on average 1 M tonnes per year of sediment would be delivered to the Ntabelanga dam and predicted a 47-year lifespan for the dam. Rehabilitation of the eroded catchment slopes is therefore aimed at reducing sediment input to the dams and increasing the lifespan of the Mzimvubu Water Project. Most of estimates of catchment sediment yield are derived from models and vary greatly. There is limited data on measured sediment loads in the Tsitsa. A DEA funded sediment monitoring programme was started in late 2015 and is ongoing (Bannatyne *et al.,* 2017). The early monitoring period, for which data has been analysed, covered a period of drought so the data are likely to underestimate long-term yields.

Bester (2016) used early estimates by Le Roux *et al.* (2015) to calculate the cost of siltation on the dam's operational capacity to be R890,000,000 over an estimated lifespan of 47 years. This amounts to R0.11 for every cubic metre of water extracted from the dam. These values assume 2014 figures. The projected cost of the dam has increased from R12.45 billion in 2014 to R15.3 billion in 2017 (Mkhize, 2017), indicating that the cost of siltation will also increase.

Whether or not the dams go ahead, the DEA-NRM is committed to rehabilitating the catchment so as to improve ecological infrastructure in support of ecosystem services and livelihoods.

Although rehabilitation itself tends to be a technical activity, many authors have stressed that it cannot be a sustainable solution to the sediment problem unless it is done in a manner that engages local communities in an appropriate and beneficial manner (Morgan, 2005). NLEIP describes itself as "unashamedly socio-biophysical …and systemic (holistic) in nature and centres around local livelihoods, especially in the ex-homeland areas of the catchment." (Draft NLEIP Adaptive Management and Restoration Plan July 2017). The project vision is given as:

> *"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."*

Research in support of NLEIP is organized through the following three communities of practice (COPs):

- Sediment and Restoration,
- Livelihoods and Ecosystem
- Governance.

Each has its own vision to guide activities as stated in the Draft Adaptive Management and Restoration Plan:

1. Sediment and Restoration

"To service the NLEIP 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"

2. Livelihoods and Ecosystem Services

"To build a robust and dynamic community of practice that:

a) fosters learning among different actors
b) guides and synthesizes integrated research on livelihoods and ecosystem services
c) distils key lessons and recommendations for promoting resilient livelihoods within NLEIP."

3. Governance

"Understand, prototype and help implement effective (polycentric) governance. While the main focus is on NLEIP outcomes we imagine the sphere of influence may necessarily reach neighbouring catchments. We will also advise on internal project governance."

The on-ground implementation of the DEA-NRM's biophysical rehabilitation measures is currently the responsibility of the Gamtoos Irrigation Board (GIB). Employment of workers is through the Expanded Public Works Programme (EPWP). There has been some activity in the Elangeni Tribal Authority, in which the Sinxaku Administrative Areas are situated but this has been intermittent over the two years of our project, partly due to funding delays and partly due to the recognition by the DEA-NRM that a more coherent plan is needed.

To date (July 2017) much of NLEIP's activity has been focused on planning the biophysical and social aspects of rehabilitation with less progress being made on engaging communities in the process. One exception has been the Sinxaku Green Village Project that aims to develop beneficial livelihood initiatives and entrepreneurship that can be linked to rehabilitation. The project embraces the three communities of practice and provides a prototype that can provide lessons for NLEIP. Researchers from the Sinxaku project are active members of the Sediment & Restoration and the Livelihoods and Ecosystem Services COPs. We attend biannual NLEIP Science-Management Meetings and have made significant contributions to the Adaptive Management and Restoration Plan. The Sinxaku project's workshop facilitator was closely involved in data collection for the Stakeholder Analysis and is also facilitating the current community mapping programme that is covering a number of tribal authorities. There is thus much opportunity for sharing learning between NLEIP and our project. This is discussed further in Chapter 7, specifically Section 7.2.2.

CHAPTER 4. GUIDELINES FOR PRODUCTIVE AND SUSTAINABLE GREENING OF THE LANDSCAPE, INCLUDING MONITORING

4.1 Introduction

This chapter presents guidelines for productive and sustainable greening of the landscape, including monitoring. It addresses the key aim of the WRC project K5/2423 to develop and test practical and appropriate mechanisms, manuals and guidelines for landscape development and management that will protect the infrastructure and improve ecosystem services. There are a number of other guidelines that have been produced for natural resource management in the region, Africa and globally. It is not the intention to reproduce the wealth of material available from these reports but rather to highlight their key principles and learning. This chapter has been informed by the experience gained through working with the Sinxaku community – the Sinxaku Green Village.

In common with much of the former homelands of the Ciskei and Transkei, Kwa-Zulu Natal and Lesotho, the area adjacent to the proposed Ntabelanga dam is dominated by dispersive, duplex soils. As noted in Chapter 3, these soils contribute greatly to land degradation through tunnel erosion. The intractable nature of problems relating to these soils will be a continuing theme through this review.

Braid and Lodenkemper (in preparation) provide a comprehensive outline of lessons learnt from previous South African projects that have attempted to instigate more sustainable management of natural resources, including rehabilitation projects. The reader is referred to their report for further details of the different projects. Key South Africa projects listed that relate closely to the NLEIP and Sinxaku green village are the uMngeni Ecological Infrastructure Partnership (UEIP) and the Umzimvubu Catchment Partnership Programme (UCPP). Further lessons come from the Baringo Fuel and Fodder Project (BFFP) (Rift Valley Province, Kenya) described by De Groot *et al.* (1992). It is an example of successful community-based natural resource management that achieved the duel aims of rehabilitating badly degraded land and resuscitating the livestock economy of the area.

A comprehensive data base on the practice of sustainable land management has been compiled by WOCAT (World Overview of Conservation Approaches and Technologies). WOCAT describes itself as “an established global network which supports innovation and decision-making processes in Sustainable Land Management (SLM)” [https://www.wocat.net]. South Africa is a member of this network. Liniger *et al.* (2011) provide a comprehensive set of guidelines for SLM in sub-Saharan Africa, prepared on behalf of WOCAT.

It is beyond the scope of this report to review all the vast material that is available through the WOCAT the site. Rather it is the intention to direct the reader to this resource that “provides tools that allow SLM specialists to identify fields and needs of action, share their valuable knowledge in land management, that assist them in their search for appropriate SLM technologies and approaches, and that support them in making decisions in the field and at the planning level and in up-scaling identified best practices” [https://www.wocat.net/en/ Available: 4th July 2016] Users of this extensive knowledge base are required to register online with WOCAT, a short process.

This report draws also on our experience from research in the Sinxaku area and the Tsitsa catchment. First-hand knowledge of working on natural resource management projects with local communities also comes from the Kat Valley where we facilitated the creation of the Kat Valley Catchment Forum and helped them

to develop the proposal for and implement the two-year Sisonke LandCare project designed to control erosion in the area.

Before examining remedial actions to address land degradation it is necessary to understand land degradation processes that directly increase sediment production from the landscape. The sediment system is described using a framework of sources, pathways and sinks (Figure 4.1) which is then used to describe practical rehabilitation guideline. The problems of rehabilitating dispersive soils and the importance of managed grazing are highlighted. Legal implications of rehabilitation are also considered. The last section relates to monitoring techniques.

4.2 The Sediment System

Effective rehabilitation requires a good understanding of the processes that effect sediment movement through the landscape. It is necessary to consider the components of the sediment system – sources, pathways and sinks. The relationship between sources, pathways and sinks, the relevant landscape components and associated anthropogenic features are illustrated in Figure 4.1.

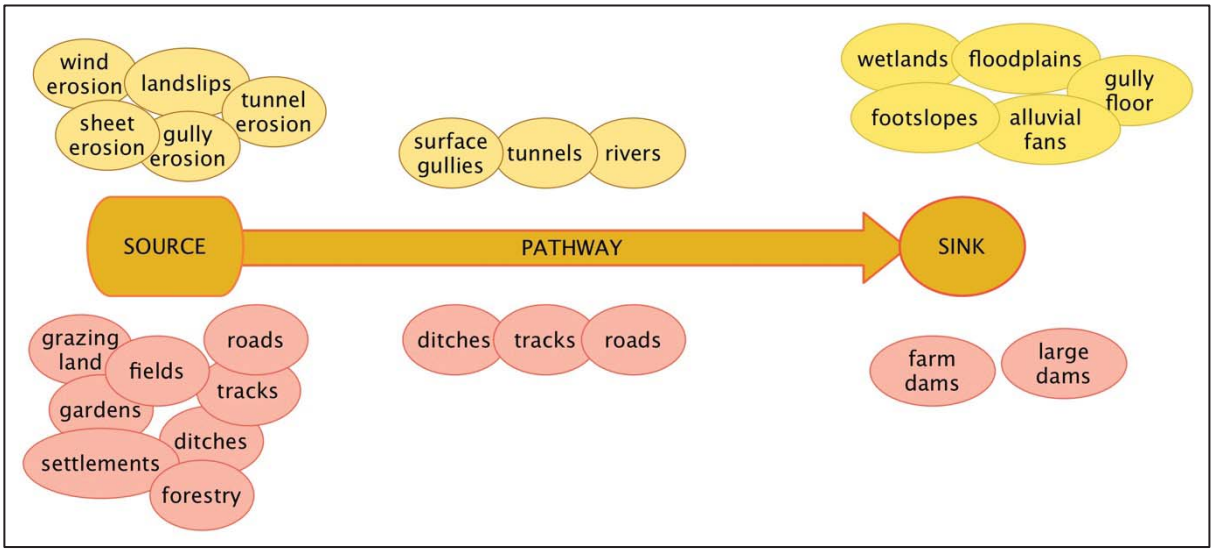


Figure 4.1: Potential sources, pathways and sinks in the Tsitsa catchment. The upper blocks represent components and processes in the natural system. The lower blocks represent modified components of the natural landscape that act as source areas, pathways and sinks.

4.2.1 Definitions

i. Sources

Sediment is sourced via erosion processes that operate in different parts of the landscape. It is common to differentiate between two categories of sources – source provenance and source type. Both are important when planning rehabilitation.

Source provenance – this relates to the AREA that is contributing erosion and may be identified as a sub-catchment or an area typified by a particular geology or broad land use classes. Identifying the source provenance will enable rehabilitation efforts to be directed to the most beneficial area within a catchment.

Source type – this relates to the FEATURE that is contributing sediment. In Sinxaku these would include surface erosion v. gully erosion, agricultural fields v. grazing land, forestry, settlement areas, roads and tracks. Knowing which source type contributes most of the sediment will guide which interventions will be most effective.

ii. Pathways

Pathways connect sediment sources to sinks. They take the form of stream courses, erosional features such as gullies and rills, tracks, ditches, underground pipes/tunnels and any other linear feature that can transport sediment when activated by flowing water. Pathways can also act as sources so play a dual role in the landscape and are therefore an important rehabilitation target. They are often visible features that attract attention and occupy a relatively small proportion of the catchment surface. Protecting pathways from erosion and, where feasible, converting them to sinks can be an effective rehabilitation strategy.

iii. Sinks

Sinks are the areas where sediment derived from source areas is deposited. In Sinxaku the Ntabelanga dams is considered to be the final sink but there are many other potential sinks upstream or upslope of the dams which can be used to store sediment and reduce delivery to the dam. An important aspect of rehabilitation therefore is to enhance the trapping effect of these sinks. Established sinks must also be protected so that they do not themselves become sources. Larger sinks connected to main channels include floodplains and wetlands. Channel incision disconnects the channel from these sinks and reduces their effectiveness. Smaller sinks associated with low order tributaries and hillslopes include gully floors, alluvial fans, hillslope deposits on low angled slopes and behind obstructions such as dense vegetation, rock outcrops or walls.

4.2.2 Erosion processes

i. Source areas

The land degradation process observed in Sinxaku is largely the result of increased runoff due to surface hardening and reduction in vegetation cover. Figure 4.2 illustrates some causes and effects of storm water runoff. Erosion in source areas can be through landslips, sheet erosion, wind erosion, gully erosion and tunnel erosion (Figures 4.3 & 4.4). These will be considered in turn.

Figure 4.2: Surface runoff processes

ii. Landslips

Landslips in Sinxaku occur on steep slopes in relatively shallow soil (Figure 4.2a). The key factor controlling the spatial distribution of landslips is slope gradient; the timing of landslip activity is a function of soil saturation resulting from heavy and prolonged rainfall. Hillslope seeps may be at risk to landslips due to their saturated status. The failure plain of a slip is commonly at the base of the soil profile and slips can occur even where the soil surface is well vegetated. Deep roots that form an anchor into the bedrock provide protection against slope failure.

Landslips result in exposure of bedrock and movement of disturbed soil downslope. Unless it becomes stabilized by vegetation this soil can become a source of surface erosion by sheet wash. The exposed bedrock promotes rapid surface runoff, increasing downslope erosion.

iii. Sheet erosion

Sheet erosion is caused by relatively shallow water flowing over an unprotected soil surface (Figure 4.2b). Soil can be detached by direct raindrop impact onto bare soil, by raindrops acting through shallow flow and by the energy of the flow itself. Rates of erosion are often in the order of a few millimetres a year and may not be noticeable in the short term, but where widespread over a catchment sheet erosion can account for large masses of sediment moving downstream. The slow loss of soil also results in a lowering of its ecological potential.

9a) Shallow landslips on steep back slopes

(b) Sheet erosion on cultivated land

(c) Aerial view of gullies incised into colluvium

(d) Gully incised into colluvium

(d) Gully headcut

(g) Discontinuous gully

(h) Infilled gully showing signs of stability

(f) Rejuvenation of gully infill.

Figure 4.3: Types of erosion

Sheet erosion can progress to rill erosion where shallow channels form at the soil surface, often in parallel to each other. The concentration of water into small channels increases the erosive force and the overall rate of erosion. Rills commonly form on bare surfaces with a significant slope. On cultivated land they tend to be short lived as they are removed by tilling but if not attended to they can lead to gully erosion. This is a common problem of formerly cultivated land that has been abandoned (Kakembo and Rowntree, 2003).

Rates of sheet erosion depend on three key factors: the amount and velocity of runoff, the resistance of the soil to erosion and the degree of protection of the soil surface. These in turn are related to the erosion factors of rainfall erosivity, slope gradient, slope length, soil erodibility and vegetation cover. These are the factors considered in the Universal Soils Loss Equation (Wishmeier and Smith, 1978), which was developed to guide soil conservation panning on farmland in the USA (Equation 1).

$$\text{Soil Loss} = f(E, SL, K, V, P) \qquad \textit{(Equation 1)}$$

where E is rainfall erosivity, SL is a slope factor combining gradient and length, K is soil erodibility, V is vegetation cover and P is a soil conservation factor.

Rainfall erosivity is the product of rainfall intensity and amount. If rainfall intensity exceeds the infiltration capacity of the ground surface, runoff will result. The amount of runoff depends on the rainfall depth. The available energy for erosion is directly related to velocity. The velocity of runoff depends on the flow volume, slope gradient and the surface roughness. Runoff volume accumulates downslope, hence slope length is an important factor.

The erodibility of the soil is the result of a number of different properties that affect its ability to promote the infiltration water and to resist detachment of soil particles. Rapid infiltration depends on having sufficient large pore spaces in the soil. Porosity depends on the size of soil particles and soil structure. Resistance to erosion increases with particle size. The most erodible soils tend to be silts and fine sands that lack cohesion but are small enough to be moved by flowing water. Clay increases cohesion and can aid aggregation of soil particles into larger, less erodible units. Cracking of clay can also increase structure when dry, promoting infiltration. Once wet, however, swelling of the clays results in an impervious surface and rapid runoff. The special case of dispersive soils will be considered below.

Factors which tend to increase the erodibility of soil to sheet wash include:

- Particle size in the silt to fine sand range
- Low organic content
- Surface crusting by raindrop impact
- Compaction by livestock, pedestrians or vehicles
- Limited development of soil aggregates

Factors which reduce erodibility of soil to sheet wash include

- Particle size in clay or medium to coarse sand range
- An open structure
- Good development of soil aggregates due to high organic matter levels, iron rich soils, moderate clay content.

Vegetation cover is one of the key factors to consider when planning rehabilitation. A good vegetation covers reduces sheet erosion in a number of ways.

- The surface cover reduces (or eliminates) the erosive nature of rainfall, providing protection against splash erosion and compaction by raindrops.

- The surface cover increases roughness and slows down the flow, inducing deposition rather than erosion.
- Roots break up the soil, improve structure and increase infiltration capacity.
- Roots hold the soil together, increasing its effective strength.
- Vegetation adds organic matter to the soil, aiding aggregate stability and increasing both the moisture holding capacity and nutrient retention ability. This in turn promotes a good vegetation cover.

The vegetation cover is the factor most prone to modification by human activity. Promoting strong vegetation growth is one of the fundamentals of soil erosion control. It is a key consideration in any soil and water conservation effort. Vegetation increases soil water and nutrient retention in the landscape which in turn increases the potential for vegetation growth.

iv. Wind erosion

Wind erosion can be important in areas with a reduced vegetation cover during dry spells when dust from the soil surface can be mobilised. The direction of movement will be determined by the dominant wind direction. Although important in redistributing sediment it is unlikely to be a significant contributor to sediment in the Ntabelanga dam.

v. Gully erosion

When water is concentrated into sloping depressions the force of the water can overcome the surface resistance and cause incision into the soil to form a gully. The initial incision may be at a small scale but engenders further flow concentration and vertical erosion. Gullies are normally formed either in deep soils, such as colluvium on lower slopes, or in highly weathered bedrock such as is characteristic of Karoo shales or mudstones. Once initiated the gully may extend upslope by headcut erosion until a point is reached where the soil is too shallow and the underlying bedrock is resistant to erosion.

Gullies may form a part of a continuous drainage network that is well connected to the main stream, in which case they act as important pathways for sediment. In contrast, discontinuous gullies disgorge onto the lower, gentler hillslope where they deposit sediment in a local sink. This sediment can be reworked at a later stage and become a source, but until this happens discontinuous gullies do not form a source of sediment transported to the catchment outlet.

Gullies often form in shallow drainage lines overlying deep sediments. These may have been seepage lines or shallow stream channels. The likelihood of gully erosion being initiated is increased by steep slopes, a large catchment area and poor vegetation cover along the drainage line. Vegetation cover, however, is not necessarily a limiting factor. Once incision takes place the gully will undermine the surface soil layers by upslope or lateral erosion, causing bank caving, irrespective of the vegetation cover.

vi. Tunnel erosion

In the Tsitsa catchment, many gullies are linked to tunnel erosion due to the widespread occurrence of duplex soils with their dispersive nature. This is especially true of the Sinxaku area. Duplex soils have a sandy topsoil with a relatively high infiltration capacity and a clay subsoil with a columnar structure. When dry, water can percolate through the structural cracks in the clay but, once wet, swelling reduces downward movement. Once saturation builds up the clay disperses and, at hydraulic drops, can start to flow. Eventually tunnels form, which grow larger through time. As they get bigger these tunnels collapse, creating surface gullies. The entrance to a tunnel is often a vertical shaft which may link to a surface stream. Figure

4.4 illustrates some of the processes of tunnel erosion. Relevant reviews of erosion in duplex soils is given by Beckedahl and De Villiers (2000) and Parwada and Van Tol (2016).

Figure 4.4: Erosion processes in dispersive soils

Tunnel erosion is not well understood due to its underground nature. Its occurrence is believed to be related to three main factors: dispersive soils, a propensity for saturation, an increased hydraulic gradient.

Dispersive soils are normally sodic, with a high concentration of exchangeable sodium. The salt draws water between clay platelets causing a breakdown of aggregates. Dispersive soils can be identified by looking for dribbling patterns on exposed soils (Figure 4.4g) and early stages of pipe erosion can be recognised by small holes (pitting) or tunnels on the flatter soil surface (Figure 4.4a & b) (Hardie, 2009). A simple field test can be done by placing a few sun dried aggregates in a small dish in distilled or rain water for 2 hours. The degree of dispersiveness can be determined by using the classes given in Figure 4.5. Laboratory methods that assess the chemical and physical character are described by Hardie (2009).

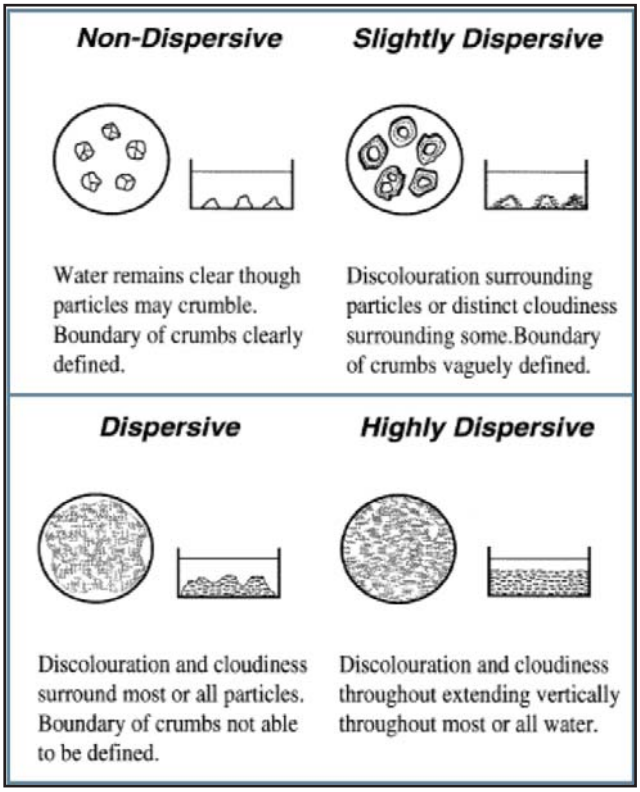


Figure 4.5: Field test for aggregate dispersion (Sorensen, 1955)

Subsurface saturation is a necessary condition for tunnel erosion. They are often associated with seepage zones. This makes their control problematic because any intervention that increases soil moisture can also increase tunnel erosion. It is important not to concentrate water at any point in the landscape prone to tunnelling. A good vegetation cover that reduces surface runoff from upslope areas is considered to be an effective means of preventing tunnel erosion.

An increase in hydraulic gradient will encourage the lateral movement of water and soil. Gully erosion is a common cause of increased gradients as associated incision forms a near vertical fall at the potential tunnel outlet. Other disturbances that can make the landscape prone to tunnelling include road construction and ditching, or any other activity that creates an incision on the hillslope.

A further problem with sodic soils is that most plants cannot cope with the conditions of poor aggregate structure, poor hydraulic conductivity, limited water infiltration and alkalinity associated with dispersive soils (Brady and Weil, 2008). This makes rehabilitation challenging unless vegetation species tolerant of these chemical conditions are used as ground cover.

vii. Gully evolution

The previous sections have explained how a gully can be initiated. Once formed they go through a process of increased instability and expansion before becoming more stable. It is important to consider how gullies evolve as the stage of gully development determines whether or not rehabilitation is an effective option. A conceptual model of the evolution of gullies initiated by either tunnel erosion or surface water erosion is presented in Figure 4.6.

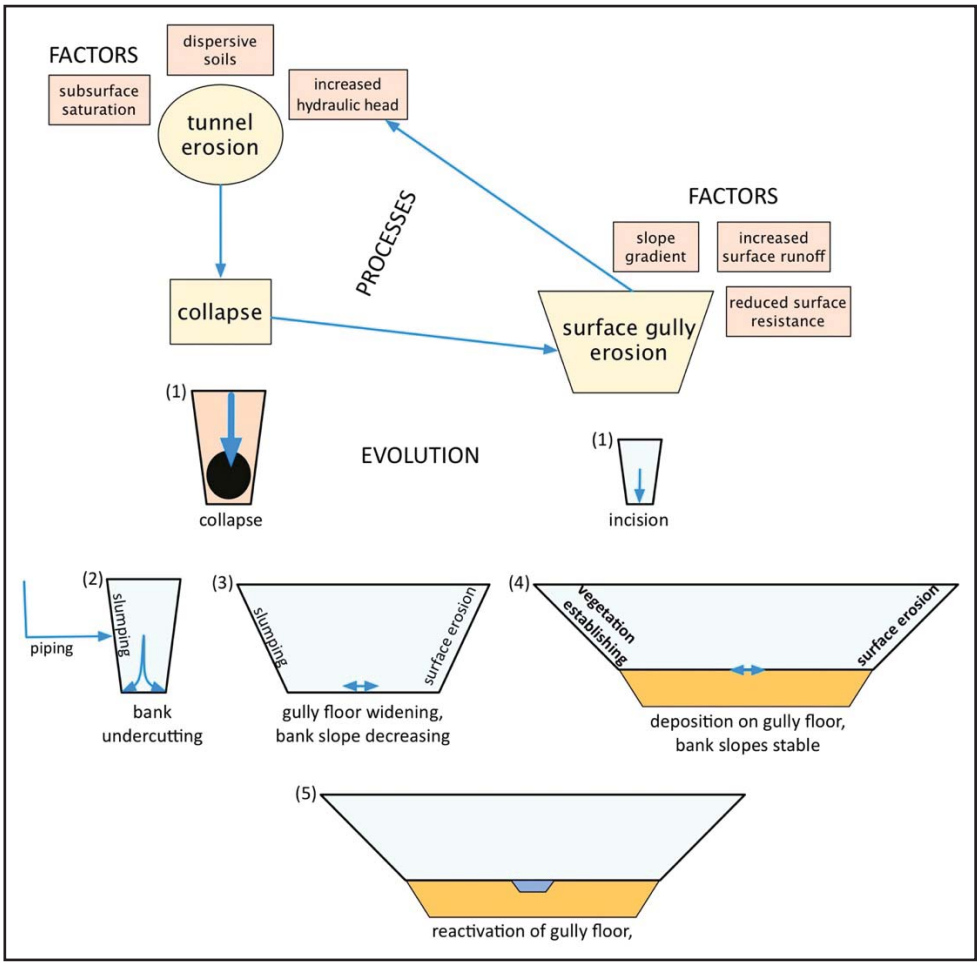


Figure 4.6: Gully development by tunnel erosion and surface erosion

In stage 1 an open gully is formed either by the collapse of a tunnel or incision by an actively eroding water course. In this stage the gully will be relatively narrow and will deepen until a new equilibrium profile is established. The gully stream will then start to move laterally on the gully floor and erode the base of the wall, causing it to collapse (Stage 2). In dispersive sediments the newly created hydraulic head will cause new tunnels to form, eventually resulting in small tributary gullies. Over time the gully widens but the walls may flatten and become more stable (stage 3), eventually supporting a vegetation cover. Sediment is deposited on the gully floor (stage 4). A second stage of incision may cause this sediment to become incised and reworked (stage 5). This process can be observed in many of the gullies of the Sinxaku villages.

This process of evolution can also be observed along the length of a gully. The head of the gully may be in stage 1 whilst lower down the gully may be in stage 3 or 4. From the perspective of rehabilitation, it is difficult and costly to stabilize a gully in stage 2 whereas a stage 3 gully, that is starting to stabilize, can be moved towards stage 4. Effort should be put into preventing the initiation of the gully process, stabilizing headcuts and preventing rejuvenation of gully floor sediments.

4.2.3 Sinks

Sinks are areas of sediment deposition. They vary in size from small deposits on gently sloping segments of hillslopes to large scale deposits in reservoirs. Deposition takes place when the carrying capacity of the flow is reduced either by reducing the slope gradient, spreading the water out over a larger area, increasing surface roughness or ponding water in a basin or behind a barrier. Moisture recharge is normally associated

with sink areas so if carefully managed they can become useful resources, either as water storage areas or areas of high biological productivity. Effectively managing sink zones can to some extent offset the negative impacts of upslope erosion.

The simplest form of sink is a well vegetated hillslope below an actively eroding area. If water can be spread over the slope the vegetation increases roughness and infiltration capacity so that both the velocity and flow volume are reduced. In the case of discontinuous gullies, the sink zone forms at the downstream end of the gully where water spreads out over the unconfined slope in a manner similar to an alluvial fan. Deposition on the confined gully floor also forms an effective sink.

While erosion acts to reduce the slope gradients (stage 1 in Figure 4.6), deposition has the opposite effect and over time the surface gradient of the sink increases. This has the effect of making the deposit more unstable and prone to reworking. This is a natural process that can be observed in many fluvial systems but can be delayed by protecting sinks by enhancing vegetation cover for example. Rehabilitation efforts should aim to enhance and protect natural sinks upstream of the reservoir.

4.2.4 Pathways

Pathways connect sediment sources and sinks so are a critical element of the sediment delivery system. Without pathways the sediment would remain on the slope in close proximity to its source, as is the case with a discontinuous gully. As was indicated in Figure 4.1, pathways may be natural erosion features or may be manmade. Roads, tracks and ditches are significant pathways in many landscapes.

Rehabilitation planning can consider pathways from two perspectives. Firstly, by mapping pathways it is possible identify source areas that are most likely to deliver sediment to downslope areas. These source areas should then become the focus of rehabilitation. Secondly, if pathways can be disconnected from their source zones, or be converted into sinks, the downslope/downstream delivery of sediment will be significantly reduced. Thirdly, pathways can be redirected towards effective sink zones, thus disconnecting them from downslope sinks where their impact is thought to be negative. Redirection of road runoff on to adjacent fields or gardens is an example.

4.3 Putting rehabilitation into practice: technical guidelines

4.3.1 General principles

This review is structured according to the concept of sediment sources, pathways and sinks described above (Section 4.2). Figure 4.7 indicates the principles that should be applied in each component. There are many texts that provide a comprehensive background to rehabilitation through soil and water conservation. The reader is referred to the key texts in Box 4.1.

Box 4.1 Soil and water conservation guidelines

Everson, T.M., Everson, C.S., Zuma, K.D. 2007. Community-based research on the influence of rehabilitation techniques on the management of degraded catchments. WRC Report no. 1316/1/07.

McCosh, J., Dickens, J. and Johnston, R. 2013. Sustainable Land Management Interventions for the Uthukela District Municipality. Report to Afromaison, a project funded under the Seventh Research Framework of the European Union. Institute of Natural Resources, Pietermaritzburg, South Africa.

Morgan R.P.C. 2005. Soil Erosion and Conservation. Blackwell.

Shire River Basin Management Project 2016a. National Catchment Management and Rural Infrastructure Guidelines: Volume I. National Catchment Management Planning.

Shire River Basin Management Project 2016b. National Catchment Management and Rural Infrastructure Guidelines: Volume II. Village Level Catchment Planning and Technical Guidelines.

Morgan (2005) describes interventions under three categories: agronomic measures, soil management and mechanical. Agronomic measures refer to managing vegetation cover, which is the most effective and easiest way to control erosion. Soil management refers to measures that increase the resistance of the soil to erosion. This includes increasing aggregate stability through addition for example of organic matter or gypsum, or ripping the subsoil to increase vertical permeability. Mechanical interventions take the form of engineering structures to control movement of water and sediment. They are most appropriate in the transport phase. Morgan (2005) points out that they are ineffective on their own, are costly to install and maintain and, in the case of terraces, can create landscapes that are difficult to farm (terraces). They can be destructive if they fail.

The source, sink and pathways model as described above can be used effectively in planning catchment scale rehabilitation. Figure 4.7 illustrates how different geomorphic principles can be applied to the sediment zones. In the source zone the main aim should be to reduce the rate of surface runoff and soil loss, with a strong emphasis on establishing a good vegetation cover as this will also increase infiltration capacity, add to roughness and through addition of soil organic matter can reduce soil erodibility. In sink zones the emphasis is on increasing deposition by reducing the flow velocity. It is also important to protect sinks from further reworking of sediment. Pathways can be disconnected from source, diverted to alternative sinks or converted to sinks themselves. Working with pathways can be difficult because by nature they tend to be high energy transport zones. Unless carefully managed, an intervention can simply divert the problem elsewhere.

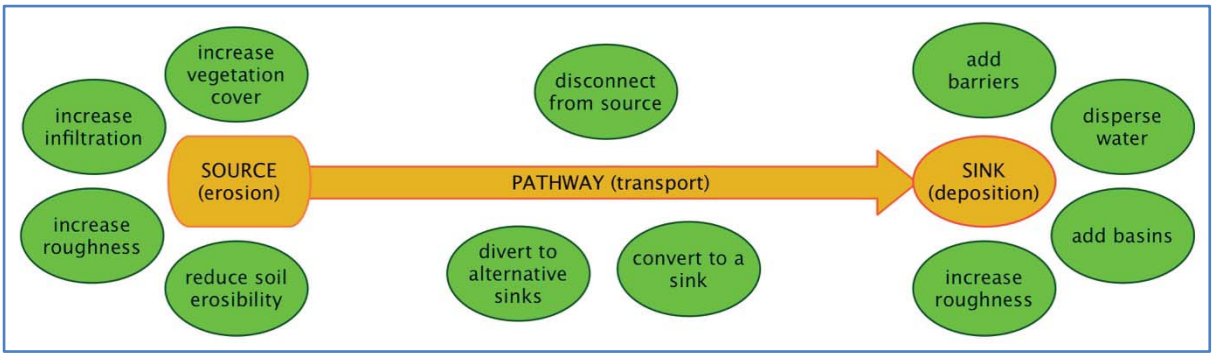


Figure 4.7: Rehabilitation guidelines based on source, pathway and sink zones

4.3.2 Rehabilitating sediment sources

Morgan (2005) states that managing vegetation cover is the most effective and easiest way to control erosion. Vegetation not only protects the soil from the direct impact of rainfall but also increases the infiltration rate, increases roughness and reduces soil erodibility through the addition of organic matter. A dense vegetation cover that enables uniform infiltration over the slope surface is the most effective was to control tunnel erosion. Pawarda and Van Tol (2016b, 2017a, 2017b) have demonstrated experimentally that additions of organic matter to the soils from Sinxaku significantly increases aggregate stability, and reduces dispersivity and soil detachment by splash. Dung and kraal manure is a good source of organic matter.

i. Controlling erosion on cultivated land

Managing vegetation cover depends on land use. Morgan (2005) provides detailed background to effective soil conservation methods. On cropped land the type of crops and planting times can be managed so as to reduce exposure of the soil to erosive rainfall. A cover of at least 70% provides effective protection against erosion. Row crops, tall and tree crops provide the least cover but multi-cropping can be effective. Maize provides a poor ground cover; small grain crops such as wheat and sorghum tend to be better if planted at a sufficient density. In areas of high erosion risk, such as in Sinxaku, it is important to establish a good cover as soon as possible in the wet season. Figure 4.8 illustrates some of the practices used in Sinxaku to conserve soil and water in Sinxaku gardens.

Permaculture is a practice that is promoted as a means to improve ecosystem processes in a garden context, increasing soil health, crop productivity and at the same time reducing erosion (Nel, 1996). Permaculture guidelines are provided in Volume II of the National Catchment Management and Rural Infrastructure Guidelines produced by the Shire River Basin Management Project (2016b). Further information on its application in South Africa can be found in the web site of Permaculture Design – http://www.permaculturedesign.co.za/

(a) Vetiver and grass planted below a swale in a steeply sloping garden

(b) Aloes protecting the top of a gully bank

(c) Multi-cropping (maize and butternut) provides a protective soil cover

(d) Mulching along a trench bed keeps moisture in the soil

(e) Kraal manure adds organic matter to a garden soil

(f) Dung on old fields adds organic matter and microbes to the soil

Figure 4.8: Soil and water conservation practice in a Sinxaku garden

Increasing effective rainfall, that is the rainfall that contributes to plant growth, is important. This can be done by increasing infiltration through providing good ground cover supported by mechanical means to harvest surface runoff. Diversion trenches, swales and micro-catchments are mechanical means to achieve this in non-dispersive soils. Vegetation strips along the contour can be used to trap soil and vegetation on cultivated land while terraces can be used to reduce the slope gradient. Morgan (2005) warns that

engineering structures to control movement of water and sediment are ineffective on their own. They are costly to install and maintain, can create landscapes that are difficult to farm and can be destructive if they fail. Susceptibility to failure increases in duplex or dispersive soils.

ii. Rainwater harvesting

Soil and water conservation in source areas is closely aligned with water harvesting, where surface runoff is captured for beneficial use on gardens and fields. Comprehensive guidelines for implementing water harvesting are given by Denison and Wotshela (2009) and Denison *et al.* (2011 a-e). These and other sources are given in Box 4.2. Rainwater harvesting principles as applied in Sinxaku are described further in Section 5.2.

Box 4.2 Water harvesting guidelines

Denison, J. and Wotshela, L. 2009. *Indigenous water harvesting and conservation practices: historical context, cases and implications*. WRC Report No. TT 392-09. ISB No. 978-1-77005-829-

Denison, J., Smulders, H., Kruger, E., Houghton, T. and Botha, M. 2011a. *Water Harvesting and Conservation – Volume 1: Development of a comprehensive learning package.* WRC Report No. TT 492/11 ISB No. 978-1-4312-0131-0

Denison, J., Smulders, H., Kruger, E., Houghton, T. and Botha, M. 2011b. *Water Harvesting and Conservation – Volume 2 Part 2: Facilitation and Assessment Guide for the Technical Manual.* WRC Report No. TT 494/11 ISB No. 97and-1-4312-0132-7

Denison J; Smulders H; Kruger E; Houghton T; Botha M 2011c. *Water Harvesting and Conservation – Volume 2 Part 3: Facilitation Manual.* WRC Report No. TT 495/11 ISB No. 978-1-4312-0133-4

Denison, J., Smulders, H., Kruger, E., Houghton, T. and Botha, M. 2011d. *Water Harvesting and Conservation – Volume 2 part 4: Facilitation and Assessment Guide for the Facilitation Manual*. WRC Report No. TT 496/11 ISB No. 978-1-4312-0134-1

Everson, T.M. and Smith, M.T. 2015. *Improving rural livelihoods through biogas generation using livestock manure and rainwater harvesting*. Vol 1: Research Report. WRC Report no 1955/1/15.

Everson, T.M. and Smith M.T. (2015) *Improving rural livelihoods through biogas generation using livestock manure and rainwater harvesting.* Vol. 2 Guidelines Report. WRC Report no TT 645/15

iii. Vetiver grass and soil conservation

Vetiver grass *(Chrysopogon zizanioides)* is a plant indigenous to India that has been widely adopted as a 'green engineer' in soil and water conservation projects (World Bank, 1993; Hailu, 2009; Are *et al.*, 2012). Hedge rows of vetiver grass *(Chrysopogon zizanioides)* can be planted as effective water and sediment barriers on hillslopes, it helps water infiltration, improves soil condition and promotes the establishment of other plant species (World Bank, 1993; Hailu, 2009; Are *et al.*, 2012). It can be used to strengthen earth bunds downslope from swales and other areas of potentially unstable soil.

Vetiver is a robust grass species that grows well in many climatic zones, on a wide range of slope gradients and soil types, including sodic and saline soils. It is drought and flood tolerant, and can tolerate snow, frost, fire and heavy grazing once established. It is easily grown and transplanted and can establish dense hedge rows within years. The species *Chrysopogon zizanioides* is non-invasive, the seeds being sterile, and is easily controlled by cultivating near the established plants. The natural spread of the plant is highly unlikely. Because of its deep roots it is unlikely to compete with adjacent crops. It is easy to propagate and has potential to be used in income generating projects where community members can establish vetiver

nurseries and sell the plants for rehabilitation. In addition to the use of vetiver in erosion control, its leaves can also be used as a mulch, for thatch or materials for weaving. The roots can be harvested for the extraction of essential oils.

Vetiver should be planted early in the wet season. The roots of the plants are trimmed to about 5 cm and the shoots to 10 cm. Slips of 2-3 shoots (tillers) are planted 10-15 cm apart in a furrow about 20 cm deep with fertilizer and lime. The crown of the plant is buried 6-7 cm below the soil surface. The trimmed leaves are used to cover the base of the plants to form mulch. Distance between vertical rows is about 2 m. The slips should be watered for the first 2 weeks after establishment.

iv. Controlling erosion on rangeland

The key to erosion control on rangeland is to promote a good groundcover to protect the soil surface an increase infiltration. Water harvesting techniques may be useful where capturing runoff can improve vegetation growth. The use of hoops (micro-catchments) to harvest water and establish woody browse vegetation was used successfully in Baringo District, Kenya (De Groot *et al.* 1992). Micro-ponds have been used extensively in the DEA-NRM's rehabilitation project in Elangeni (Figure 4.9) but care needs to be taken when using these in duplex soils (Figure 4.9d). Silt fences and sausages have also been used to trap water and sediment in shallow gullies (Figure 4.10a). Gullies up to one meter is depth can be shaped and protected with brush pack or hessian netting (Figure 4.10 b & c). Stone packs can be used in gullies but again great care needs to be taken when used in dispersive soils (Figure 4.11).

These techniques can be used to address key points where erosion is most apparent; they also provide short term employment. They cannot be used effectively to restore vegetation over the wider landscape. The investment would be too high, continued maintenance is necessary and the techniques are difficult to apply on steep slopes, key source areas for runoff and sediment. Erosion in former homeland areas of South Africa is widely blamed on overstocking and lack of grazing controls; reviving a managed grazing system should aid the restoration of grassland. Rangeland stewardship is advocated by the uMzimvubu Catchment Partnership Programme as explained in the UCPP Rangeland Restoration Toolkit (uMzimvubu Catchment Partnership Programme, 2016). Their philosophy, that has evolved from five years of practice in the Matatiele Municipality, is that good stewardship leads to livelihood improvements through better returns on livestock. Improving access to livestock markets is integral to their strategy. The UCCP Rangeland Toolkit a modified form of holistic grazing supported by ecorangers. Similar systems are being implemented by the MaMaSe Mau Mara Serengeti Sustainable Water Initiative in conservancies adjacent to the Masai Mara reserve in Kenya (Wachira, 2016). Because grazing practice is key to the restoration of a vegetation cover that is sufficient to reduce erosion, the relevant principles are discussed in more depth in Section 4.6.

Rehabilitation of rangeland requires a good understanding of the social and economic structures that underpin stock ownership. Ainslie (2002) provides a critical analysis of cattle ownership and productivity on the communal areas of the Eastern Cape. He advocates increased recognition via government policies of the social and economic importance of cattle and better support through safe guarding and enhancing investments in livestock. Preventing stock theft and provision of veterinary and dipping services are key interventions.

(a) Micro-ponds collecting runoff and sediment in an upper slope position

(b) A rehabilitation team creating micro-pond

(c) Micro-pond, brush packing and silt fencing used in combination to reduce surface runoff and stabilise a shallow gully.

(d) Pipe forming below a micro-pond

Figure 4.9: Use of micro-ponds to trap water and sediment in rangelands

4.3.3 Rehabilitating sediment pathways

Pathways transport water and sediment from sources to sinks. Hillslope runoff concentrated into a channel promotes further erosion and therefore exacerbates the probable. The best long-term solution is therefore to control runoff and erosion at the source as described above. In the short term possible approaches to rehabilitating sediment pathways are to disconnect the pathway from the sediment source, divert sediment and water to alternative sinks and convert the pathway to a sink. All these require engineering interventions which, as pointed out by Morgan (2005), are difficult, costly and prone to failure.

(a) SILT FENCES
Silt fences constructed from hessian can be place across shallow drainage lines to trap sediment. Vetiver can be planted along the line of the silt fence to continue its trapping function after the fence has decayed. Silt fences made of hessian are vulnerable to fire.

(b) GULLY SHAPING
Shallow gullies less than 1 m deep can be shaped to form wider channels that can be further protected with netting or throw branches Silt traps can be incorporated into the design.

(c) NETTING
Netting on a gully floor

(d) TRAPPING ROAD RUNOFF
Silt fences and brush packing are used here in a road-side ditch to slow down runoff and trap sediment.

Figure 4.10: Use of silt fences, brush packs and hessian blankets to control erosion in shallow gullies

i. Disconnecting pathways

In certain cases, it may be possible to build structures upslope from the head of the pathway to prevent downward movement of water and sediment. These could include diversion ditches, swales or contour vegetation strips that are part of source control strategies. In dispersive soils it is important to make sure that diverted water is spread across the landscape so as to avoid soil saturation and tunnel erosion.

Figure 4.11: Use of stone lines and stone packs to control gully erosion

(a) STONE LINES
Stone lines are placed on slopes along the contour to prevent erosion. A trench is dug along the contour line 30 cm wide and 10 cm deep. Large stones are placed on the lower side of the slope and smaller stones were used to fill in the spaces. This enables water to seep through the stones and the soil to deposit above the trench. [Photo and text from Everson & Everson (2014)]

(b) STONE PACKS
Stone packs are used in erosion gullies (dongas) to slow runoff (Plate 5). A stone barrier is formed by digging a trench across the donga and packing stones close together. Keying in the stones along the bottom and sides of the donga prevents water from eroding underneath and around the sides.
An apron of stone is built below the stone pack so that overflow hits the stone and does not cause erosion. The centre of the stone pack should be the lowest point to form a weir so that water is discharged down the middle of the structure. Stone packs should be built at wide parts of the donga so that the force of the water is lower. [Photo and text from Everson & Everson (2014)]

ii. Diverting sediment and water to alternative sinks

Water (and sediment) can be diverted from low energy pathways onto land where it can be put to beneficial use. An example is the capture and diversion of road runoff onto adjacent lands where it can enhance field or garden cultivation. Care must be taken to prevent further erosion along the diversion path or to divert water onto dispersive soils where it can exacerbate tunnel erosion.

iii. Converting pathways to sinks

Converting a pathway to a sink is probably the most common intervention. By placing a structure across the pathway, sediment is trapped and the energy of the water is reduced. The type of structure depends on the width of the pathway, the gradient of the channel and the stability of the side walls. In small gullies stone packs can be effective but on steep slopes many structures are needed to trap significant sediment volumes. Stone lines or silt fences can be constructed in low energy environments. It is recommended that an erosion resistant grass such as vetiver is planted along the stone line or silt fence. Shallow gullies can be reshaped and packed with brush. Larger gullies are more difficult to control because they are high energy environments. Suitable structures are costly and must be designed by an experienced engineer and build under strict supervision. The legal implications of building such structures is discussed in Section 4.5.

Structures must be inserted well into banks to avoid erosion around the edges, especially where soils are dispersive. The volume of sediment trapped may not justify the expense. In all cases the stabilization of trapped sediment by vegetation is important. This may occur naturally once the channel bed becomes more stable and water is retained, but planting with grass plugs, vetiver or other appropriate plants is recommended to speed up the process.

Morgan (2005) suggest that it is possible to stabilize gullies by using temporary structures such as earth banks or loose rocks to trap sediment while supporting measures are undertaken in source areas. These structures would have a high risk of failure but if source area measures successfully reduced runoff and sediment they would not be required in the long term. Morgan emphasizes the need for careful design, with the structures being keyed into both walls and floor. Full technical details are provided in Morgan (2005).

4.3.4 Rehabilitating sediment sinks

Methods for rehabilitating sediment sinks are designed to increase the deposition of sediment and infiltration of water. Barriers such as stone lines, silt fences or contour strips can all be used, but they need to capture runoff across the sink area. Once again a good vegetation is one of the most effective measures as it increases roughness and aids infiltration.

Micro-catchments have been used successfully in some areas to trap sediment and increase ponding of water in sink zones. This technique should be avoided in dispersive soils.

4.4 Working with dispersive soils

The rehabilitation of dispersive soils and associated duplex profiles confronts particular problems and, globally, there are no straightforward solutions. Many recommend practices such as bringing in topsoil or adding gypsum require significant investment in labour and resources, which may not be appropriate for an area such as the Tsitsa catchment. The following points summarises some of the recommendations for working with these soils. Key references are Hardie (2009), who provides guidelines based on experience of working in Australia, and Pawarda and Van Tol (2016) who discus conservation strategies for duplex soils.

The key factor is to prevent the local accumulation of water that results in the saturation of the subsoil resultant piping. A good uniform vegetation cover provides the best protection.

i. General recommendations for pipe erosion repair (Hardie, 2009)

- A combination of chemical, physical and vegetative methods will be required to repair tunnel erosion.
- Divert water away from area of tunnelling by using mounds instead of ditches.
- Find the true head of the tunnel system using earth moving equipment or dyes.
- Dig a trench to expose the entire pipe feature. If soils have a low risk of dispersion, then soils can be treated with gypsum and carefully repacked in the trench. If the soils have a high potential of dispersion, then clays with low potential of dispersion should be brought in and be treated with gypsum to prevent future dispersion.
- All repacked soils need to be compacted (to 95% proctor maximum) using a small footprint compactor (sheepsfoot roller).
- The repacked material should have a convex shape to drain water away from the feature and the surface be treated with gypsum to act as an electrolyte source for runoff.
- Cover treated and exposed areas with topsoil and re-vegetate areas with appropriate fast growing species.
- Re-vegetate bare areas upslope of tunnel head to minimize runoff.
- Consider catchment wide application of gypsum (1-2.5 t/ha every 3-5 years) to act as a source of electrolytes.

- Fence treated areas to prevent grazing and further disturbance.
- For shallow pipe systems deep ripping and cultivation might be sufficient.

ii. Lessons learnt from South Africa, Lesotho and Ethiopia

Rehabilitation of gullies using check dams or gabions built in soils prone to piping was bypassed on an annual basis, making the method ineffective to trap sediment or rehabilitate the gully (Frankl *et al.*, 2014).
A subsurface geomembrane dam on low angled hillslopes helped prevent the formation of soil pipes around check dams, elevated the groundwater table locally and promoted plant growth (Frankl *et al.*, 2014). Flow diversions into exclosures with trees helped store water on the slopes and provided alternative lively hoods for locals through beekeeping and biomass extraction (Frankl *et al.*, 2014).

Construct check dams and contour walls where soils are not prone to pipe formation, but avoid this method where pipe formation is likely (e.g. in duplex soils) as it will increase the concentration of free water in the subsoils and promote pipe erosion (Van Zijl *et al.*, 2013, 2014).

It is worthwhile restoring a gully at the beginning of an erosional cycle, but it is less useful to restore a gully that is nearing the end of the erosional cycle as erosion processes slow down (Van Zijl *et al.*, 2013, 2014). Indications of features that are near the end of the erosional cycle are: continuous features that have reached bedrock and the headcut has reached a steep hillslope (Nordstrom, 1988).
Existing gullies can trigger further pipe erosion in duplex soils as they drain and mobilize accumulated free water (Van Zijl *et al.*, 2013, 2014).

Preventing the accumulation of free water is essential and can be prevented by water uptake by good vegetation cover and preventing runoff from non-duplex soils (check dams and contour walls) (Van Zijl *et al.*, 2013, 2014).

4.5 Legal implications of erosion control

Braid and Lodenkemper (in preparation) point out that many rehabilitation activities planned for gullies have legal implications because they take place in water courses and often require moving large volumes of soil. Authorisation, either as a basic assessment (BA) or a full Environmental Impact assessment (EIA), is required under the National Environmental Management Act (NEMA) for a range of Listed Activities of which the most relevant in this context is:
LN 1 (19) Infilling or depositing any material of more than 5 m^3 into, or the dredging, excavation, removal or moving of soil … or rock of more than 5 m^3 from a water course.

These volumes are cumulative for one property, however defined, so can be a serious limitation on gully reshaping or infilling.

The National Water Act (NWA) includes “impeding or diverting the flow of water in a water course, altering the bed, banks, course or characteristics of a water course…” as a water use for which a permit is needed. Building any form of structure across a gully floor would constitute such as use.

Both BAs and EIAs are expensive and time consuming so can hinder rehabilitation projects. Braid and Lodenkemper (in preparation) suggest that it should be possible to submit to the DEA a maintenance management plan (MMP) for a designated area to cover rehabilitation activities that would otherwise invoke a BA. Such an area can be, for example, a water course, drainage area or a municipality. Likewise, it is possible to get a general authorization (GA) from the DWS for activities as described above. Where it is

not possible to cover a structure with a BA it will be necessary to undergo a Basic Assessment Process. It may be possible to get blanket approval for a number of structures but approval from the DWS and the Department of Agriculture, Food and Forestry (DAFF) as well as the DEA might be required.

4.6 Using veld management principles to improve rangeland condition

4.6.1 Introduction

Veld management is defined by Van Oudtshoorn (2015:12) as "the science of managing natural resources (vegetation, soil, water), as part of the veld, for sustainable animal production and biodiversity conservation". This implies an integrated approach to maintain and improve veld condition that assists in soil conservation and maintaining biodiversity of a given area. This approach lends its success to the application of ecological principles (Van Oudtshoorn, 2015). The essence is to provide good quantity and quality surface cover for animal production as well as protection against soil erosion. This approach benefits both the environment, through improved surface cover by vegetation and nutrient cycling, and livestock owners, through availability of better grazing and therefore better animal production.

The principles of veld management (Van Oudtshoorn, 2015) to improve rangeland involve the following:

a) Control the movement of livestock;
b) Control numbers to avoid overgrazing;
c) Keep in check invasive plants and weeds, as well as grasses – e.g. make sure that palatable grass species dominate unpalatable species;
d) Control veld fires;
e) Manage prescribed burning to give advantage to preferred grass species and control invasion by woody species.

The economics of environmental management imply that once a farmer realizes the value of managing the environment sustainably, strategies that will assist in achieving this can be adopted. This is likely to happen by reducing some socio-economic hurdles that tend to limit available options for the farmer and by providing alternatives that make social and economic sense.

Nishat and Biswas (2005) describe how the restoration of degraded landscapes in communal areas takes place within a tension between the needs of the people and that of the ecosystem. Therefore, a participatory approach is needed that solidifies the integration of the sustainable rangeland management and the restoration or diversification of human needs. According to Nishat and Biswas (2005:6) this establishes the "fundamental connection between economic prosperity and environmental wellbeing". People must see the value of conserving the environment and that it has direct impact on their livelihoods and that they do have control over the state of their natural resources. This is the application of scientific knowledge that will improve the functioning and structure of the degraded ecosystems. This can be achieved through different grazing programmes as discussed below.

4.6.2 Grazing programmes

The objectives of grazing and browsing management are to maintain or create a favourable species composition, maintain optimum quantity and quality of plant food and maintain the highest animal productivity, with the added advantage of improved surface cover protecting the soil from the sun and erosive forces. The key driver is to give vegetation enough time to recover and regain growth vigour after defoliation by grazing. The vigour of grasses is proportional to both its root system and the above-ground photosynthesizing system. Sustainable grazing programmes use this knowledge to manage rangeland and allow vegetation to recover.

There has been a long debate as to the best system to use to achieve optimum veld and stock condition (McGranahan and Kirkman, 2013; Briske, 2017a & b). Briske (2017b) describes how natural resource models that include grazing management have progressed from steady state, through ecosystem management to resilience-based management. The latter recognises that there are multiple social-ecological systems and that many landscapes are 'novel', that is the trajectory of change into a new state is effectively irreversible. The important message from rangeland scientists and managers is that any system adopted must be appropriate for the ecological and social context. Macleod (pers. com.) warns that any system adopted must be modified to take account of local conditions, including community dynamics and capacity. Rehabilitation of rangeland requires a good understanding of the social and economic structures that underpin stock ownership (Ainslie, 2002).

The main groups of grazing systems used are **continuous grazing,** the common practice used currently in communal areas, **rotational grazing** (controlled selective and non-selective grazing), used mainly in commercial farms, and **rotational resting**. **Holistic grazing** is an approach based on rotational grazing that is advocated as being ecologically sound and capable of supporting higher stock numbers than can conventional systems.

Continuous grazing is the common system in communal areas where fences have been lost and the practice of herding has broken down. Animals are left to graze at will so tend to favour certain areas. There is no formal rest period. This is thought to lead to loss of palatable species and increases in those that are less palatable or non-palatable. In many communal areas in Africa animals are brought back to homestead kraals at night for protection against stock thieves and predators. This leads to the intensification of tracks that can be the forerunners of gully erosion.

Rotational resting is one of the simplest forms of stock management. An area is set aside for a period of time to allow the vegetation to recover. Uncontrolled grazing is normally practiced on the rest of the area. A common form of rotational rest is to have separate areas for summer and winter grazing. Kirkman (2017) differentiates between the need for quality grazing in the summer and quantity grazing in the winter. He recommends that the pasture is grazed short in summer to give optimum quality as this encourages new shoots to grow. Burning can be used to start summer grazing. Bulk forage must be saved for winter. The rested area also provides a seed source. Kirkman (2017) recommends that the length of summer grazing in an area such as the Transkei is equal to the normal period of summer rainfall (4-6 months depending on location). The areas used for summer and winter grazing should be alternated to allow recovery. Optimal stocking rates can be determined with experience. There are too many animals if stock have to be moved to winter grazing before the end of the summer.

Rotational grazing is a more sophisticated form of rotational resting. Animals are moved between camps or relatively small demarcated areas so that stocking densities are higher and selective grazing of palatable species is reduced. The smaller the camps the more the animals will be bunched together. A four-camp system is common. Kirkman and Carvalho (2003) describe an example of a three camp system from South Africa where two camps are used in each of the wet and dry season and the third is rested for a full year.

Holistic grazing is a grazing philosophy that maintains that high stock numbers are good. Animals are moved around the landscape in tightly bunched groups, encouraging all plants to be grazed, soil crust to be broken up by hoof action and dung and urine to be added to the soil. The length of time that animals remain in one area and the time before they return to the same area is critical to achieving optimum plant condition. Grass should be allowed to recover to the three-leaf stage but should not be left to become moribund. While advocates of holistic grazing are forceful in its praise, its effectiveness under a wide range of

conditions is yet to be tested Hawkins, 2017). Where the principles of holistic grazing have been adopted it has largely been on commercial farms where there is the capacity to monitor grazing and adapt the grazing strategy to suit. The suitability for communal areas with assumed lower management capacity is questionable but there are examples where it has worked. Holistic grazing is being implemented by MaMaSe Mau Mara Serengeti Sustainable Water Initiative in conservancies adjacent to the Masai Mara reserve in Kenya (Wachira, 2016). It has also been adopted with positive results by the Wange Community in Zimbabwe (Neely & Butterfield 2013). A number of publications and websites providing guidelines to holistic grazing are given in Box 4.3.

Box 4.3 Holistic grazing management guidelines

Bingham, S. date unknown. Grassroots Restoration: Holistic Management for Villages. The Savory Centre.

Neely, C. L. & Butterfield, J. 2004. Holistic management of African rangelands. LEISA Magazine. http://www.agriculturesnetwork.org/magazines/global/farming-with-nature/holistic-management-of-african-rangelands#sthash.6s60fwYC.dpuf

Neely C.L., Butterfield J. 2013. Holistic management of African rangelands. Agricultures network. http://www.agriculturesnetwork.org/magazines/global/farming-with-nature/holistic-management-of-african-rangelands

Savory Institute. 2015. The Foundation of Holistic Management – E Book One. Savoury Institute

uMzimvubu Catchment Partnership Programme (2016) The UCPP Rangeland Restoration Toolkit (DRAFT). Available: http://umzimvubu.org/rangeland-toolkit/.

Wachira, L. 2016. Sustainable range-land management in the Mara ecosystem: piloting holistic management in the upcoming Siana and Enonkishu conservancies. MaMaSe Mau Mara Serengeti Sustainable Water Initiative Available: http://mamase.org [4 July 2016]

4.6.3 The grazing plan

Developing and implementing a management strategy within a communal area such as Sinxaku would be a five step process as depicted in Figure 4.12. In step 1 a short training course on managed grazing would introduce the broader community to the general principles, benefits and the support required by the community. Developing a vision with the community (Step 2) should follow shortly afterwards. This would entail creating a vision statement that includes both the land and the community. Participants would need to describe what forms of production are needed to achieve that vision and what is the future resource base that fulfils the vision. Step 3 requires the setting up of the institutional structure needed to support managed grazing. This would entail considering among other things the leadership structure, grazing rules, record keeping, marketing and the financial system. Step 4 is the development of a grazing plan for the first season (growing or non-growing) as described earlier. With limited resources for fencing in a communal context, herders (eco-rangers) are required for controlling livestock according to the agreed plan. Herders need knowledge about grassland management, the local landscape geography and ecology and care of livestock and should be given relevant training. Income, for example from a cattle levy, will need to be generated to employ the necessary number of herders. A maintenance manager, whose role is to oversee the installation and maintenance of the necessary infrastructure such as watering points and dips, will also need to be employed. Step 5 entails monitoring the condition of the veld to enable feedback into the grazing plan.

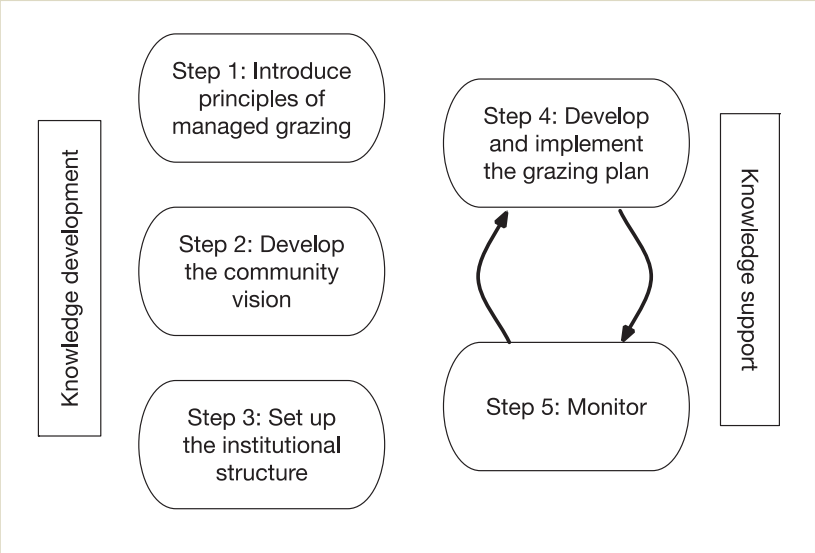


Figure 4.12: The 5-step process in developing a managed grazing plan

4.7 Sustaining rehabilitation into the future: monitoring guidelines

4.7.1 Monitoring rangeland condition

A prevalent recommendation arising from rehabilitation practice is the need to monitor its outcomes. Monitoring should be initiated during the active phase of the project and continued afterwards to assess its sustainability. Engaging local monitors from the community will help to achieve long-term success.

A number of monitoring guidelines have been compiled both internationally and locally (Box 4.4). Many of these are specifically for assessing rangeland condition. Milton *et al*. (1998) provide guidelines for assessing the health of karoo shrubland that are designed for land users with a minimal knowledge of plants and soil processes. These guidelines could provide a suitable template for assessing rangeland condition in more humid areas such as the Tsitsa catchment.

Tongway (1994) and Tongway and Hindley (2004) apply the concept of landscape function analysis to assessing rangeland condition. Their assessment is analogous the framework of source, pathway and sink in that the authors look at sites of accumulation and sites of mobilization and transport. The degree of connectivity of accumulation patches via pathways of mobilisation is an important measure of degradation. They use three main soil habitat quality indices assessed using stability or resistance to erosion; infiltration/ water holding capacity; nutrient cycling, assessed using soil surface indicators. These require a high technical capability and are not suitable for community monitoring. They would also need to be adapted to conditions in the South Africa.

Bunning *et al.* (2011b) provide a comprehensive set of assessment tools for dryland areas developed from global experience that are relevant to South Africa. Their guidelines are applicable to both cultivated land and rangeland, with an emphasis on communal management.

Box 4.4 Monitoring guidelines

Bunning, S., McDonagh, J., Riuox, J., 2011a. Land degradation assessment in drylands. Manual for local level assessment of land degradation and sustainable land management. Part 1. Planning and methodological approach, analysis and reporting. Food and Agriculture Organization of the United Nations, Rome.

Bunning, S., McDonagh, J., Riuox, J., (ed), 2011b. Land degradation assessment in drylands. Manual for local level assessment of land degradation and sustainable land management. Part 2. Field methodology and tools. Food and Agriculture Organization of the United Nations, Rome. Overview of landscape degradation processes: causes and manifestation.

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4.7.2 Tools for community-based monitoring

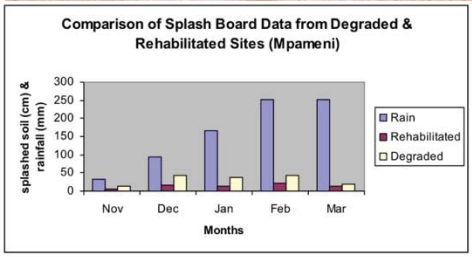
Everson *et al.* (2007) and Everson and Everson (2014) report on how they set up a community-based monitoring system to support the payment for ecosystem services in the upper uThukela, KwaZulu-Natal. Their experience is reflected below. They stress that community-based monitoring programmes should be implemented at the start of a project so that community members can evaluate its success for themselves. Monitoring techniques can also be used to compare eroded and rehabilitated areas. Since many rural community members have little formal education, the techniques selected should result in data that can be easily recorded and interpreted. In addition, the monitoring equipment should be robust and of low cost. Examples include splash boards, runoff plots, erosion standards, donga profiling, plant basal cover quadrats, clarity tubes and rain gauges. These are illustrated in Figure 4.12.

A runoff plot is an experimental technique that can best be used to demonstrate the effect of different surface conditions. Splash boards can be used in this context but can also be used as a long term monitoring tool. Erosion standards and donga profiling are used to monitor the accumulation or loss of sediment associated with soil conservation structures while plant basal quadrats are commonly used to monitor the condition of grazing land. Clarity tubes are used to measure the turbidity of streamflow.

(a) A homestead rain gauge in Sinxaku. Daily rainfall is collected in a notebook.

(b) A quadrat used to measure basal cover of vegetation. By dividing the quadrat into 100 square (10x10) the percentage of ground cover by rooted vegetation can be estimated. The quadrat should be placed at the same point for monitoring changes through time. The location of opposite corners of the quadrat should be marked permanently on the ground.

(c) Profiling a donga. Erosion or deposition on a gully floor and changes to gully width can be monitored by profiling a transect between two fixed points. Metal stakes are used to locate the ends of transect. The depth to the gully floor is measured at equal intervals across a stiff wire stretched between the stakes.



(d) Splash board and graph of data collected by the community. The board measures the intensity of erosion by raindrop impact. The height to which soil particles are splashed onto the board is measured and recorded.

(e) Runoff plots for comparing response of different areas. Runoff and sediment lost from the plots is collected downslope in a container connected to the lower end of the plot by a plastic pipe. A 20 litre container is recommended where rainfall is heavy.

Figure 4.13: Monitoring techniques suitable for use by village communities to monitor changes to rangeland condition and erosion status (photos b-e © Terry Everson)

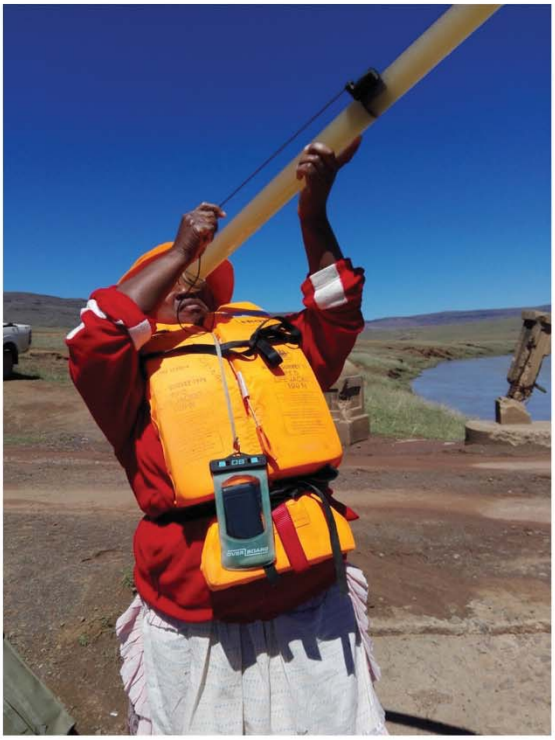
Bryson and Lodenkemper (in preparation) describe how community rainfall monitoring in Namibia through the Skeppies project: Building Resilience to Climate Change helped the community to become more attuned to the relationship between rainfall and livelihoods and brought about the implementation of water saving and water storage technologies.

Bannatyne *et al.* (2017) describe a community-based monitoring system for collecting suspended sediment in the Tsitsa River. Local residents have successfully collected samples over a two-year period from eleven sites, including flood samples that are critical to estimating sediment loads. Figure 4.13 shows residents collecting samples.

Huchzermeyer (2018) developed a set of guidelines for monitoring post-dam impacts on the Tsitsa river. The majority of recommended techniques required surveys using high level equipment and expert knowledge so are not suitable for use by community members. One technique, however, holds possibility. Huchzermeyer (2017) developed an index of bed sedimentation based on the SASS scoring system used by ecologist to monitor water quality. His scoring system used the full suite of invertebrate families identified at a site in the river, a method that would require considerable training and experience to be effective. There is potential to adapt this index to mirror that of the mini-SASS scoring system that is advocated for use by school children and other interested people who are not expert invertebrate ecologists.

4.7.3 Applying mobile phone technology to community-based monitoring

Bannatyne *et al.* (2017) describe how a combination of community-based monitoring and mobile phone technology is being used to monitor sediment flux in the Tsitsa river. Citizen scientists are provided smartphones linked to Open Data Kit – (ODK) software with which to record their monitoring results. The ODK application is a smartphone and computer-based suite of tools and applications that support data collection via mobile phones (https://opendatakit.org/). GeoODK allows spatial and mapping information to be incorporated into data collection (GeoODK, 2014). Monitoring results are sent directly to a central data base where they can be analysed. There is potential to adapt the system used for monitoring the Tsitsa river to monitoring on-the-ground rehabilitation works.



Using a clarity tube to estimate turbidity

Collecting a water sample at high flow

The water sampler with water bottle full of a sample

Figure 4.14: Monitoring suspended sediment in the Tsitsa River (Photos: © Laura Bannatyne). Smart phones are used to capture data on site and transmit this to the researcher at Rhodes University.

CHAPTER 5. APPROACHES TO LANDSCAPE GREENING IN THE SINXAKU VILLAGES

5.1 Catchments, Sustainable Livelihoods and 'Green Economy': towards improving local livelihoods and the 'Common Good'

5.1.1 Catchments as complex socio-ecological systems

The catchment of a river is the land area that provides the source area for water draining to the river, and all material carried within in. This includes eroded soils, dissolved minerals and various pollutants including fertilizer, pesticides and the ubiquitous plastic waste. The catchment is also the land surface on which we as humans live and from which we derive our main sustenance. Our actions on the catchment surface have a direct impact on the flow of water into a river and the quality of that water. A catchment is therefore the most logical management unit for any water-based activity. Our activities in Sinxaku will be framed, therefore, within a catchment context.

Catchments cover a range of sizes, from the scale of a roof top draining into a water tank or the land surface draining into a small headwater stream, to the scale of a large river basin such as the Mzimvubu. Large catchments are made up of a hierarchy of smaller catchments that feed into the greater system.

Terminology about catchments differs around the world. The term watershed is often used synonymously with catchment, although in some parlance watershed is the boundary between two catchments. In this report we will use the term catchment except where a certain programme or concept has adopted the term watershed.

Catchments are increasingly understood as complex socio-ecological systems involving numerous inter-related elements from the natural environment and the human dimension. These factors and relationships influence land, water and biological resource-use; the way in which they take place can have either beneficial or negative consequences for the system as a whole (Pollard *et al.*, 2011). Biophysical degradation of the catchment in the form of erosion, biodiversity loss and reduced productivity is a widespread concern and occurs within this dynamic complex where people impact the environment and the environment in turn impacts on people. There is a direct interdependence between healthy catchments and healthy people as people are directly dependent on the services that these ecosystems provide (e.g. water, nutrition, forest products, grazing, etc.). Ecosystems can also act as regulators of climate, provide cultural linkages, economic opportunities and support life on earth as a whole (Alcamo *et al.,* 2003). Figure 5.1 illustrates the notion of healthy and unhealthy land use practices and their effect on the land surface and river.

Catchment restoration initiatives, such as the ones promoted in the Tsitsa Catchment in the Eastern Cape, can potentially generate not only green jobs in rural areas but also enhance sustainable livelihoods and well-being. Restoration initiatives such as investments in ecological infrastructure, rainwater harvesting and sustainable grazing practice can be applied at a catchment scale as soil erosion prevention methods and at the same time can be integrated into local rain-fed irrigation systems and domestic water supplies.

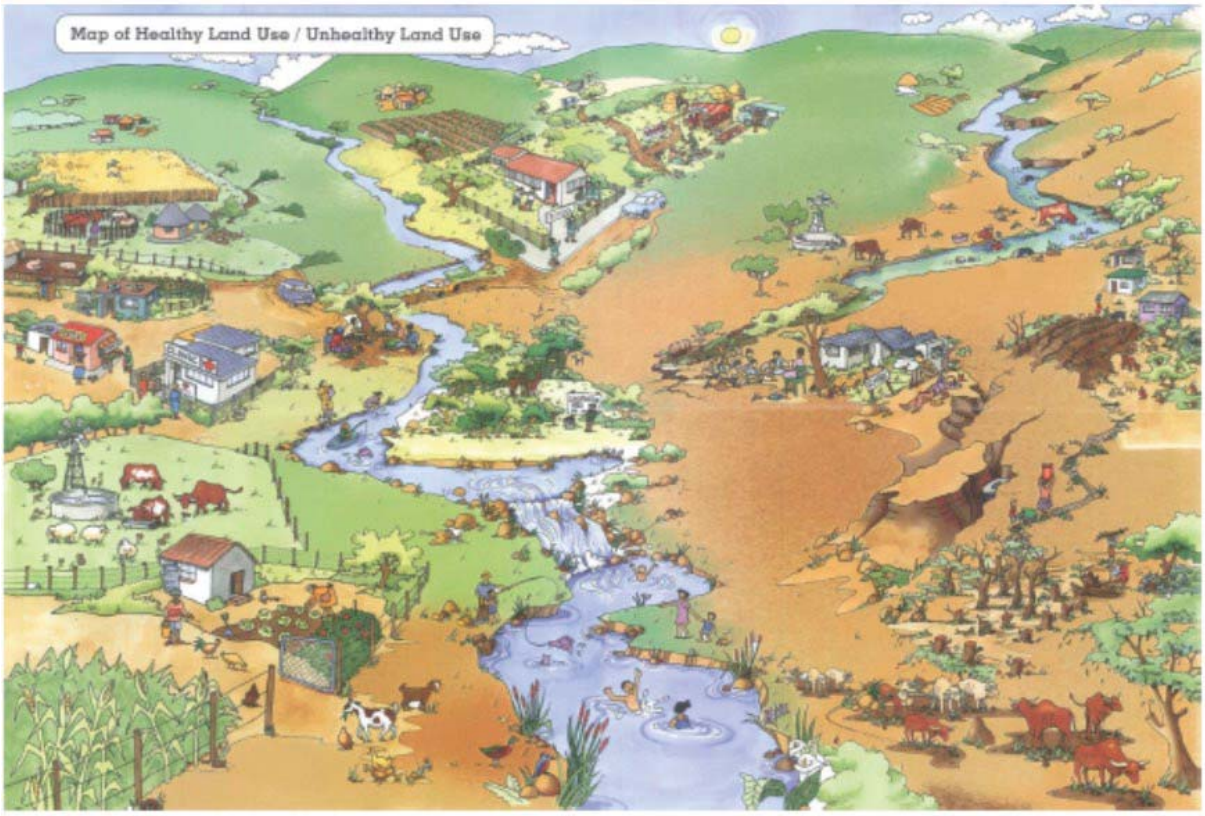


Figure 5.1: Healthy/Unhealthy Land Use Practices (Source: *MOAIWD, 2015*)

The following sections introduce the concept of Integrated Catchment Management (ICM), drawing from the complementary watershed development literature and work from around the world. ICM, or Watershed Management, is an approach that intends to improve the ecological functioning of catchment areas at different scales, placing the enhancement of local livelihoods and benefits at the centre of the strategic planning and implementation process.

5.1.2 Integrated Catchment Management and the Watershed Management Approach

In general terms, Integrated Catchment Management (ICM) is a specific process to manage the natural resources, people's actions and their livelihoods in a catchment in a sustainable way. ICM links the management of land, water and related natural resources. The aim is balanced use for current and future needs. All resources in our catchment and the way they are used are linked and all environmental, economic and social problems must be managed together in a catchment area (MOAIWD, 2015). ICM is based on five key principles that encourage good practice and addresses land degradation (MOAIWD, 2015):

1. Land and water resources are parts of connected natural ecosystem, and so a catchment must be managed as a unit.
2. Catchments change through time and management must adapt to this change.
3. Land and water resources must be managed together, based on best available information.
4. Users and managers must understand what is needed – stakeholder engagement, awareness building and capacity development is very important.
5. There must be a sound balance between economic development and environmental protection.

Likewise, the World Bank (2013) defines watershed management (WSM) as
"the integrated use and/or management of land, vegetation, and water in a geographically discrete drainage area for the benefit of its residents, with the objective of protecting or conserving the hydrologic

services that the watershed provides and of reducing or avoiding negative downstream or groundwater impacts. WSM is ultimately about achieving water resources-related objectives and it is implied that this approach deals with the interaction of land, water and people within complex systems" (World Bank, 2013:11).

In summary, WSM frameworks are guided by the following considerations (World Bank, 2013).

1. Adoption of the micro-watershed as a building block for planning and watershed development
2. Decentralized and participatory development where the development aspirations of the poor themselves take stage
3. Stakeholder inclusion
4. Capacity building and information sharing
5. Sustaining outcomes through linking conservation to livelihoods
6. Monitoring and evaluation.

Together, the ICM principles and the WSM framework provide a sound basis for sustainable rural development through promoting a green economy. ICM and Watershed Development Programmes are being internationally recognised approaches and strategies that foster participatory planning at watershed scale to ensure cooperative governance in implementation and integrated water resource management (Pollard et al., 2011; World Bank, 2013; Denison *et al.*, 2015). Examples of this approach have been demonstrated to play a significant role in achieving rural development targets envisaged for the country. These include job creation, sustainable agricultural livelihoods, gender equity and empowerment, as well as ensuring healthy management of our natural resources. As evidence of the impact derived from this type of approach, Rahendra Singh was awarded the 2015 Stockholm Water Prize for his decades of work in rainwater harvesting and watershed conservation in India to support agricultural and environmental water productivity.

Since the 1980s, catchment approaches and technical interventions have been implemented in order to improve natural resource management issues and counter catchment degradation impacting on downstream users through the increase of sedimentation and flooding concerns. More recently the focus was broadened to incorporate the potential for sustainably improving incomes of the rural poor through strategies for decentralized governance and participatory development of the communities' asset base, especially the natural assets (Word Bank, 2013) and thus create a more inclusive economic growth model and sustainable livelihoods. Catchment development programmes provide a useful planning tool for achieving both rural development and water resources conservation and management goals.

5.1.3 Integrated Planning Scales within South Africa's Catchment Management Policies and Regulatory Frameworks: Situating the Watershed Development approach

In South Africa, Catchment Management Agencies (CMAs) are being established with the broad purpose of managing water resources within their areas of jurisdiction, the Water Management Areas, for the ultimate benefit of all stakeholders. At present there are nine WMAs, one of which is Mzimvubu to Tsitsikamma WMA in which the Mzimvubu and Tsitsa catchments sit. According to the DWS, these larger CMAs

The broad hydrological and developmental objectives are established and reflected in the CMA's Catchment Management Plans. CMAs are responsible for large areas and a wide range of stakeholders. The location of the Mzimvubu and Tsitsa catchments within their WMA is illustrated in Figure 5.2. The implications for upscaling our work from the micro-catchment level to the basin and CMA will be considered further in Chapter 7.

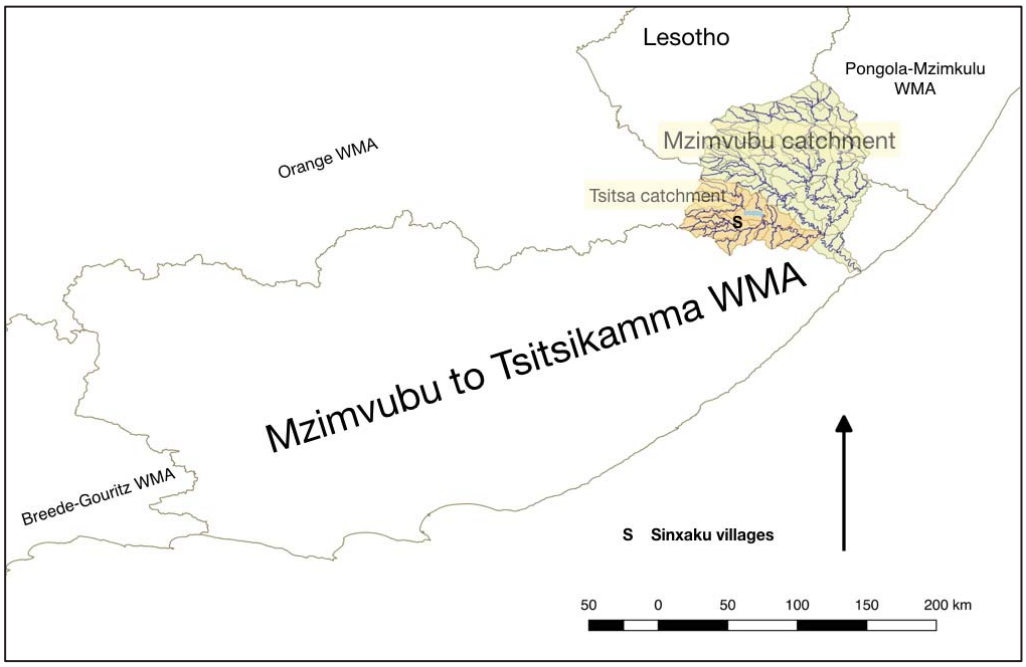


Figure 5.2: The location of the Sinxaku villages, the Tsitsa and Mzimvubu catchments within the Mzimvubu to Tsitsikamma WMA

At the lower level of water management are Catchment Management Forums (CMFs) that are being promoted as networked spaces to address the aspiration-justice tensions that still exist in the democratization of water resources, particularly for the voiceless rural poor and marginalized. The development of catchment forums in the Mzimvubu basin is being addressed by Palmer and Wolff of Rhodes University Institute for Water Research, with the aim of building local CMFs and civil society participatory capability, and foster functional institutional relationships between CMFs and CMA at sub-catchment scale.

Functioning CMAs can potentially regulate, coordinate implementation and monitor catchment management plans down to sub-catchment level through the various structures and institutional arrangements in place to enable feedback loops between the different levels of intervention; allow for reflexive and adaptive processes; and ultimately drive a CMA agenda with stakeholder buy-in across the different scales of the spectrum (e.g. from municipal authorities to local catchment residents). However, catchment management can be difficult to coordinate, because catchments do not respect political or tribal boundaries, and in many instances fall over several economic, cultural or even national boundaries. There are three levels of planning – a Catchment Management Strategy; a Catchment Management Plan (catchment or sub-catchment scale) and a Village Level Action Plan (VLAP). It is important to understand the links between broader catchment and village level planning (MOAIWD, 2015). It should also be noted that the actual sizes of the catchments (or watersheds) vary according to local geographical factors and density of settlements within the catchment. Figure 5.3 presents the different catchment or watershed scales one can work with. Table 5.1 describes the watershed or catchment nomenclature, sizes and associated planning units. This spatial planning framework developed for the Neeranchal National Watershed Project in India (DoLR, 2014) and adopted in other projects in Africa such as the Shire River Basin Management Project in Malawi and Ethiopia. Around the world, typical watershed plans are developed at the scale of sub-watersheds or micro-catchment level which tend to include between one to five villages or settlements with its own plans and specific local projects or activities identified. There are benefits when

working at local level as this are smaller planning units and deeper engagement and consultation could be attained than working at larger scales.

Catchment management planning can therefore be carried out at various scales from a catchment level strategy down to village level planning.

A **'Catchment Plan**' includes a set of actions to manage the natural resources, as well as people's actions and livelihoods in a catchment. The plan aims to set a balance between how resources are used in a catchment for today's needs (like harvesting wood, planting crops, herding livestock and building houses) and protecting those resources for tomorrow's needs (MOAIWD, 2015). A catchment plan would be strategically oriented and would identify catchment level priorities, challenges and opportunities. It should also consider information and outcomes derived from sub-catchment or quaternary planning process and the local knowledge and need of stakeholders. This plan should be developed interactively with the micro-catchment plans developed at group village level.

'**Micro-catchment Plans**' are more practically oriented and will be directly linked to the local context opportunities. These plans should define mini-projects at the village level. These mini-projects could include, for example, soil and water interventions such as erosion protection works, plants nurseries, RWH among other (MOAIWD, 2015).

Plans, whether at catchment or micro-catchment level, should be integrated so that everyone is working towards the same goal. For integrated catchment management to work, it needs the input of all stakeholders and the whole community. The best results are achieved when all players are involved early in the process, which should be underpinned by participative resource use planning supported by scientific input, for instance scientific water-management techniques, and knowledge exchange interventions.

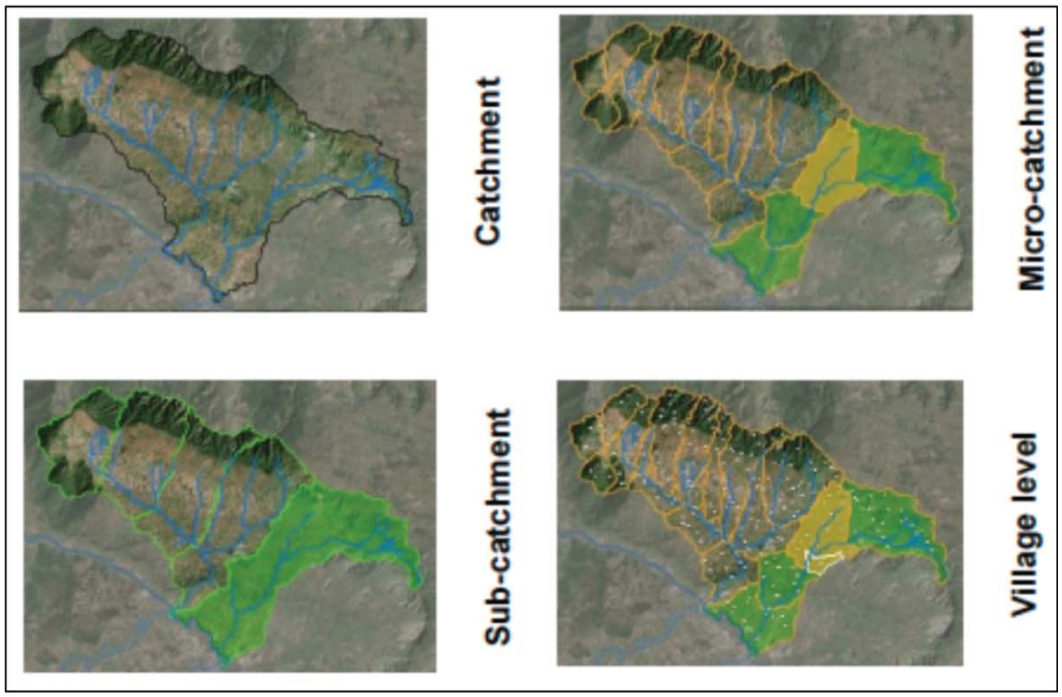
Table 5.1/...

Table 5.1: Watershed or Catchment Nomenclature, Sizes and Implications (Source: Adapted from Project Implementation Plan: Neeranchal National Watershed Project (DoLR, 2014)

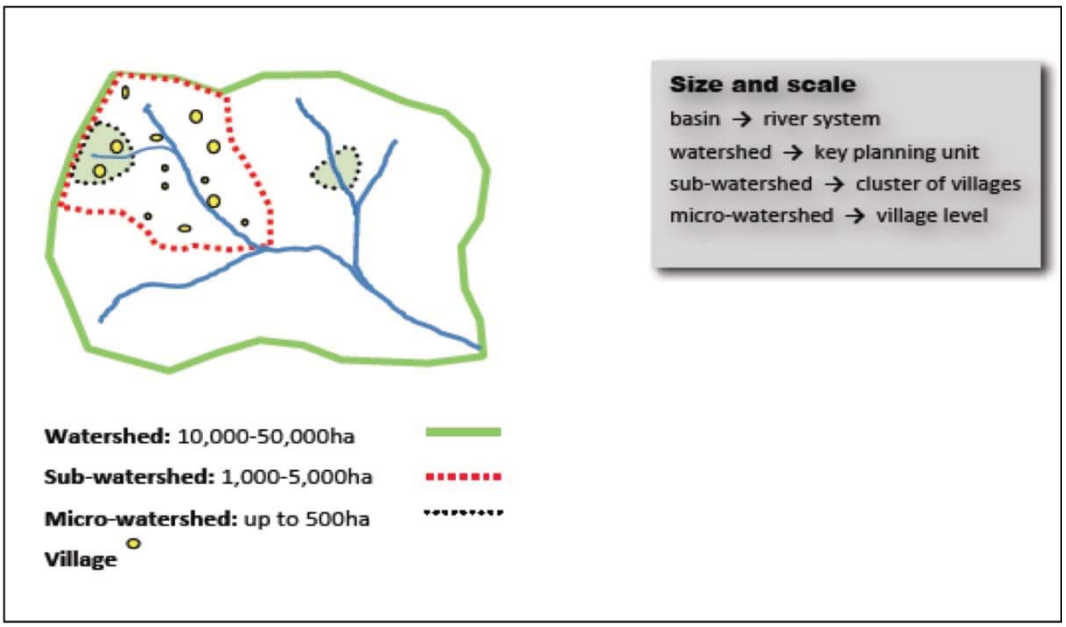
Watershed Unit	Indicative Size Ha	Influence of Land Use on Hydrology	Primary Stakeholders	Typical Management Focus/Instruments
Basin	500,000+	Weak to Very Weak	State, multi-State, or federal w/principal regional & State stakeholders	Basin planning; stakeholder management policy, legal framework & incentives
Sub-basin	100,000- 500,000	Moderate to Weak	Local, regional or State w/principal regional stakeholders	Basin planning; stakeholder management; policy, legal framework & incentives
Watershed/ catchment (Landscape Level)	10,000-100,000	Strong to Moderate	Local or multiple local governments w/principal local and regional stakeholders	Watershed-based zoning; land use & water resources planning; stakeholder management; policy, norms, regulations & incentives
Sub-watershed/ catchment	1,000~10,000	Very Strong to Strong	Local government w/ principal local stakeholders	Stream classification; land use planning/zoning; land, water resources & stakeholder management
Micro-watershed/ catchment	Around 500 - 1000	Very Strong	Property owners (local)	Participatory planning; site design; village-level plans and mini-projects

Plans should ensure that local strategies are aligned to higher-level strategic catchment management plans and social development priorities. If any of these plans are carried out in isolation within a larger catchment system, there is no certainty that at the required scale (e.g. river basin) the goals of protecting and conserving hydrologic services (and natural resources) and/or managing negative downstream and groundwater impacts will be met unless carefully integrated with higher level objectives. At the same time, local priority areas (e.g. agricultural productivity aspiration and improvement of livestock) should be communicated through the institutional channels, such as a Catchment Management Forum (CMF), for these plans to be relevant and of value to the catchment's residents.

Furthermore, the integration of rainwater harvesting (RWH) into watershed development and thus catchment management plans and projects ties into national Integrated Water Resource Management (IWRM) priorities through the participatory formulation of strategic responses that deal with resource degradation and development outcomes. Rehabilitation, remediation and restoration of degraded ecosystems through RWH is not only one of the techniques applied to ensuring sustainability of the watershed functioning and delivery of critical services (e.g. stream flow regulation, maintenance of base flows) but is one of the practices with the potential to unlock employment opportunities, sustainable development and human-well-being. RWH can provide opportunities for wage employment or "green jobs" associated with the manpower required in the application of these techniques at this scale (i.e. contour bunds).



a) Catchment Scales & Management Plans *(Source:* Shire River Basin Management Project, 2016b *catchmentguidelines.org.mw)*



b) Watershed Planning Scales (Source: India Neeranchal National Watershed Project Plan)

Figure 5.3: Catchment planning scales as given by two different development agencies

The Sinxaku Green Village Project has worked with 'mini-demonstration catchment' linked to a government driven food garden initiative that can be considered to be situated within the micro-catchment scale. Livestock management initiatives are at the sub-catchment scale, the scale of the communal grazing lands. We are also cognisant that these activities should be linked to higher level objectives of the NLEIP strategic plans in the Tsitsa Catchment.

The next section introduces the concept of rainwater harvesting and some methods and techniques that could be applied at different scales for improved local productivity (e.g. household crop-production) and land restoration work. These two applications have the potential to be interlinked depending on the context and both goals achieved with a well-planned and designed watershed plan and RWH system.

5.2 Overview of rainwater harvesting methods and techniques to reduce erosion and boost agricultural productivity

As land resources deteriorate and the demand on freshwater resources increases in South Africa, interest in building on some traditional technologies such as rainwater harvesting is rising amongst environmental, rural development and government agencies. These have evolved through Water Research Commission and Agricultural Research Council applied research studies over the last 20 years (Denison *et al.,* 2011, Denison *et al.,* 2015) as highly scientific and locally appropriate responses to sustainable development. Together with participative resource planning, and implementation modalities, RWH brings targeted technical solutions to the inexorable challenge of agricultural-water deficit, while achieving catchment protection by reduced soil erosion, increased base flows and increased ground-water recharge, through the direct incentive of increased agricultural productivity.

Rainwater harvesting (RWH) techniques are central to watershed development in poor and marginalised populations who face significant problems of land degradation. The term rainwater harvesting refers to collecting, conveying and storing rainwater for various end uses such as agricultural production, domestic purposes or environmental/conservation outcomes. RWH is used as a way to restore and drought-proof local ecosystems, capture rainfall and runoff and put it into productive use for enhancing agricultural productivity in rain-fed areas. Linked to rainwater harvesting is soil water conservation through increasing infiltration and moisture retention in the soil. This combined approach to water management is integral to our research in Sinxaku as all activities adopted sought to either reduce runoff and increase soil moisture availability or capture runoff for productive use. Runoff control has the additional advantage that it also reduces erosion and captures any soil carried by the runoff, and should therefore be included in any rehabilitation strategy that aims to reduce soil erosion and trap mobile sediment.

RWH works within the spatial entity of a catchment that varies in scale depending on the application. Figure 5.4 presents a model of RWH methods applied within a catchment or watershed development approach. RHW at this scale is being considered globally as a tool that can be adopted to ensure the hydrological functioning of catchment areas. RWH can address land use degradation as well as enhance rain-fed crop production and domestic water supply. It can also be used to improve grasslands and support livestock, to foster plant nurseries and support forestry projects. RWH could be considered as relevant green engineering and contemporary innovation that builds on traditional water management techniques. RWH also helps to reduce the growing demand placed on the country's limited water resources.

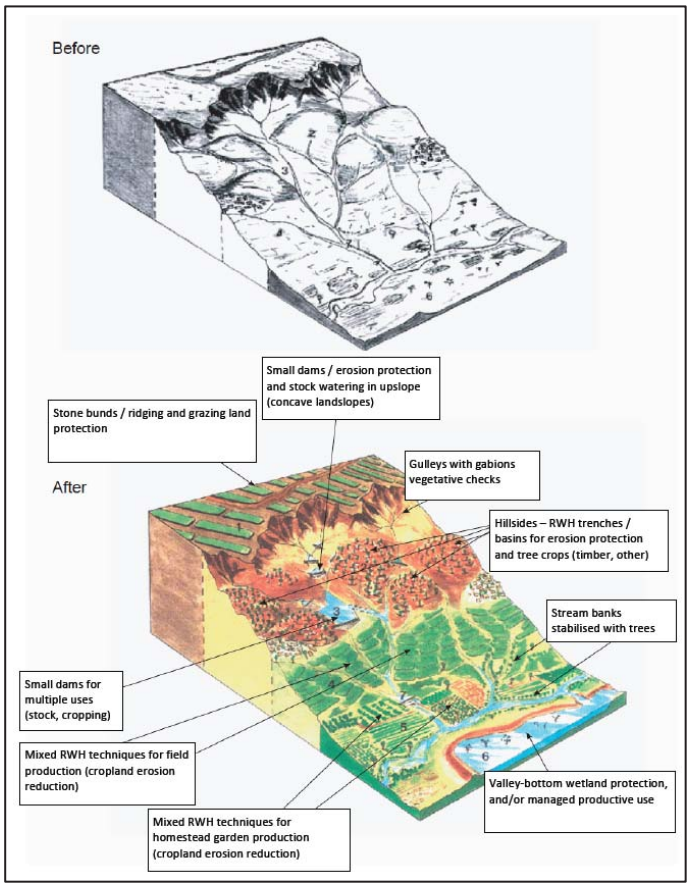


Figure 5.4: Integrated implementation of multiple RWH techniques at the watershed scale (from Desta *et al.*, 2005)

There are various definitions of RWH found in the literature, with Oweis widely regarded as an authority. He describes RWH as "…the concentration, collection, storage and use of rainwater runoff. RWH can be developed for human consumption, environmental purposes and a number of productive activities such as agriculture" (Oweis *et al.*, 2001).

Furthermore, RWH has the following components (Kahinda *et al.*, 2008):

- A **catchment** area where water is harvested. It can be a rooftop, path, road, communal land, etc.
- A **storage** facility or conveyance system where water harvested in the catchment area is stored. The storage can either be a reservoir (surface and subsurface water infrastructure), the soil profile, etc.
- A **targeted** area where the harvested water is used. The targeted area can be households, crops, plants, animals, enterprise, etc.
- The **management** of the RWH systems created.

In practice, RWH involves applying methods and techniques in a way that water is a) *intercepted* or captured; b) *slowed down* so it doesn't flush away everything in its path; c) *channelled* to where it is needed; and d) *stored* for use either directly into the soil profile, groundwater or/and in tanks or containers (DWAF, 2010). However, the potential for RWH to augment the water resource needs to be viewed in two ways; the 'upper limit potential' and the 'demand potential'. The upper limit potential or RWH yield determines the kind of RWH technique that needs to be applied to meet the demand potential or purpose for which RWH is being introduced, as well as taking into account its economic viability, financing and implementation capacity. For example, in the case of RHW for restoration of

grazing areas and/or rain-fed cropping 'the emphasis is on techniques that improve the infiltration capacity and the water holding capacity of the soils, and on shaping the runoff path to channel and concentrate water where it is needed' (DWAF, 2010:64).

Table 5.2: Rainwater harvesting methods (adapted from DWAF, 2010)

Scale of RWH	End use	Storage/Techniques*	
		Soil profile	***RWH Infrastructure***
Large catchment or floodwater harvesting (200 ha – 50 km^2)	Cultivation Restoration	Swales/bunds Basins Contour ridges Diversion farrows Saaidam	Earth dams Concrete dams
Macro-catchment (0.1-200 ha)	Cultivation Restoration	Swales/stone bunds Basins Contour ridges Dome water harvesting	Earth dams Concrete dams
Micro-catchment (< 0.1 ha)	Domestic Cultivation Restoration (only when methods are adopted in large numbers)	Trench beds Contour stone bunds Infield RWH Diversion ditches Level contours & swales Semi-circular bunds Fertility pits Tied ridges Ploegvore Terraces Road water harvesting	Earth dams Concrete dams
Rooftop	Domestic Cultivated areas in home-based food gardening Other productive purposes	Rainwater is channelled to French drains, vertical gravel columns & trench beds	Above ground & underground Plastic/concrete tanks Earth dams

Selected RWH examples from the many applicable to South Africa are listed in Table 5.2. The methods given in this table should be integrated with soil and water conservation techniques such as re-vegetation to stabilize slopes, and water management practices (e.g. wise water use). These can be applied at micro-catchment scales (Figure 5.5) and macro-catchment scales. RWH methods are distinguished on the scale of runoff collection, the end use or purpose and the medium of storage. Further guidelines on rain water harvesting methods are provided in Appendix C.

Figure 5.5: The 'in-field' RWH method, reduces soil-erosion, increases drought resilience and profitability (from Botha *et al.*, 2003)

Different techniques have been developed for the built environment (e.g. homesteads, villages, towns and urban areas), cultivated areas (e.g. dryland and irrigated production in crop fields and home-based gardening) and uncultivated areas (e.g. grazing, natural veld, mountains areas, conservation areas, etc.). Their catchment area or scale varies from rooftop, micro-catchment areas (< 1000 m^2), to macro-catchment (1000 m – 200 ha) and large catchments (200 ha – 50 km^2). Further to this, a number of approaches to categorizing rainwater harvesting have also been fostered such as that of the Food and Agriculture Organisation (FAO) which deals with water harvesting for production; the RHADESS for South Africa uses a categorization according to the catchment area, to name a few.

Generally, most human activities that occur on land affect the water cycle, with RHW being no exception. The National Water Act (Act No.36 of 1998) considers stream flow reduction activities as land-based activities that reduce stream flow, and therefore RWH needs to be established as a stream flow reduction activity as it has potential for diverting considerable amount of surface runoff, depending on the scale, from the watercourse. Having said that, RWH generally captures water from high rainfall incidence events and has the dual effect of making water available for catchment restoration and productive use, as well as acting as 'sponges' in the same way the wetlands do. This effect can reduce the peak flows and increase the base flow by recharging the springs and rivers in the system. In hydrological terms, RWH makes more water available from peak rainfall. It is necessary to understand these effects in an integrated manner as the effect of RWH may bring more benefits than those anticipated.

Consequently, a decision support system is required in order to inform the potential impact of RWH applied at this scale (Kahinda *et al.*, 2008) as well as decision-making structures driving Integrated Water Resource Management (IWRM)[1] and water resources planning at the basin and/or sub-basin levels in order to make the most viable recommendation that is both socially, economically and environmentally sound. This is supported by the National Environmental Management Act (NEMA) (Act No. 107 of 1998) that stresses the need for an integrated approach for implementation of any RWH, and does not include RWH as one on of the activities requiring Environmental Impact Assessments. Some examples of these decision support systems (DSS) are the RHADESS (Rainwater Harvesting Decision Support System) which aims to indicate the RWH suitability of any given area and to provide the means for quantifying and qualifying potential impacts associated with its wide-scale adoption in the South African context, as well as the SACWAT III (South African Crop Water Use Assessment Tool) formally adopted by the Department of Water and Sanitation as the national water use planning tool.

[1] Integrated Water Resource Management (IWRM) is a comprehensive, participatory planning and implementation tool for managing and developing water resources in a way that balances social and economic needs, and ensures the protection of ecosystems for future generation (source: GWP Tool Box for IWRM)

Benefits associated with RWH development include:

1. Environmental/conservation (Denison et al., 2011):

a) reduce soil erosion and thus siltation of the streams, rivers and estuaries from harvesting and managing runoff from roads and steep slopes
b) increase base-flow and thus stream and river recharge
c) mitigate flood peaks

2. Water supply-demand and municipal service delivery (DWAF, 2010):

a) less pressure on municipal services to provide bulk water infrastructure, operation and maintenance costs
b) release pressure on irrigated agriculture and on water resources

3. Poverty reduction, economic development, improvement in general well-being and health, and gender equity (Kahinda et al., 2008):

a) improved diet and food security from increased crop production
b) improved household economy from new income earning opportunities
c) provision of clean water, adequate sanitation and improved health
d) reduced vulnerability to drought, helping resource-poor farmers deal better with the risks involved in rain-fed agriculture
e) gender equity by reducing the burden on poor rural people, with less time spent in collecting water (particularly for women and children)

However, RWH also bring its own limitations. While successes and positive impacts are widespread and convincing, there is some need for caution around an over-optimistic expectation that RWH techniques can ensuring drought-proofing (Lankford, 2009), as the fact remains that when there is no rain there is no runoff, and water stored in a soil-water reservoir can only go so far, particularly in lighter-textured soils and locations with a high aridity-index. In our own research area, we have the added problem of dispersive soils which are prone to tunnel erosion if they become saturated. Water harvesting methods that promote localized soil saturation should avoid such soils.

RWH practices need to be planned with attention to the particular site conditions and cropping systems (Rockstrom *et al.*, 2007; Denison *et al.*, 2015). In agriculture development, a hybrid system with localized storage and supplementary irrigation, even in a small part, becomes important in certain locations. Agricultural RWH interventions, combined with a range of climate-smart agricultural practices and implemented in a watershed framework, is an approach that has demonstrated positive results in Sub Saharan Africa and other developing regions.

Furthermore, watershed development programmes, and thus RWH methods, can also be in line with other water development approaches such as the multiple use system (MUS). MUS adopts a people-centred approach by trying to understand peoples' multiple water needs (e.g. productive, domestic, cultural, etc.) and their water resource available as a starting point for providing water services to support their specific livelihood strategies (Denison *et al.,* 2015). Here RWH infrastructure can be developed in order to store rainfall in tanks or reservoirs to support the multiple water needs found in the household and thus contribute towards improved well-being of the family.

Overall, the adoption of RWH methods and techniques could be considered within a watershed approach as an integral solution to enhance the resilience capacity of any catchment system. Application of RWH in this context will better equip the watershed system and agricultural sub-systems to adapt to climate change

and continue to develop in order to meet attainable human development aspirations and well-being. Furthermore, on-going reflexivity on the way RWH is applied and integrated into the watershed activities allows better ways of responding to emergent issues, mediated through participatory and co-developed watershed management plans, from rural communities to higher level governance structures.

The following section presents a case-study from Sinxaku where agricultural activities and catchment management were interlinked through the adoption of RWH and soil conservation methods and mediated through participatory and learning process.

5.3 Our Entry Point: A Case-Study of the Sinxaku Community Works Project Food Garden located in the Tsitsa Catchment

5.3.1 The Community Works Programme (CWP) food garden project

The learning and adoption of rainwater harvesting (RWH) methods has been investigated as part of the Green Village Project as an approach to not only reduce the impact of run-off on soil degradation and erosion but also as a technique and practice that can potentially assist in overcoming livelihood constraints, particularly in relation to small-scale rain-fed agriculture. Initially, as explained in Chapter 2, the researchers intended to facilitate a village-based catchment plan with the Sinxaku village residents as the process of situating RWH in relation to both uplifting home-based food production and livestock, as well as assisting in maintaining and restoring the mini-catchment where these activities were taking place. However, overtime the Green Village Project researchers came to realise that in order to promote catchment management practices in the Tsitsa Catchment where Sinxaku falls under, the focus needed to shift to the livelihoods themselves rather than the protection of the catchment as the primary point of departure. By turning the focus on local agricultural practices, the research team searched for a suitable active small-scale gardening project to work with. The aim was to investigate whether a social learning process would lead to the adoption of RWH solutions, thus benefiting food production. At the same time, it had the potential to contribute to land management at a larger catchment scale. In doing so, the unit of analysis shifted from the original idea of working from a micro-catchment scale and village-level plans to working from a 'project level' and from this outwards into the catchment (See Figure 5.6)

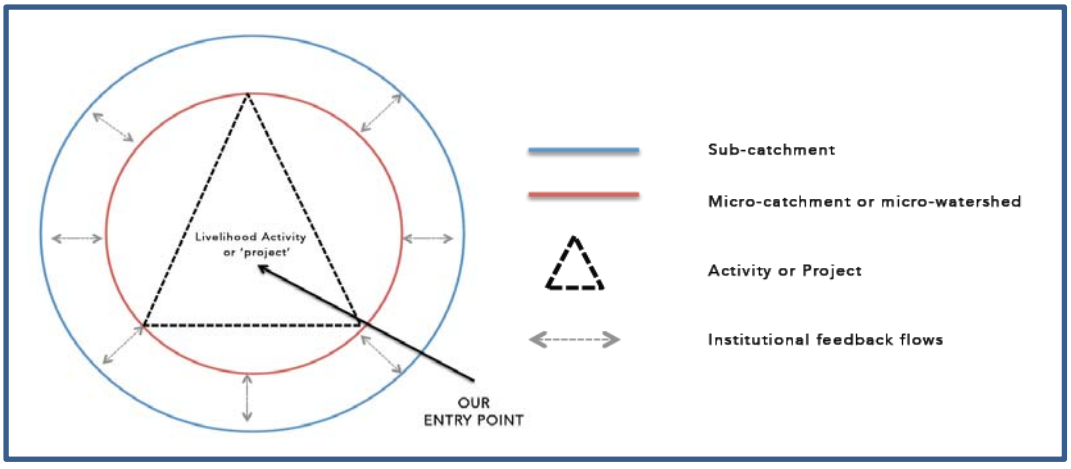


Figure 5.6: Project or activity level as the entry point for further expansion into catchment management practices

A Community Works Project (CWP) was identified through a process of local consultations with the village residents and direct observations of local livelihood activity. The final selection was based on: a) location; b) levels of land degradation within and outside the boundaries of the project; c) nature of the activity being undertaken by the project, in this case, food production and; d) voluntary willingness to participate. The identified CWP project consisted of two sister projects, one located in Maxesibeni and the other in Qulungashe, both belonging to Lower Sinxaku village cluster. The Maxesibeni food garden is situated at the bottom of a hill and adjacent to the village main road from where storm water run-off opens up small erosion gullies along the pathway between the village households and home-based food gardens. Run-off water eventually meets the Tsitsa River by crossing the local grazing lands and creating more erosion gullies along the way. The project's location was ideal to test RWH methods of channelling water running from the hillslopes into the food garden. The Qulungashe project's topography consists of a flat area in the centre of the village, also adjacent to the village main road. Although it was not a suitable location to demonstrate run-off control methods, the main practices explored were linked to water conservation, such as 'mulching'. Each project team constituted 12 people and both teams were undertaking food gardening as their primary community project. During the course of 2017, the project teams engaged in Developmental Work Research based on an expansive learning cycle methodology.

The next sections describe the theoretical orientation, methodology, process and outcomes of the 'intervention' mediated by the research team in a quest to investigate the features of a learning process that would mobilise new knowledge and new practices towards the expansion of small-scale agriculture project and catchment management in the Sinxaku area.

5.3.2 Theoretical Framework, Methodology and Methods: Aspirations, learning and expansion

i. Activity Theory and Expansive Learning

Activity theory is a theory of object-driven activity. Objects can be concerns; they are generators of foci of attention, motivation, effort and meaning (Engeström, 2009). An activity is therefore defined as the engagement of a subject toward a certain goal or aspiration (goals with value). In other words, an activity system can consist of a group, of any size, pursuing a specific goal in a purposeful way (Mukute, 2010). The emphasis on the 'object' of activity is of considerable relevance in this component of the project because it has essentially become the beacon for change and new practice for the CWP teams to take up RWH practices, food production and, over time, it could catalyse catchment management practices beyond their own project. However, 'objects' or aspirations are elements interrelated with other elements within activity systems that at the same time are influenced by socio-cultural and historical events. An activity is explained by Ryder (1998) as:

> *"An activity is undertaken by a human agent (subject) who is motivated toward the solution of a problem or purpose (object), and mediated by tools (artefacts) in collaboration with others (community). The structure of the activity is constrained by cultural factors including conventions (rules) and social strata (division of labour) within the context".*

Table 5.3 describes the different elements found in an activity system. These can assist in developing a deep contextual understanding of the activity investigated, particularly if the contextual profile is developed in collaboration with the participants being investigated. This initial participatory step can lead to the first level of analysis, the identification of tensions and contradictions within the activity system restricting the 'object' from expanding.

Different generations of activity theory can be found, from the original triad subject-tool-object conception of activity system attributed to Vygotsky and Leont'ev (Mukute, 2010), to the second and third generation further developed by other key theorist such as Yjro Engeström (Daniels, 2008). The second generation of activity theory builds on the first generation by taking mediating tools of practice as the crucial component through which its relationship with three new components of rules, community and division of labour needs to be focused (see Figure 5.7); essentially it takes stronger account of contextual and power relations in the mediation process.

Third generation of activity theory exists when there is more than one activity system of the second generation and there is interaction between the activity systems. The third generation of activity theory as proposed by Engeström is intended to develop conceptual tools to understand dialogues, multiple perspectives and networks of interacting activity systems and the complexities that arise when their boundaries meet (see Figure 5.8). Engeström draws on ideas of *dialogicality* and *multivoicedness* in order to expand the framework of the second generation (Daniels, 2001).

Table 5.3: Elements of an activity system (Source: Engeström, 1999; Daniels, 2001)

Element of activity	Explanation of element
Subject	Individual or group of people whose agency is chosen as a point of view in the analysis of the activity system. The subject's relations to the object is mediated by four elements: rules, tools, community and division of labour, all of which carry cultural meaning and historic
Object	Raw material or problem space being worked on, a horizon never fully reached.
Outcome	Desired result of working on the object.
Tools	Conceptual and material artefacts for understanding or transforming the object (carry culture, history, skill and knowledge involved in developing them).
Community	Group of people who share the same object.
Division of labour	Horizontal and vertical allocation of responsibility which mediates the relationship between the community and the object.
Rules	Mediate the interaction between the subject and the community, as well as between the subject and the object.

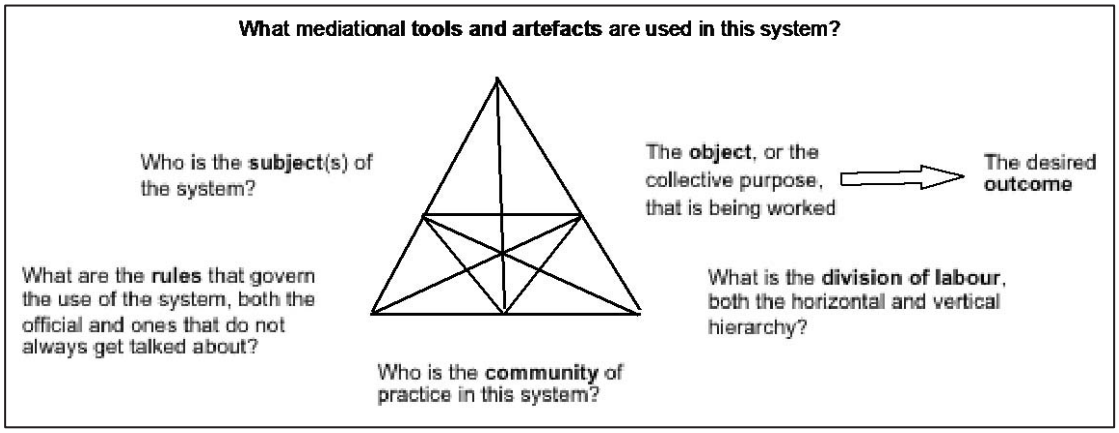


Figure 5.7: A second generation mediational triangle of a cultural and historically constituted activity system (adapted after Engeström, 2000)

In the Green Village Project, second generation CHAT (Cultural Historical Activity Theory) (or activity system triangle) has been used to, firstly, better understand the motive or object of the activity and, furthermore, to gain insights into the different relations, contradictions and tensions within the CWP project activity system that contribute to, or constrain expansion of their envisaged food garden. However, third generation CHAT could eventually become an optimal conceptual framework for the formation of a catchment-wide (at any scale) shared vision and plan as it could bring together a range of different activity systems (e.g. agriculture activity, livestock activity, etc.) into a process of learning and transformation of the catchment (Figure 5.9).

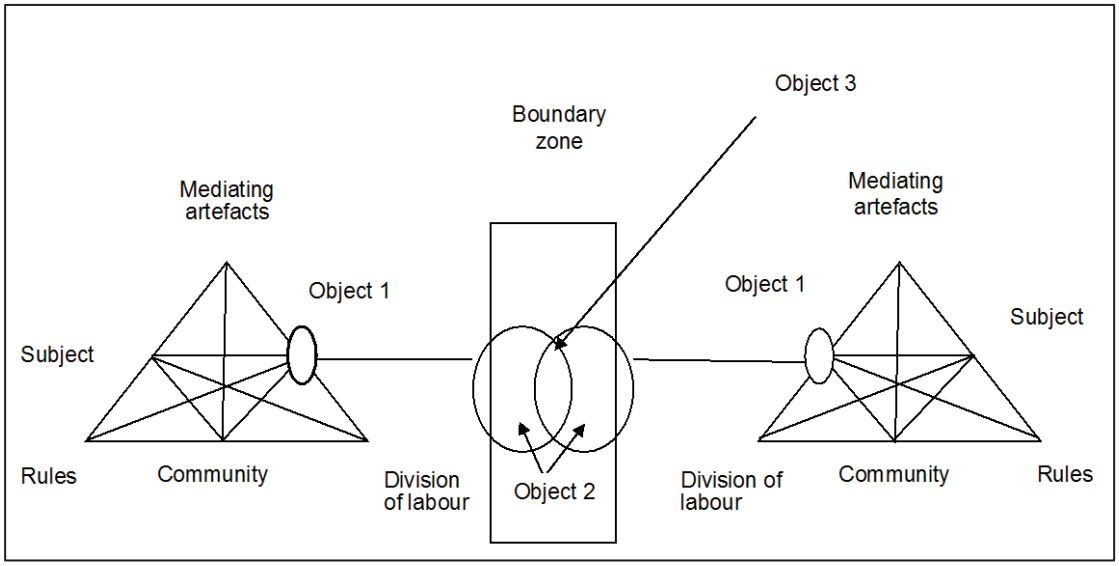


Figure 5.8: Third generation activity theory: two activity systems with a partially shared objective as a minimum unit of analysis. (Source: Engeström, 2008, Figure 1, p.14)

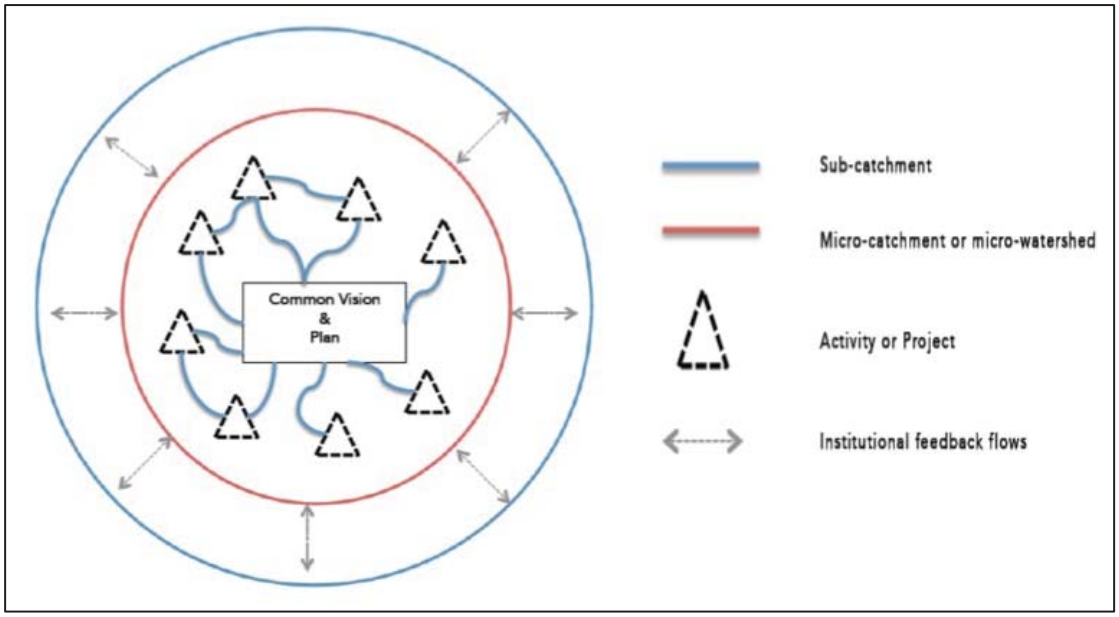


Figure 5.9: Networked-activity as niches for development and catchment management practices

Furthermore, Engeström suggests that activity theory may be summarized with the help of five principles (Engeström, 1999):

1. the prime unit of analysis is a collective, artefact-mediated and object-oriented activity system in a networked relation to other activity systems;
2. an activity system comprises a community of multiple points of view, traditions and interests;
3. activity systems take shape and get transformed over lengthy periods of time and can only be understood against their own history;
4. contradictions within the activity system are sources of change and development which have historically accumulated structural tensions within and between activity systems;
5. activity systems bring the possibility of expansive transformation.

These principles have been taken into the design of the CWP participatory and learning sessions as described in the sections that follow.

In summary, expansive learning originates in activity theory and *"*involves the creation of new knowledge and new practices for a newly emerging activity; that is, learning embedded in and constitutive of qualitative transformation of the entire activity system. Such transformation may be triggered by the introduction of a new technology or set of regulations" (Daniels, 2008:126). This means that food production in the CWP project could be unlocked by, for instance, improving water systems, including RWH; or even a higher aspiration or change in the 'object' of the activity.

ii. Expansive Learning Cycle and Change Laboratory Workshops

As previously alluded to, Engeström's work involves developmental intervention-based research, arguing that research has a dialectical, dialogic relationship with activity focusing on contradictions as causative and disturbances as indicators of potential. As mentioned, his approach to intervention research is derived from activity theory and has its roots in the Vygotskian method of dual or double stimulation. Although the essence of his approach is that "subjects are placed in a situation in which a problem is identified and provided with tools with which to solve the problem or means by which they can construct tools to solve the problem" (Daniels, 2008, p.131) the approach to this study was not to initiate the process by emphasising problems in relation to unsustainable livelihoods and poor natural resource management as a whole. It was rather to mediate a participatory vision building exercise of self-evaluation and reflection where the mediation becomes the intervention from which positive change could evolve. Engeström uses a series of Change Laboratory intervention sessions or workshops based on the expansive learning cycle, often referred to as Developmental Work Research (DWR) (Daniels, 2008; Mukute, 2010), which this research process is based on.

A series of "change laboratory workshops" based on Engeström's expansive learning cycle methodology took place during March 2017 followed by a workshop in July 2017. The change laboratory workshops took the form of: 1) questioning current food production practices and assembling a project vision or collective aspiration with ethnographic and historical evidence; 2) deep analysis of cultural and historical origins of current practices to enable more detailed and better articulated practices in relation to the food production enterprise and its interconnectedness to the broader catchment; 3) modelling an alternative way of working expressing solutions and needed capabilities; 4) examining the model to understand its dynamics, strengths and pitfalls; 5) implementing the model and monitoring the processes and impact of implementation in the dispositions and actions as ongoing self-evaluations in context; 6) drawing on these data to reflect on the processes and outcomes; and 7) consolidating new practices, capabilities and sustainability (see Figure 5.10).

The next section provides a detailed description of the expansive learning process undertaken with the CWP team, including main outcomes and lessons learnt.

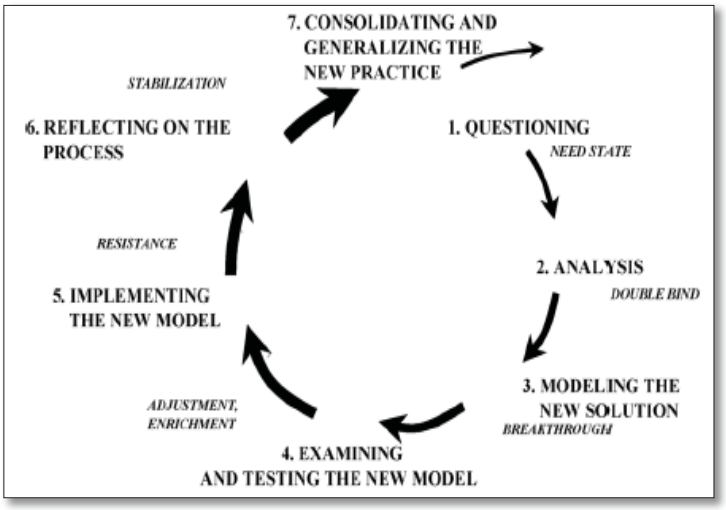


Figure 5.10: Sequences of learning actions in the expansive learning cycle (Engeström, 2000)

5.3.3 Description of the Learning Process with the CWP Food Gardening Teams

As alluded to in the section above, our entry point was to identify a degraded mini-catchment area within the Sinxaku Villages which would benefit from the implementation of RWH methods from a soil conservation point of view, and thus also provide a source of water for productive use to local rain-fed small-scale food gardens located in this mini-catchment. The CWP Food Gardening project was selected through a criteria-based process previously described. The learning process with the CWP teams commenced in March 2017 with a three-day programme. During these three days Step 1 to 4 of the outlined expansive learning cycle where completed.

The workshop programme was designed in a way that the community food garden project's vision and challenges were defined and analysed in detail using the second generation activity 'triangle' (Figure 5.7) before going into possible solutions such as RWH and water conservation practices. The reason for such approach was to make sure that the knowledge and skills developed during this learning process would not sit in a vacuum. An opportunity was provided to the participants to co-create other relevant solutions for their farming enterprise (e.g. improve access to agricultural inputs such as tools). Often the outcomes of knowledge workshops end up not being implemented nor assisting those involved in improving their current situation or practice. Therefore, the programme was two-fold:

Map out the collective food garden vision/aspirations, and identify and analyse dissonances and constraints found in the attainment of the proposed aspirations.

Design and plan RWH solutions for improved food gardening productivity within the broader context or mini-catchment where the project was located.

A workshop programme overview for the three days can be found in Table 5.4.

Table 5.4: CWP Food Garden – Water Harvesting and Conservation Workshop Programme

Programme Outline		Expansive Learning Steps
Day 1	Introduction to Research Objectives, Methodology and Ethics	Overview of the learning process
	Defining participants' collective vision, aspirations and envisaged outcomes in relation to their CWP Community Food Garden project and questioning current practices	Step 1
	Description and analysis of the CWP Community Food Gardens activity system, being water security at the centre of the activity	Step 2
Day 2	Mapping and prioritization of solutions to achieve participants' goals and aspirations	Step 3
Day 3	Introduction to rainwater harvesting and conservation principles and methods as solutions situated in watershed management and sustainability Design rainwater harvesting – food garden system Practical implementation of rainwater harvesting and conservation methods	Step 4
	Way forward for Implementation	Step 5

At the start of the workshop in Day 1, the group gathered in a semi-circle facing a blank wall used as a presentation board. The workshop was conducted primarily by the main facilitator/mediator, Laura Conde-Aller, supported by the project's interpreter, Monde Ntshudu, and a Rhodes University ELRC Masters scholar, Patience Shawarira. The Expansive Learning Research and Development Process was presented to the workshop participants in detail in order to alert the participants about the commitment required to complete this process, as well as relevance to their food garden and potential for improvement and development. The facilitators emphasised the voluntary nature of participating in the research process as well as ethical considerations during and after completion of this project. All members gave us their consent to continue with our workshop and future plans.

Illustrations of workshop activities are shown in Figure 5.11.

STEP 1: Project Vision

The first activity on Day 1 focused on clarifying the CWP Food Garden Vision as defined by the team members. The teams were allocated to three groups that worked on their vision guided by the facilitators and some key pointers. The facilitator took all the comments on board and summarized their statements in the following project vision: "The CWP Project should be a centre of excellence and work towards a self-sustaining income generating food garden with great produce diversity". The vision, thereafter, became the focal point for engaged discussions. In other words, it became the beacon of hope or common ground for participants to collaborate in mapping solutions and purpose, in activity theory terms, the 'object' of the activity.


(a) CWP Teams engaging in groups


(b) CWP Team Members reporting back on their project challenges and proposed solutions


(c) CWP Team Member assisting with the interpretation and facilitation of the action plan session

Figure 5.11: CWP Team Members engaged in workshop activities

STEP 2: Description and Analysis of the WCP Food Garden Project

By the end of Day 1 the group had developed their food garden project contextual profile in some detail. The exercise provided an opportunity to interrogate the resources available (e.g. water and land resources), including agricultural inputs (e.g. seedling supply, utensils, natural fertilizer); the current agricultural support pertaining in the area (e.g. from government, NGOs, private); local knowledge and skills in relation to sustainable food production and water management; the project roles and responsibilities allocations (e.g. ploughing, sowing, watering, selling production); and access to markets (e.g. local, regional, national). The exercise continued with the process of identifying the constrains and opportunities for the CWP Team to develop and expand their food production capability, as per project vision, and how the different contextual aspects and capabilities have changed, or not, over time.

Table 5.5: Consolidation of WCP Food Garden Challenges and Guiding Questions for further discussions

Group	Challenges	Guiding Questions
1. Water Management & Conservation	• Water infrastructure and services not delivered • Water management and conservation practices not traditionally applied nor learnt from others/support agencies/learning resources • Uncertainty in rainfall patterns yet food gardens mainly depend on rainfall or tanks • WH&C knowledge not available	*a) How it used to be?* *b) How is it now and why?* *c) How it should be?* *d) Solutions?*
2. Operational Support	• Suitable equipment/ implements/ water infrastructure not available nor accessible • Compost not available	
3. Land Access and Management	• Vegetable production can increase in land available if focus in on "kitchen" vegetables – land is not maximized • Crop production (e.g. potatoes, maize, etc.) need bigger extension of land – fencing not available • Production dependency on rainfall or other scarce water sources • Land management/soil erosion is understood but appropriate practices not in place	
4. Team Work & Dynamic	• Project roles and responsibilities not assigned to maximize production and sales • Unreliability and unwillingness from some project members affecting production and distribution of revenue • Lack of stimulation and exposure • Lack of cohesion and purpose in defining/achieving a common goal/vision	
5. Agricultural Knowledge and Skills	• Lack of access to agricultural extension support and knowledge • Lack of access to knowledge networks and information resources • Sometimes access to new knowledge and training but not applied in project	

After Day 1, the facilitator carefully consolidated their contextual profiling responses and main challenges into Table 5.5. The summarized challenges were reflected back to the group on Day 2 as stimuli for further discussion and reflection.

STEP 3: Co-creating solutions and action plan

Day 2 was assigned to map out relevant solutions as per challenges and contextual realities influencing the success of the CWP Food Garden Project as per the project vision. Five groups were formed and worked on the challenges and questions outlined in Table 5.5. The groups had a chance to report back on their discussions and provided an opportunity for other members to comment and input.

The facilitator took the time to synthesize all responses and consolidate them into ten key actions that support the solutions collectively worked out during Day 2. These were presented back to the group on Day 3 as a preliminary action plan framework as 'mirror data'. The whole group carefully went through each 'action' and decided its level of importance to support the realization of their project vision; the level of feasibility; appointed task leaders and finally the time-frame by which they should accomplish and report on each task. The "action plan" developed can be found in Table 5.6.

This activity generated a good discussion about the strategy in which each task was going to be accomplished. Furthermore, the group agreed that the achievement of the majority of these tasks and solutions was in their hands and that having a well-managed, productive garden would help to attract further support. The final conclusion was that if the group works well and the dynamics are sorted out they will be able to achieve their vision. They suggested meeting again in July to follow up on progress and reflect on their process.

STEP 4: Learning and Modelling Water Harvesting and Conservation Solutions

The last session of Day 3 was dedicated to introducing water harvesting and conservation components, principles and methods. The session started by asking the group about their understanding of this topic and whether they currently harvest water from the rain, how and why. They all agree that it is common to catch water in containers and transfer it for both domestic and irrigation purposes. Their feedback became the grounds from where the components and principles of RWH and conservation were introduced and represented with an illustration of a house that was easy to relate to. The house roof represented the "catchment area", the water tank the "storage", the food garden the "target area". This system needs to be managed if it is to work well. The discussion was followed by applying the same concepts to the local mini-catchment were one of the CWP food garden is located. Here the roof was the actual catchment running from the hills towards the main road; the storage was potentially water tanks, ponds or/and the soil and the target area their food garden. Thereafter four methods were introduced using the Amanzi for Food translated hand-outs (Appendix C). These were diversion farrows, swales, mulching and trench beds. The group also analysed each method as good practices to slow down run-off and thus control soil erosion, as well as making the most of the water available by conserving it using techniques such as mulching. The illustrations used can be found in Figure 5.12.

Table 5.6: Brief CWP Food Garden Team Action Plan

ACTIONS	Level of Importance			Level of Feasibility			Time-frame
	High	*Medium*	*Low*	*High*	*Medium*	*Low*	*Month*
1. Mobilize service delivery for 1.1 Supply water tanks 1.2 Deliver water	 X X					 X X	July
2. Apply water harvesting and conservation methods for improved water access and irrigation	X				X		
3. Build water reservoirs and ponds for improved irrigation supply	X			X			
4. Hold CWP meeting to sort out group dynamics and foster better team work	X			X			
5. Set up exchange system for improved support with labour needs and other needs (e.g. equipment)	X			X			
6. Attract potential sponsors and outside support to access agricultural equipment	X			X			
7. Mobilize training from government for agricultural skills and knowledge	X			X			
8. Set up knowledge exchange visits with other food gardeners from the Eastern Cape to learn new agricultural and food production skills	X			X			
9. Set up a project "bank" to enable the purchasing of agricultural equipment (e.g. fencing)	X			X			
10. Intensify vegetable production (intercropping) for better use of available fenced land	X			X			

The group proceeded to take a transect walk through their mini-catchment, following the run-off pathways and identifying how rainwater could be intersected and channelled to either a storage place (e.g. pond in the garden) or directly to their garden. A few suggestions emerged from these discussions. The group moved into the project's garden and explored the possibility of intensifying their production in the land available by applying intercropping methods and companion planting. The benefits of mulching were also discussed and practically demonstrated. Finally, the group looked into preparing a trench bed. All groups had already prepared to facilitate one of the four methods the day before so the discussions built from the information available on the hand-outs. By the end of this section the group felt that some of these methods would be easily to apply and others would require more effort.

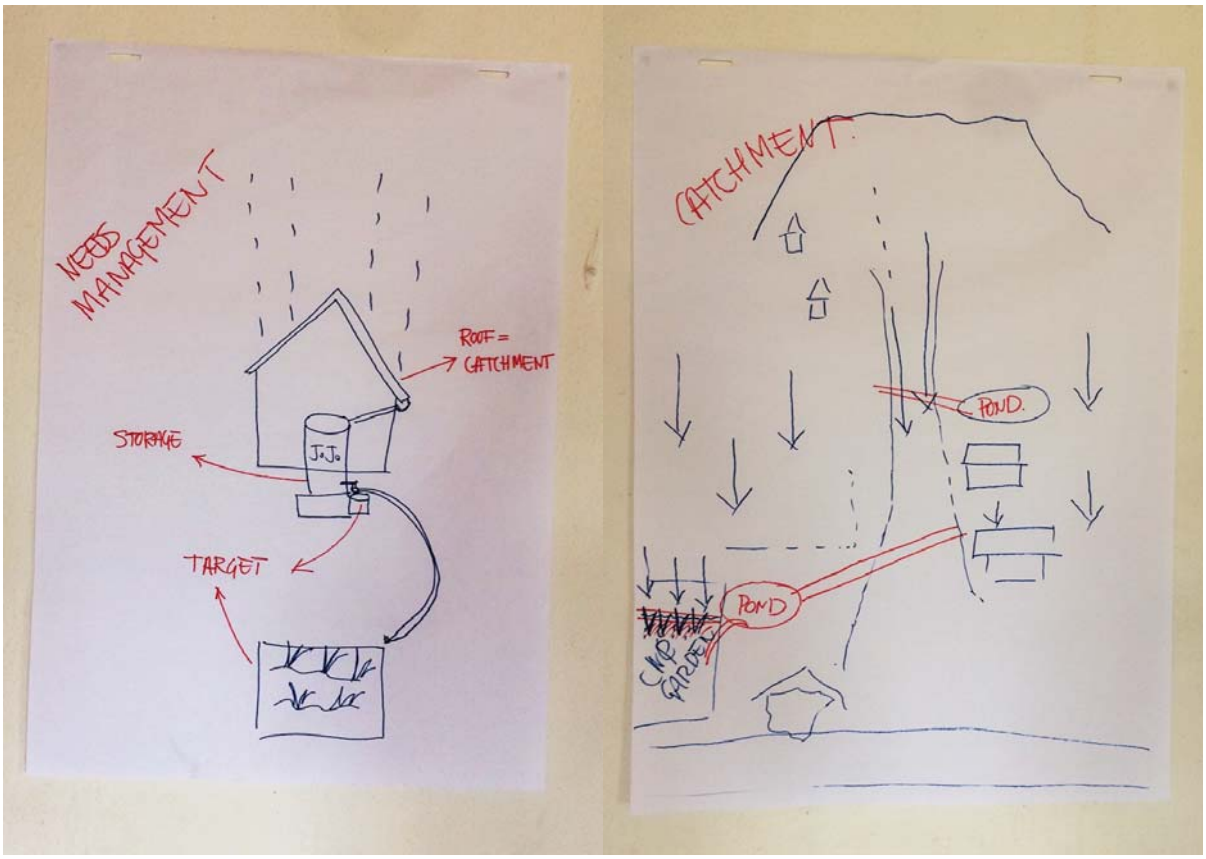


Figure 5.12: Illustrations of WH&C principles, components and methods

STEP 5: Implementation of Solutions

In July 2017, the Green Village project research team travelled to the Tsitsa Catchment area to follow up on the CWP Food Garden project outcomes derived from the previous workshop in March. The workshop was planned over two days with the CWP teams from Maxesibeni and Qulungashe in Lower Sinxaku. In general, and despite the lack of good rains, the teams had made some progress since March, as detailed under STEP 6. The next section provides a more detailed description and reflections on the implementation of the team's planned solutions.

STEP 6: Feedback and Reflections on Food Gardens and Water Harvesting Plans

The workshop began by reminding the participants about our research purpose which aims to track social expansive learning and collective agency towards improvement of run-off control and food production via the application of RWH and conservation methods in their food gardens. The facilitator also confirmed the team's vision for their garden as developed during the previous workshop in March. This is as follows:

"To create a centre of excellence and work towards a self-sustaining income generating food garden with great product diversity"

Table 5.7: Feedback on CWP Food Garden Team Action Plan

(M-Maxesibeni participant, Q- Qulungashe participant)

ACTIONS	FEEDBACK
11. *Mobilize service delivery for* 1.1 Supply water tanks 1.2 Deliver water	(M&Q) We gave feedback to supervisor on workshop. To access tanks is not an easy task. The supervisor is on to it. We have faith that she is trying her best but we haven't followed up with her.
12. *Apply water harvesting and conservation methods for improved water access and irrigation*	(M) We built a small 'farm' dam. Also starting digging a trench but stop because the ground was very hard. We are also apply mulching. (Q) In 2014 we made a request to the Municipality for a spring protection system and for water to come through taps but the water is not enough. We have also used mulching but we did not put enough so we had weeds coming through.
13. *Build water reservoirs and ponds for improved irrigation supply*	(M) See above. We started to build the pond by the river. We have started with trenches for when water comes (Q) We have not built a dam. Used to collect water from the spring but now with the new spring protection system, there is not water. We will make a plan to sort it out. Otherwise we collect water from the Tsitsa river
14. *Hold CWP meeting to sort out group dynamics and foster better team work*	(M) The group held a meeting. We are now working well together. The evidence is that the garden is better. (Q) We have sorted out. The garden is now flourishing. The main problem is water
15. *Set up exchange system for improved support with labour needs and other needs (e.g. equipment)*	(M) We didn't get tools from Q but we ended up getting tools from our homes and working with those. (Q) Same for our area
16. *Attract potential sponsors and outside support to access agricultural equipment*	(M&Q) The supervisor is not here today but we can answer for her. We have been given gardening equipment (spade, rake, wheelbarrow, uniform) however these were supplied a long time ago. No changes since March to now. We are still waiting.
17. *Mobilize training from government for agricultural skills and knowledge*	(M&Q) Also supervisor is responsible. No workshop since then.
18. *Set up knowledge exchange visits with other food gardeners from the Eastern Cape to learn new agricultural and food production skills*	(M&Q) Exchange between Port St Johns, Sinxaku and Matatiele is under process for Sept 17
19. *Set up a project "bank" to enable the purchasing of agricultural equipment (e.g. fencing)*	(M) We also have some money but not enough to take to the bank or buy fencing and we are still using it to buy seedlings (Q) We have collected money but not enough to open a bank account. We have already used it to buy seedlings. Our ability to collect money is based on our sales which depend on water availability
20. *Intensify vegetable production (intercropping) for better use of available fenced land*	(M) We have intercropping in the lower plots of the garden. It is working for us. We are harvesting more and we will continue with this. (Q) We are doing intercropping. We are using it to conserving land. We mix the root crops and leaf crops

Thereafter, the CWP members and facilitator (with support of an interpreter) ran through the list of actions outlined in March. Feedback on progress against these actions was provided by each task leader with comments from the rest of the team when appropriate. The teams' feedback is captured in Table 5.7.

In general, there had been positive change from the previous workshop in March. Some RWH and conservation methods were applied. For instance, both teams implemented mulching as a water conservation method on their vegetable plots. They found out that mulching assists in conserving water in the soil and has enhanced vegetable productivity such as for spinach and cabbage. However, one team recognised that they needed to apply more quantity of grass (mulching) in their plots in order to avoid 'weeds' from growing between the vegetables. Both teams also met with the supervisor and ironed out some of the team dynamics highlighted in the last workshop. As a result, both teams have worked better together and their food gardens have improved. However, the teams still need to sort out water infrastructure constraints as well as further financial support to access more gardening implements and advance their knowledge and skills. They will motivate their supervisor to pursue such shortfalls.

Further to the open discussion and reflections facilitated during the workshop, the research team conducted semi-structured interviews with a few members of the CWP team. They verified that some of the RWH and conservations methods learnt from the workshops have been implemented. For example, following the training, the CWP team dug a trench bed in the community garden to direct rainwater and they went on to illustrate how they were planning to use the trench to capture and store rainwater. It was also observed by the research team that the CWP had planted a selection of mixed vegetables such as cabbages, spinach, potatoes, onions and beetroot and in some instances applied 'intercropping'. During one interview, a CWP group member revealed that they had learnt this method of intercropping from the workshops, and in this way "we are doing it to save land". Mulching was another method of soil conservation that was highlighted by the CWP group. Commenting on the effectiveness of mulching, one of the CWP members said that "mulching is effective as we have noticed that out spinach is much greener after mulching". Furthermore, "the mulch helped in keeping the moisture in the ground for longer'. He also indicated that they were using tins underneath the garden to trap water and to retain soil fertility as a method applied towards water conservation. This method was also learnt during these workshops.

STEP 7: Adopting the new practice

Overall, there is evidence that the expansive learning methodology that guided the workshop process and learning engagements has been positive. Despite the lack of external support between March and July, both teams managed to navigate through some constrains to improve their food productivity and RWH and conservation practices. However, the adoption of new practices into a new reconstituted activity is a longitudinal process and may take a few years. The evidence presents positive steps towards the application of soil conservation and RWH that can potentially evolve into a progressive approach towards larger scale catchment management changes, especially if these activities are networked and a vision shared with similar activities or projects across the catchment. At a project level, further support from either an external facilitator and/or their CWP local supervisor would assist the teams to get closer to their project vision. At this point, there is no further plans from the Green Village team to continue with more learning sessions as we have come to the end of the funding period.

5.3.4 Conclusion and Recommendations

a) Engeström's methodology of expansive and reflexive social learning provided a methodological and theoretical opportunity to engage at local project level inasmuch as it:
   - allowed the definition of what 'really matters' through a project visioning exercise with the CWP project participants. Their aspirations became the foundation from which tensions and

contradictions in their activity system were surfaced and mirrored back to the participants as data to reflect on and new knowledge and solutions to emerge from;

- fostered careful analytical processes with cautious mediation on the part of the research team facilitation in order to sensitively unravel the cultural and historical auras that shaped the aspiration-practice tensions found and thus the level of transgressive capability needed by the participants to free structural dominances and power dynamics from controlling the aspiration-practice relationships;
- situated RWH practices within a watershed development and catchment management approach which in turn fosters the development of water resources for the benefit of greater agricultural output.

b) A supporting mechanism to enhance the agricultural livelihood enterprise should be available to not only taking into account the development of 'hybrid' water systems through, for instance, RWH, water infrastructure and irrigation, but also to develop other agricultural productivity domains such as agronomy capability (e.g. human capital and agricultural inputs), marketing (including value added) as well as sorting out the institutional and governance arrangements needed across the catchment scales.

c) In order to either upscale from project level to catchment level or the other way around the following three levels of planning scales could be considered.

1. Take into account catchment management strategies and plans from the relevant CMA in order to link to high level priorities and long term national and provincial agendas through promoting inclusiveness of both the political and traditional authorities to gain support throughout. These processes may require stakeholder awareness raising and sensitization to catchment management at the mesa level.
2. With this in mind, at the quaternary or sub-catchment catchment level, 'hot spots' of biophysical, social and political priorities could be identified as primary nodes to work in and mini-project identified based on most do-able projects, resources available and other potentials. Local priorities could be introduced here to drive or yield benefits. This level of planning may act as the intermediary between the higher and the micro spaces.
3. At a micro-level or 'intervention' phase, project level plans may be networked to other village-based activities within a micro-catchment scale. Small groups of enterprises can be formed and expanded on a modular approach.

Contextually, the study shows that mini-projects within a catchment management framework, if supported with meaningful social and expansive learning processes, have the emerging potential to become local niches for development and their networked engagement with local activities and catchment institutions could drive the integrated catchment management agenda as a modular and 'organically' expansive approach.

5.4 Integrating vetiver grass, soil conservation and water harvesting

Vetiver grass has been used widely in soil conservation projects due to the properties highlighted in Chapter 4. Because it is easy to propagate, vetiver has potential to be used in income generating projects where community members can establish vetiver nurseries and sell the plants to rehabilitation projects. In Sinxaku we have promoted vetiver growing as a business venture that can be established in home gardens. Vetiver is to be propagated in an integrated rain water harvesting system and propagules sold to the NLEIP rehabilitation. A small demonstration plot was established in November 2016 in a garden in Maxisebeni that was growing maize above and below a swale along which vetiver was planted. A successful maize crop was harvested despite the lower than average rainfall and by July 2017 the vetiver was well established (Figure 5.13).

With the help of the Green Village Committee, seven households were identified in November 2016 as being interested in establishing vetiver gardens. These households were visited by the research team and their suitability assessed. Key factors were the suitability of the soil and availability of water. Gardens with dispersive soils should be avoided whereas gardens on doleritic soils should have stable soils. Qulungashe is situated on a dolerite ridge so gardens here should work well. A number of gardens were located in places where it would be possible to direct runoff from roadways or small water courses to augment water supplies and at the same time reduce the erosion risk. It would be necessary to construct small storage dams to hold water. An example is shown in Figure 5.14.

It was decided to work initially with one household and in July 2017 we identified a householder in Qulungashe who showed commitment and had a suitable garden with deep soils. The female head of household also works for the CWP garden project so she has shared in the learning around RWH. She is willing to set aside an area of gently sloping land 30 by 35 metres (0.1 ha). We propose digging nine swales 3 m apart along the contour to harvest runoff water. Each swale could support two rows of vetiver, above and below it. Vetiver plants should ideally be planted at the beginning of the summer wet season to give sufficient time to become established. Because of the unreliable nature of the rainfall it is necessary to have an additional water supply to ensure the young plants get established. The house owner has access to a 5000 l water tank that can be filled by a tanker from the river.

In 2015 we bought plants from the Hydromulch nursery in Brakpan to experiment with their propagation potential. Due to the ongoing drought and unsuitable planting positions we lost many of them, but those that survived have now been planted along swales in the CWP garden. At a conference in September 2017 we met Roley Nöffke of Hydromulch, who is a vetiver ‘champion’. He has a long experience in growing vetiver for the market and its application in soil conservation work. He visited the site in November to advise on planting and is willing to assist further in the future. A business plan based on this garden has been developed and is explained further in Appendix A.

Using an A-frame to lay out a contour line

Laying out the line of the swale

Digging the swale

The finished swale with protective turf along the top of the downslope bund. The pipe was used to water the grass until it had become established

Maize growing along tthe swale. vetiver well established after four months

Vetiver growth after 8 months

Figure 5.13: Demonstrating the integration of RWH using swales and vetiver propagation in a maize garden in Sinxaku

Figure 5.14: A small water storage dam constructed in a garden in Sinxaku for watering vegetables

Figure 5.15: Examples of vetiver products made in Thailand displayed at the Southern African Association of Geomorphologists biannual conference, Swaziland, September 2017

5.5 Landscape Greening through Grazing Management

5.5.1 Introduction

The key to erosion control on rangeland is to promote a good groundcover to protect the soil surface an increase infiltration. Water harvesting techniques can be used where capturing runoff can improve vegetation growth. The use of hoops (micro-catchments) to harvest water and enable woody browse vegetation to become established was used successfully in Baringo District (De Groot *et al.* 1992). In the

duplex soils that dominate Sinxaku, concentration of water in this way is not recommended. Far better is to increase *the* vegetation cover through optimal grazing management.

Rangelands in Africa are generally considered to be overstocked and consequently degraded (Toru and Kibret, 2014). In South Africa a similar situation persists, especially in the areas under communal land tenure where communities have to eke out a living from the surrounding, often sensitive, environment. In the 1990s, it was estimated that rangelands supported 90% of livestock production in South Africa (Hurt, 1998) but there has been very little effort to ensure that there is sustainable management of these systems. Since then, considerable attention in the academic literature has been given to communal rangelands, with most of these studies focused on examining their resilience. In their seminal work, *Range Ecology at Disequilibrium*, Behnke *et al.* (1993) reshaped the thinking around communal rangelands, setting off a number of studies that challenged the then conventional theories about rangeland management whose objective was tied to economic objective and based on assumptions of a linear progression of ecosystem dynamics.

Hurt (1998) argued that it was common to use the dogma of commercial farming as a model to define the operations in communal rangelands without looking at culture or value systems that inform subsistence farmers. For restoration or rehabilitation of rangelands, Higgs (2005) pointed out that it is important to approach the subject in a holistic manner by also looking at human, natural and economic factors, politics, technologies, and the cultural dimensions. This acknowledges the complimentary role played by both the scientific and technological knowledge and the equally important support by local communities, effective policies, appropriate legislation, and other factors. This means that rehabilitation of degraded rangelands does not take place in isolation; for it to be successful it has to take into account a host of these factors mentioned. Central to this approach of making communities the centre for sustainable land management is the adoption of participatory research tools to ensure meaningful engagement. What is clear in Sinxaku is that previous attempts at rehabilitation or control of land use were rejected as a top-down approach, which led to their collapse. Any new approach has to seek to avoid such a trap by engaging the communities as equal partners.

5.5.2 Past and current grazing management at Sinxaku

i. The past

By interviewing some of the livestock owners (those with a substantial number of livestock – e.g. Mr Mkona from Lower Sinxaku with 200 sheep), it has been ascertained that there have been some considerable changes in livestock and grazing management over the years. In the far distant past, which should be treated with some caution as it relies heavily on nostalgic memory, it seems everything was under control, including a "favourable climate" and social order. Livestock was looked after by herders with strict rules of ensuring livestock do not graze in cultivated areas but only on rangelands. The herders would guide the animals to areas with better grazing depending on the season. The enforcement of a school system for most children in the 1950s, especially young boys, meant that there were fewer herders available or herding became an afternoon vocation – one justifications of the betterment system was that it would free up herders to attend school.

The betterment scheme introduced in the 1960s directed and dictated to communities where to graze their livestock. Livestock were impounded if found grazing in camps not open for grazing, penalties were levied and livestock only released when such penalties were paid. This system, in the fullness of time, was rejected. The imposition of penalties seems to have been the straw that 'broke the camel's back'. The resulting defiance set the scene for the current grazing management patterns.

Communities felt that their knowledge of the rangelands was undermined by eco-rangers and authorities who forced them to graze livestock in demarcated camps at specific set intervals, even if the owners perceived such areas as overgrazed. There is an implied sentiment among the older livestock owners that they knew when the rangeland was overgrazed and no longer offering good grazing to livestock but this sentiment is not verbalized in ecological or veld management terms.

ii. Current grazing management

Currently the communal rangelands of Sinxaku are not divided into any camps, and the animals are not looked after by herders for the full duration of their grazing. Herding seems to have evolved over the years, from looking after livestock from morning until late afternoon, to only doing basic care of herding into a kraal and then releasing in the morning, together with the related animal care.

Interviewing key livestock owners as informants revealed the current practices of livestock management which in turn impacts on grazing. Currently all livestock graze freely in the veld with no specific demarcated areas for grazing. Often the livestock graze where they have found their preferred palatable grass species or other vegetation species. This is commonly along the steep slopes of the mountain and at the top of the mountain. In the afternoon the livestock tend to graze at the bottom of the valley close to the Tsitsa River, an area which was previously cultivated but has now been turned into grazing land.

The livestock are herded home in the late afternoon and kraaled as there is a common stock theft problem. In the morning animals are released past the last homestead in the village in the direction of the rangeland, to avoid unwanted grazing in other residents' gardens. Thereafter they are left to seek better grazing by themselves. The reality of this practice is that there are currently no set rules for management of the veld other than ensuring there is no damage to community members' gardens. The veld is not given time to recover from grazing but grazed throughout the year and all seasons.

5.5.3 Putting communities at the centre of grazing management

Choi (2005) pointed out that it is important to take action to rehabilitate or restore degraded ecosystems, considering the bigger picture of human survival on earth and nature itself. In the case of Sinxaku and other communal areas in the country, the land provides livelihoods to communities through the provision of grazing for livestock, trees for fuel wood, arable land for crops and so on. The lives of rural communities are intertwined with the land and therefore sustainable land management is key to their continued food and livelihood security. Lack of involvement by communities in the management of their resources has been flagged as the source of many project failures. Community projects now seek to foster participation by all stakeholders to ensure sustainability, more often using a participatory approach as engagement tools.

Most recent participatory rangeland rehabilitation approaches have emphasised community participation as a critical success factor. Critchley and Turner (1996) presented the work of the Associates in Rural Development (ARD, 1992) which came up with a guiding framework (as given below) from their study of *Decentralization and local autonomy: conditions for achieving sustainable natural resource management*. These authors identified technical issues, project design, implementation and institutional issues as critical in the management of natural resources. The following factors were identified as fundamental to sustainable management of natural resources; they also apply to grazing management in communal areas.

- Capitalising on local knowledge or integrating both scientific and local knowledge. Most failures resulted from imposed knowledge that ignored local knowledge.

- Amplifying the voice of locals in the management of their natural resources through self-governing institutions. A stable institution and use of participatory principles is critical. All regulations and control systems must be derived from participatory engagement within the community.
- Low-cost mechanisms of conflict resolution – converting the guaranteed presence of conflict to cooperation
- The governance and management of communal resources must take into account diverse and legitimate interests. In this regard, for instance, Shackleton and Gambiza (2008) pointed to the use of an invasive woody species in Macubeni (Eastern Cape) as firewood, conflicting with the campaign to eradicate it on the grounds that it was reducing grazing land. In the attempt to rehabilitate communal rangelands there will be challenges between livestock owners and those who do not own any or only a few.
- An enabling environment created by national and provincial policies or even international conventions. This environment exists in South Africa but proper implementation takes longer to happen at the grassroots level. The legislative framework and the constitution allow extensive consultation of communities on all matters that affect their lives.

The lessons learnt from previous rehabilitation attempts dictates that promoting cooperation and participation in rangeland management could be best achieved through the use of participatory methods, capacity building through knowledge sharing and training. This approach implies that all the planning, implementation, monitoring and evaluation of rangeland rehabilitation must be people-driven and be entrenched within the community. The local community must actively and meaningfully participate and be an integral part of all key stages of the endeavour. For the success of any restoration or rehabilitation project, it is important to leverage the linkage of participatory rangeland management practices with the improvement of livelihoods and resilience.

As has been stated above, rangelands are useful natural resources in communal areas with livestock, climate change and people (poor management) contributing to degradation of these resources. As a response to improving the situation, participatory rangeland management is used as an approach to ensure that all stakeholders involved in resource management participate meaningfully and that their interests, positions and needs are central in restoration efforts of degraded areas. Working in Ethiopia, Flintan and Cullis (2010) developed Guidelines (*Introductory Guidelines to Participatory Rangeland Management for Pastoral Areas*) that set out the sequential steps in conducting Participatory Rangeland Management (PRM) that emphasized – (a) investigation, (b) negotiation and implementation – as a way to ensure community participation. It is used as a land use planning and management tool to improve rangelands for better use. These sequential steps are used to develop a participatory rangeland management agreement that is endorsed by all stakeholders and is legally enforceable (Flintan and Cullis, 2010). These steps are demonstrated in Table 5.8.

Table 5.8: The Participatory Rangeland Management (PRM) Process (source: Flintan and Cullis, 2010)

1. Investigation	Step 1: Stakeholder analysis and rangeland use/user information
2. Negotiation	Step 2: Setting up or strengthening rangeland management institutions
	Step 3: Defining the management area including a rangeland use
	Step 4: Development of the rangeland management plan
	Step 5: Establishment of the rangeland management agreement
3. Implementation	Step 6: New roles for rangeland managers
	Step 7: Improving management of rangelands, their health and their rehabilitation
	Step 8: Participatory M&E and adaptive management

5.5.4 Introducing improved livestock management to Sinxaku

Erratic rainfall, a poor vegetation cover, and highly dispersive soils are undoubtedly the underlying driers of erosion in Sinxaku and adjacent areas. Structural rehabilitation interventions can provide short term solutions to the problem of sediment loss from the catchment but the long term solution must lie in rehabilitating the vegetation cover itself. Grazing practices that are in line with rainfall variability are key to this.

Livestock owners in Sinxaku are aware that the current grazing practices are not optimal and regret the loss of control over animals. To restore something akin to the previous system requires clear incentives for stock owners and the reinstatement of a community-based governance system to oversee the control of livestock. Strong leadership from within the community is needed to encourage everyone to follow the new system. Incentives are twofold. Firstly, through the adoption of managed grazing, stock condition and stock numbers in the communal herd can increase as the grassland condition recovers. This meets the cultural desire for larger herds. Secondly, a market incentive can demonstrate that livestock can be economically profitable and bring much needed cash income into the household. The rangeland stewardship model promoted by ERS and Meat Naturally Pty aims to achieve both these things (uMzimvubu Catchment Partnership Programme, 2016).

Rangeland stewardship is based on integrated grazing principles modified to suit the local context. Assistance is given to communal livestock owners in return for adopting at least basic changes to their grazing system. Meat Naturally Pty runs auctions in the local area. They arrange for buyers to come to the village, bring the necessary infrastructure to run the auction (pens, scales, etc.) and ensures that the money from sales gets quickly to the seller. A small levy is taken from the income received to be invested into a trust fund to support future interventions. ERS supports training for livestock owners and eco-rangers who are responsible for herding duties.

In Sinxaku we have introduced the principles of managed grazing and the possibility of livestock marketing through auctions. There has been a mixed response to date as outlined below.

The advantages of rotational grazing were explained to Green Village Committee members at a number of workshops in 2016. These were fed back to the broader community at village meetings and met with a generally favourable response and the desire for a more focussed workshop. This took place in January

2017. Two research team members first visited the UCPP, ERS and Meat Naturally Pty in Matatiele to learn about the rangeland stewardship model. Representatives from UCPP accompanied the research team back to Sinxaku for the workshop, where they were able to explain the model to the livestock owners. There was a positive response and a desire to learn more. The meeting participants were told that if they started to implement some simple controls they would get further support from ERS. The community members agreed to set aside an area of land where grazing would not be allowed and would approach the chief to get his support for the project. Both these conditions had been met by the time of our next visit to Sinxaku.

In March 2017 three representatives from the Sinxaku livestock owners attended an auction in the Matatiele area and were duly impressed by the number of stock sold and income received. A follow up workshop was held in May 2017. This was attended by livestock owners, the local GIB manager and two people from ERS. The workshop participants first worked in groups to identify their needs. The following common themes emerged:

- Tackling erosion, especially dongas
- Provision of water for livestock
- Rotational grazing and camps/rangers
- Improved veterinary care
- Improved breeds
- Artificial insemination
- Security against stock theft

The link between grazing and rehabilitation was explained, with emphasis on the need, firstly, for a good ground cover and, secondly, to protect rehabilitation structures until the grass cover had been re-established. The purpose of the different rehabilitation interventions that were being used in the local area were explained with the use of an illustrated manual produced by the research team (Appendix D). The ERS members explained further about how the stewardship model would work. This would meet many of the needs raised by community members and listed above. The following day four livestock owners accompanied research team members to Matatiele for a two-day learning exchange workshop (Meat Naturally: restoring landscapes and livelihoods) and auction, organised by ERS. A number of different groups from South Africa, Lesotho and Botswana learnt about the basic principles of rangeland stewardship and shared their own experiences. On the second day we attended the auction (Figure 5.16). Again, the Sinxaku people were impressed with the process and the prices achieved.

Figure 5.16: The Meat Naturally auction attended by researchers and Sinxaku livestock owners in May 2017

On our return to Sinxaku we met once again with the group of livestock owners, gave feedback on the learning exchange and auction and put together a plan of action. The agreed plan is given in Table 5.9.

Our next meeting with livestock owners was in July 2017. We met with a small group made up mostly of Upper Sinxaku sub-headmen. We talked through general progress in getting a positive community response to the proposals. Issues raised included the size and membership of the initial livestock association, the selection of eco-rangers, and the problem of absentee stock owners. It was emphasized that it is necessary to get agreement both from the bottom and the top (headman and chief). This was described as a “step by step” process.

Table 5.9: Action plan agreed by the participants at the second livestock workshop

What are we doing to take this forward? (Way forward)	How do we make this happen? (How do we achieve our objective)
Establish a livestock association or council	To establish the Livestock Association, we will attend the Chief's *imbizo* to inform him and announce the decision to the broader community and livestock owners. This is an immediate action – end of May.
We must attend training to empower us more on veld management through livestock management.	ERS and Meat Naturally (PTY) LTD can assist – by contacting Mr Mafuza or Mr Mkhize – 0794704078/0790413978/0397374849
We must select proper and suitable persons to be eco-rangers including affording them relevant training (e.g. Veld management, veld assessment, paravets)	We can ask ERS to assist with the development and submission of a funding proposal. We commit, as livestock owners, to show our seriousness about this initiative by looking after our rangeland ourselves taking turns herd livestock away from rested rangelands
Rotational grazing	
Watering points	Not sure about dams/watering points
Veterinary services/paravets	Pulling together resources to buy livestock medicine – to get a better price
Salt licks	
Land rehabilitation through construction of soil erosion control structures	Partnership/working together with Gamtoos Water Board/EPWP
Levying penalties	Levying of penalties will be discussed and agreed on in community meetings and Chief's *imbizo* (a bigger gathering with all representatives and headmen of the villages)
Fencing	We will submit a funding proposal to DEA-NRM – Prof Kate Rowntree may assist
Invasive species control/stone removal	We would need to investigate this further as we are not sure what the consequences would be
Security	Eco-rangers will help with security (stock theft, prey)
Auction (Re-investment to community and the land)	Meat Naturally (PTY) LTD are prepared to assist if their requirements for partnership are fulfilled

We have since learnt that a general community meeting was held at which there was a mixed response to the proposal. A significant number of people opposed the idea, which is a major setback as controlled grazing requires all livestock to be part of the system. A final workshop was held at the end of November. On day 1 we discussed the objectives of the rehabilitation and the advantages of managed grazing with a group of community members that we had not necessarily engaged with before. On day 2 we met the group of livestock owners who confirmed their support of managed grazing and a commitment for action.

A potential business plan for livestock in Sinxaku is given in Appendix B. Clearly this depends on acceptance by the broader community and traditional leadership. Referring back to Figure 4.12, we are in the process of going through Step 2, developing the vision. Step 3 (and step 2 of Table 5.8), setting up the institutional structure will be the most difficult to achieve but is essential if a new grazing system is to be implemented.

It must be emphasized that for this kind of work, patience is critical. The ground work to establish the foundations of working institutions, navigating local politics and balancing the interests of different land users or villagers (e.g. livestock owners vs non-livestock owners) can be daunting and slow. Communities in rural areas tend to be burdened by previous project failures and attempts, which fuels their despondency and scepticism. Building trust over time should be the ultimate goal, though an arduous task.

5.6 Integrating Sustainable livelihood approaches and entrepreneurship opportunities into village scale rehabilitation

This chapter has described the different approaches that were taken to investigate landscape greening opportunities in the Sinxaku villages. These included rainwater harvesting at the household scale and livestock management at the sub-catchment scale. In this section we consider how these enterprises can be developed further to support sustainable livelihoods and entrepreneurship. By integrating the different scales of approach with rehabilitation activities in the catchment we can start to address the key question of how to bring together rehabilitation and a better life for local communities.

It should be noted upfront that whether or not the recommendations proposed in this chapter are taken up by the community is not for us as the research team to decide. We present possibilities that can be adopted by the community, rehabilitation implementers and other external agencies. As noted previously, working with communities for change is a long process that is unlikely to be achieved in a short project such as this one. We hope that we have laid the groundwork to raise awareness of opportunities for change and working towards the vision of a better life in an ecologically sustainable landscape.

Figure 5.17 presents a framework demonstrating how the various activities in Sinxaku can work together to achieve the objectives of improved livelihoods through landscape greening. Three goals are identified: rehabilitation goals, goals to restore ecological function, and goals to restore the social system. The immediate goals of rehabilitation are clearly linked to restoration of the ecological system. A restored ecological system is one in which vegetation cover is in dynamic equilibrium with the climate and soils, it is able to support high numbers of herbivores and other fauna and reduces erosion rates to natural levels. This leads to reduced runoff and erosion and aids the recovery of gullied areas. However, it is only through bringing real social benefits (restoring the social system) that rehabilitation goals will be achieved. Each of these goals will be reviewed in turn with reference to Figure 5.17.

The primary rehabilitation goal in the Tsitsa catchment is the reduction of sediment delivery to the Ntabelanga Dam (and the Laleni Dam downstream). This is to be achieved through stabilising gullies and reducing surface runoff and erosion. Key to this is water and soil retention on the landscape, largely through increases in vegetation cover but also through interventions such as silt fences, ponds and other structural interventions as described in Appendix D.

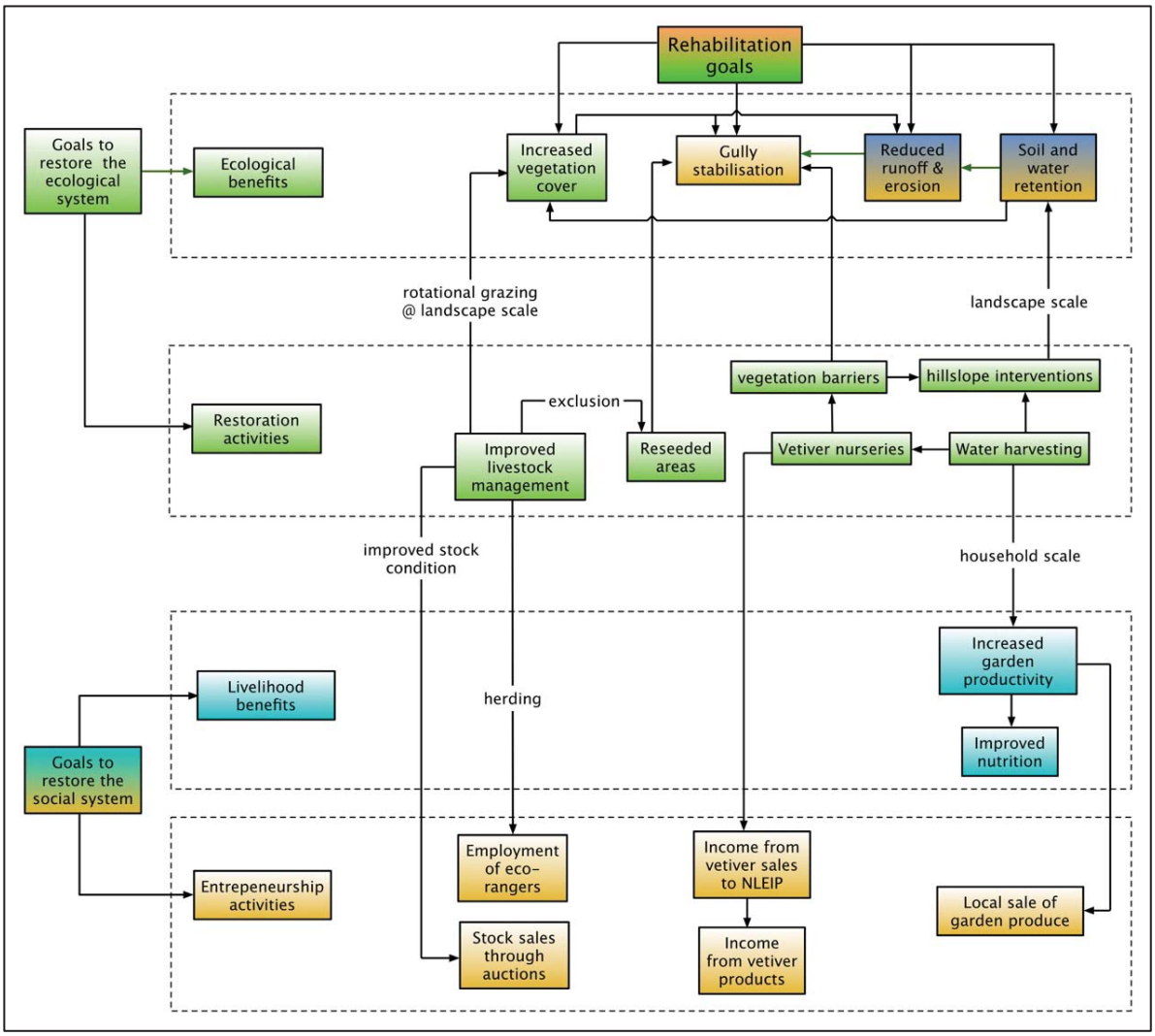


Figure 5.17: Integrated solutions to the restoration of socio-ecological systems

The vegetation cover on the hillslopes in this communal area is a direct response to rainfall and grazing practices. The latter is therefore a crucial target for sustainable restoration. Livestock should be managed in such a way as to promote the optimum ground cover and rehabilitation interventions that need to be protected until a resilient vegetation cover has been established. Clearly there is a need for constructive engagement between the implementer of a rehabilitation project and the community of livestock owners. A version of managed grazing that is based on the principles of rotational grazing is recommended as the system that has the best chance of meeting the livestock owners desire for larger herds and better stock condition and the restoration goal of increased ground cover.

We can now turn to the goals to restore the social system. Two options are presented that can support more sustainable livelihoods, livelihood benefits and entrepreneurship. The first is to foster direct livelihood benefits through increased garden productivity based on rainwater harvesting. This leads in turn to improved nutrition and a reduced demand on monthly cash income to purchase food. Rainwater harvesting can also be integrated into vetiver nurseries, the vetiver being used to achieve ecological restoration goals. This contributes to the second option of entrepreneurship as plants can be sold by participating households to the rehabilitation project. Entrepreneurship is also embedded in livestock enterprises. Sales of stock brings in cash income; employment of eco-rangers creates job opportunities. Employment is also offered by the rehabilitation project itself but these jobs are temporary, lasting only as long as the project. They do

provide an opportunity to learn skills and the short term injection of cash could be used to start to a business.

The village area in Lower Sinxaku (houses, gardens tracks and roads) takes up approximately 10% of the total area, in Upper Sinxaku it is 6%. The compacted nature of tracks and roads and of ground around the houses makes this a significant runoff area, runoff that feeds directly into downslope gully systems, along with eroded soil. If this runoff was directed into gardens where it could be put to productive use it would serve both to support livelihoods and reduce the erosion risk. It is recommended that the village areas are targeted by the DEA-NRM rehabilitation project. To date the attention has been on grazing lands only. The erosion problem here can perhaps be better addressed through improved livestock management as advocated in this report.

In Sinxaku there is evidence that there are local sales of surplus garden produce but in this project we have not considered this further as an option for entrepreneurship. Entrepreneurship opportunities have been identified through livestock and vetiver nurseries, both of which can make a direct input into rehabilitation for landscape greening. Business plans were developed for these two options. These are presented in Appendices A and B. The business plans follow the format used by the Okhombe component of this project. Both plans were presented to the NLEIP forum held at Rhodes University in December. Inputs from range scientists and DEA-NRM managers were used to confirm or modify components of the plans.

CHAPTER 6. 'SINXAKU LIVES' ENVIRONMENTAL EDUCATION PROGRAMME

6.1 Introduction

In support of the Green Village project an environmental education initiative was started in Sinxaku. Lower Sinxaku Primary School agreed to participate in the initiative and expressed enthusiasm throughout the process. This education initiative was designed to support the work the teachers are already doing (e.g. link to the curriculum); make knowledge relevant, i.e. link to the local context; build on local culture and local rules; and introduce valuable scientific concepts and knowledge. The initiative had three main aims:

1. Lower Sinxaku Primary School understands and supports the Green Village process and the ecological restoration practices to achieve this. They are empowered to be active participants in improving their system, which includes transforming the school grounds into a hotspot of environmental care.
2. Learners at Lower Sinxaku Primary School deepen understanding of their local social-ecological context.
3. Learners develop a love for the environment, particularly of their local environment, and see the relevance of a career in environmental work.

The initiative focused on developing an **identity** of connection with their local landscape, deepening **knowledge** about their local landscape and strengthening **agency** to improve their local landscape.
The initiative was structured around a resource pack that links locally relevant social-ecological knowledge to the curriculum, an eco-club run at the school to improve the school grounds and a variety of activities organised throughout the three years. The eco-club was formed with 14 learners from grades 5, 6 and 7, where they identified themselves as the 'Green Farmers'. The club participated in a number of activities that will be detailed in Section 6.4. The teachers expressed interest in the development of this eco club and Mrs Jokazi was selected as the teacher who would lead the club.

6.2 The process followed

The process was underpinned by four key factors. Firstly, **participation**, where the teachers were invited to contribute to the design of the resource pack, and they were responsible for using this resource pack to enrich their teaching practices. Secondly, the strategy was **holistic,** aiming to positively affect learners' identity with their local environment, knowledge about their local environment and their actions within their local environment. Thirdly, the aim was to work with **smaller groups** (e.g. the Green Farmers Eco Club) to impact the larger school.

6.3 The Resource Pack

The resource pack was made up of knowledge to support the transformation of the school grounds into a hotspot of environmental productivity and care, while having clear links to the Curriculum Assessment Policy Statements (CAPS) curriculum. The knowledge resources, available in Appendix E, included the following:

1. Biodiversity – key to land regeneration
2. Diversity
3. Companion planting

4. Accelerating succession
5. Soil glossary
6. What governs the fertility of soils
7. Soil health and human health
8. Soil – key to land regeneration
9. Water – key to land regeneration
10. No-dig gardening
11. Raised beds
12. Using biological resources

For each knowledge resource, clear links were made to CAPS indicating the subject(s), topic(s), grade(s) and term(s) that particular knowledge resources could support.

The links between the knowledge resources was also indicated, as well as a summary of the key themes of that particular knowledge resource. Additional resources handed out to teachers included A1 maps of the local village and catchment and photos (printed on A3) to be put up in the classrooms that expressed social-ecological dynamics. The purpose of these photos was to strengthen a connection to local place. In January 2017 positive feedback was received from teachers regarding the effectiveness of the resource pack. For example, the geography teacher used the resources for a three-week period and indicated consequent heightened interest in the subject matter. The children especially benefited from photographs showing environmental issues, such as erosion, in their local context.

6.4 List of activities and their timeframes

2015: The focus was on developing relationships with teachers at the Lower Sinxaku Primary School and designing the environmental education initiative with their input.

Mid 2015: A productive meeting was held with the principal of the school and five teachers in which both the initiative and potential structure of the strategy was explained. An opportunity was provided for the teachers to give input on their support, or not, of the strategy, potential challenges and content. All teachers were in support of the initiative, where one stated that it is a "good project". A potential challenge that was raised was the problem of people being demotivated, where they don't want to do anything unless they are paid. Knowledge was shared on important plants in the area and their use to local people. It was decided that the resource pack should be developed for grade 4s-6s. In summary the meeting was a useful space to share the initiative, begin to build relationships and trust and receive the teachers' full support.

December 8th: A teachers' meeting was held to establish their interest in the initiative and organise logistics for the following year. The structure of the proposed initiative was introduced and accepted and the teachers agreed to a training workshop in early 2016 that would equip them to help run the environmental education initiative. It was at this meeting that the teachers requested a focus of the initiative to be on beautifying the school grounds, conserving water and encouraging learners to keep the environment clean and to work in the garden.

2016

February 10th: Fourteen learners from grades 7, 6 and 5 participated in a gardening activity where they dug a swale (a water harvesting technique) and constructed a raised bed to grow fresh vegetables. This was the formation of an eco-club, in which the learners identified themselves as the 'Green Farmers'. Their

participation was enthusiastic, and the following day many of the learners had brought manure/ grass cuttings to add to the raised bed. Figure 6.1 shows pictures representing the day.

Figure 6.1: Digging a swale and making a raised bed with the Green Farmers

February 11th: A teachers' training workshop was held to share knowledge aimed to inspire good environmental practice (e.g. we are deeply connected with the ecological world; we have a choice to be earth keepers, working with the earth's elements or earth takers working against the elements and practices that promote good environmental care), equip teachers to effectively use the resource pack, hand out additional resources and establish the running of an eco-club at the school (Figure 6.2). A key theme was that children are agents of change and can make a meaningful difference. The teachers expressed interest at the development of an eco-club and construction of the raised bed the previous day. Mrs Jokazi was selected as the teacher who would lead the club. Another significant development was the selection of a name for the broader environmental education initiative, which the teachers decided as ***'Sinxaku for Life'***.

Figure 6.2: Teachers receiving their educational resources

April 7-8: An action packed two days were spent at Sinxaku and the following diverse activities were undertaken as illustrate din Figure 6.3.

(a) Seedlings planted in both the raised and sunken bed

(b) Enthusiastic participation in the litter competition

(c) Tree planting

(d) Practicing the performance

Figure 6.3: Environmental activities at Lower Sinxaku Primary School

- A sunken bed was made next to the raised bed and seedlings were planted (Figure 6.3a).
- A litter competition was held with the whole school. Learners were divided up according to their grade and given two plastic bags to fill. The class that filled these bags first won a prize. Other classes won conciliatory prices. The learners participated enthusiastically (Figure 6.3b), and encouragingly the grounds remained notably cleaner after this activity.
- Three trees were planted, including an apricot tree (Figure 6.3c).
- The Green Farmers practiced and performed a song and dance for the WRC group who were visiting the area (Figure 6.3d). The performance emphasized the importance of taking care of the environment. The apricot tree was planted at this event and the WRC group were given a tour of the developing garden.

***August 17-18**:* Two days were spent showing short inspirational and educational environmental videos to the learners of Lower Sinxaku Primary School (Figure 6.4). The aim was to inspire a deeper environmental ethos. The short videos included:

- 'Dear Future Generations' that examined the negative impact we are having on the earth;
- The 'Story of Stuff' that examined the negative impact of our consumer lifestyle;
- 'The Girl who silenced the world for 5 minutes', an inspirational clip of a 12-year old girl, Severn Cullis-Suzuki, addressing key decision makers at the 1994 Rio Summit.

The following questions were asked in relation to each movie watched to stimulate an interesting discussion:

- Why is dirt so important?
- Why is it bad for the earth to buy a lot of human made things that you don't necessarily need?
- How did watching this make you feel?
- What would a world be like where many animals have become extinct? Where there are no more trees? Where the earth is filled with pollution? What would happen to us in such a world?
- Can young people make a difference?
- What are ways that young people can make a difference?

Figure 6.4: Movie day

The learners also participated in cleaning up the grounds around the vegetable garden. They spent time sorting through the waste and learnt how plastic could be removed from the local environment by placing it in plastic bottles, which can then be used as eco-bricks (Figure 6.5). Teachers were encouraged to set up a recycling system, to store tins in anticipation of them being used in a vetiver nursery. The Green Farmers also joined a student group from Rhodes University to learn about water harvesting as practised by Mr Zwele.

Figure 6.5: Waste being sorted and eco bricks being made

20th October: A visit was made to Sinxaku Primary School and the following items were dropped off: vegetable seedlings (onion, kale, chilies), some herb plants (marjoram and oregano) and a large steel drum to be used for storing the pilchard tins that they frequently use (these will later be used as plant containers). The most useful aspect of this school visit was that learners from grade 5 to 9 were invited to participate in an essay competition, writing about their local environment and solutions to problems. The prize was an outing to the Wild Fox Hill Earth School in Hogsback.

2017

March 2017: From the 21st to the 26th of March five learners (in Grades 5-7) and one teacher from Lower Sinxaku Primary School (Figure 6.6a)) attended an environmental education program at the Wild Fox Hill Hogsback Earth School, situated in the beautiful and diverse Amathola mountains (Figure 6.6b). These children were selected as they had demonstrated a passion and knowledge for environmental care in the essay competition. The learners participated in a variety of activities designed to inspire a deep appreciation for the natural world and environmental knowledge relevant to their context in Sinxaku village. Due to the language barrier limiting effective knowledge sharing, the focus was spent on practical activities and providing experiences to develop a heart connection with the natural world.

The following activities were included.

1. A visit to a local farm to learn about managing livestock to restore degraded grasslands (Figure 6.6c). Mark Anderson, the local farmer, has been practicing an adapted form of holistic grazing management. We have been supporting Sinxaku livestock owners to adopt such practices. Mark Anderson showed us different quality grasslands to teach us what factors characterize a healthy grassland; namely good grass coverage, minimum bare soil patches and species diversity. We were shown water sources that had been rejuvenated due to the enhanced water retentive ability of the farm since holistic grazing management practices had been adopted.

   Outcomes: Looked at different quality grasslands. Children have learnt about the importance of healthy grasslands, what steps can be taken to achieve this and how this relates to their context at Sinxaku village with the extensive erosion and poor grass cover.

2. Kyla Davies led us in a workshop to develop a play with an environmental theme, to be performed at their school (Figure 6.6d).

   Outcomes: The children learnt about movement, embodied the different elements (fire, wind, water, air) of the environment and then produced a short play, which was performed at various occasions (a WESSA course, for the Cape Parrot team, and at a Sinxaku livestock grazing workshop).

3. The children performed their play at a WESSA training course where a group of adult local environmental practitioners had come together in Hogsback to learn more about best environmental practice. The children had an opportunity to perform for this group of people as well as to be encouraged and inspired by them to live in an environmentally responsible way

   ***Outcome*:** Children had the chance to feel part of a larger community of practice of people engaged in earth care. They were encouraged and inspired by the group to live in an environmentally responsible way. The children also had an opportunity to perform their play and feel they had something to contribute to such a community of practice.

4. Time was spent with the Cape Parrot Team, a local NGO that is working to restore the indigenous afromontane forest in the area (Figure 6.6e). Time was spent playing games we had learnt from the drama workshop, to create a bond between the children and the Cape Parrot team. The children then performed their play for the team. The children had the opportunity to learn from the team and engage in a transplanting activity, where they planted recently germinating Outeniqua yellowwoods into larger bags for growing out.

   Outcomes: Learn the techniques of transplanting a young seedling and realise how one can make money from growing indigenous trees.

5. A day was spent at Wolf River, a beautiful location in the Amathola mountains. Time was spent in an indigenous forest and a black wattle forest to compare the difference between the two. This was facilitated by a solitaire activity where the children were supported to write down their experiences, in terms of colours, sounds and feelings. The children then cleared an area within the wattle forest and planted seven Outeniqua Yellowwood trees (Figure 6.6f). Time was also spent in the rocks pools, connecting with the natural world.

   Outcomes: The children learnt the difference between an indigenous forest and a black wattle monoculture forest, engaged in a practical activity of invasive plant clearing and tree clearing and connected with the natural world.

6. The children dug out a swale at the Earth School (Figure 6.6g).

   Outcomes: This was a practical activity where the children learnt how one can divert water across the landscape; techniques to slow and sink the water for maximum benefit for plan growth and soil life were also demonstrated.

7. A morning was spent hiking through a healthy indigenous forest and then spending time at the famous Madonna and Child waterfall (Figure 6.6h).

   Outcomes: Experiencing the beauty of and connecting with the natural world.

8. On a rainy day, the children visited a recently cleared pine plantation forest to examine what happens when soil is exposed to the elements.
9. A meditative activity, led by Joan Wigley, to deepen appreciation for the relevance of Xhosa culture, particularly how it supports environmental care.
10. Watching the Planet Earth Series to enjoy the wonders of the natural world.
11. Listening to a live classical music concert that the children were sponsored to attend.

The participants expressed an enjoyment and enrichment from the experience and the teacher, who was very receptive, was particularly motivated to implement what he had learnt. He indicated that he will get involved in the Green Farmers environmental education programme that has been started at the school.

(a) Participants who attended the programme

(b) View from the Earth School

(c) Learning about sustainable grassland management

(d) Activities at the Drama Workshop

(e) Activities with the Cape Parrot team

(f) Trees planted at Wolf River

(g) The swale

(h) Time spent at Madonna and Child waterfall

Figure 6.6: Activities at the Hogsback Earth School

6.5 Challenges and future steps

There were three main challenges that limited the full impact of this environmental education initiative called 'Sinxaku for Life'. Firstly, there was a language barrier between the researcher (Xhosa is her third language) and the children, who were generally not proficient in English. Secondly, the time needed to travel between Grahamstown and Sinxaku village was about six hours. This required two days to travel there and back and constrained the amount of time that could be spent at the school. Thirdly, the limited budget added to the constraint of long travelling distances.

The foundation has been laid for future work to build on. Fortuitously Laura Conde-Aller will be working on the WRC project K5/2508 that will further the educational process started at Sinxuka Village at the wider scale of the Tsitsa catchment. She will be adapting the Fundisa for Change Programme, developing additional environmental educational materials that link the curriculum to local contextual environmental issues, including catchment management. We will also encourage the rehabilitation implementers to engage with local schools to explain their activities on the ground.

CHAPTER 7. UPSCALING TO THE LOCAL, CATCHMENT AND NATIONAL SCALE

7.1 Introduction

This chapter looks specifically at the last two objectives of the Green Village project, to:

- report on integration of the green solutions (tool box, manuals, guidelines and business framework) with core line function government departments and the private sector.
- provide models on expansion of the green tool box and business framework utility, from household/village to national scale indicating benefits and associated risks/mitigation measures.

Section 7.2 looks at the responsibilities of different government departments and private sector institutions that can be encouraged to take up the learning from this project and can play a role in supporting the upscaling of the recommendations.

Models for expanding (upscaling) the application of the guidelines for landscape greening and associated business frameworks are addressed in Section 7.3. Opportunities for upscaling the Tsitsa work from the village level to the catchment closely parallel the discussion in Section 7.2.2 on NLEIP. The business model for the Tsitsa project closely parallels the Meat Naturally project run by uMzimvubu Catchment Partnership Programme (UCPP). This has potential to be integrated into government led rehabilitation programmes beyond the boundaries of the Mzimvubu catchment. Other options are also explored.

Several learning materials have been produced through the course of the project, which have been used with project participants. Opportunities for developing these further as resources that can be made more generally available are examined in Section 7.4. Section 7.5 give recommendations for raising awareness among government and other institutions.

7.2 Integrating the Tsitsa experience into government core line activities and the private sector

7.2.1 Overview of potential agencies for uptake of project learning

There is potential to integrate the learning from this project into a number of government departments, the private sector, NGOs, NPOs and so forth. Figure 7.1 provides a schematic of the key government departments and their line functions that are most closely related to improving socio-economic conditions through the rehabilitation of ecological infrastructure in rural areas, specifically communal lands as characterised by the Sinxaku villages. For example, the strategic objectives of the Department of Rural Development and Land Reform (DRDLR) include improving infrastructure, supporting enterprises and industry and food production under their Rural programme (DRDLR, 2017). The Department of Agriculture, Forestry and Fisheries (DAFF) is responsible for the National LandCare programme that is designed to conserve soil, bring employment and improve agricultural outputs (DAFF, 2017). The Tourism Incentive Programme of the Department of Tourism could be approached to support small hospitality enterprises in the area (Tourism, 2017). A relevant function of The Department of Water and Sanitation is to facilitate the development of Catchment Management Agencies (CMAs) and Catchment Forums. The Tsitsa catchment falls within the Mzimvubu to Tsitsikamma WMA (Figure 5.2) and the fledgling Mzimvubu Catchment Forum. The role of the DEA-NRM in instigating rehabilitation in the Tsitsa catchment was described in Section 3.5. Their activities and the potential to take these further is described in Section 7.2.2. The current and

potential role of other national government departments and provincial government departments and agencies in the Tsitsa catchment is described in detail by Sisitka *et al.* (2016) in their stakeholder analysis for the NLEIP.

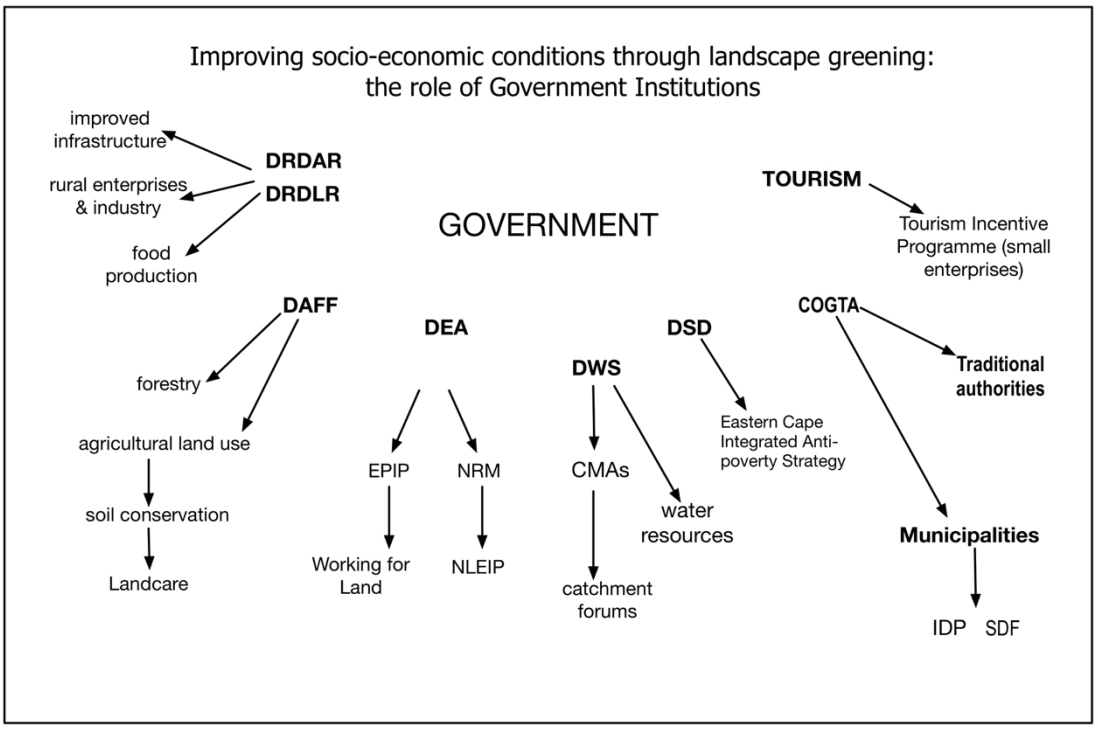


Figure 7.1: Integrating landscape greening livelihood options into government core line activities.

The Sinxaku Green Village project outcomes are relevant to a number of the government's Strategic Integrated Projects (SIPS) (Creamer, 2012). The most relevant is SIP 11: Agriculture and Rural Infrastructure, which aims to improve investment in agriculture and rural infrastructure that supports expansion of production and employment, small-scale farming and rural development. The Green Village project is also directly in line with a nineteenth SIP – Ecological Infrastructure for Water Security Components – proposed by the DEA in October 2014. The aim of this SIP was to "improve South Africa's water resources and other environmental goods and services through the conservation, protection, restoration, rehabilitation and/or maintenance of key ecological infrastructure" (DEA, 2014).

The Integrated Development Plans (IDPs) of municipalities take account of the support (actual and potential) of relevant government departments as described above. They should take account of catchment rehabilitation activities and be providing supporting infrastructure. The Tsitsa catchment above the Ntabelanga Dam falls mainly in the Elundini Local Municipality (ELM) and Jo Gqaba District Municipality (JGDM). Below the dam and on the east bank of the inundation area is the Mhlontlo Local Municipality in the Oliver Tambo District Municipality. A Tsitsa River Basin Land Use and Environmental Management Plan was commissioned by ASGI-SA Eastern Cape, Elundini and Mhlontlo Municipalities to investigate possible development opportunities in the Tsitsa River basin area. This recognized the need for commercial opportunities to alleviate poverty in the area. There was a particular focus on the middle Tsitsa which is where Sinxaku is situated.

The Elundini IDP recognizes the eroded state of the catchment and recommends that infrastructure is put in place to enable controlled grazing and that the rehabilitation of severely degraded areas is a priority. The

Municipality claims to have implemented a rehabilitation programme in Ward 6 through the DRDAR but the IDP makes no mention of the DEA-NRM's rehabilitation activities. The IDP also recommends the protection of intact grasslands and wetlands for biodiversity and provision of ecosystem services. The plan suggests that a system of Payment for Ecosystem Services is put in place to protect water resources. Further investment is needed in land care. The Environmental Management Plan recommends the following set of Environmental Action Plans for implementation:

- Alien plant species management plan
- Conservation strategy
- Climate change: adaptation and mitigation strategy
- Land management: erosion rehabilitation programme
- Land management: rural sprawl
- Investigation of renewable energy and energy efficiency technologies in JGDM
- Fresh water quality monitoring and reporting programme
- Wastewater treatment works (WWTW) and effluent water quality monitoring and reporting programme
- Proper waste management practices (Elundini, 2016 p. 123)

Despite the above recommendations related to environmental protection and rehabilitation, the Elundini IDP admits that there is no dedicated person employed by the municipality responsible for environmental issues. There is only a limited budget to develop environmental planning tools. Unlike Elundini, the Mhlontlo Local Municipality IDP has no plans for rehabilitation of eroded areas and makes limited reference to environmental concerns.

Both Elundini and Mhlontlo Municipal IDPs pay significant attention to supporting agricultural development. These include support for piggeries, poultry, goat farming, cashmere production and wool production through the provision of infrastructure such cattle feed lots, dip tanks, fencing, multipurpose sheds and shearing sheds. These initiatives are supported by the Eastern Cape DRDAR and the DRDLR. The DRDAR is to develop an Agri-Park in Lady Grey, Senqu LM, which will provide processing and packaging services and serve as a distribution centre. Skills development and marketing will also be offered. The DRDAR will also help Maclear to develop a regional Agri-Resource Centre by 2109 to enable maize, wool and beef production, to facilitate transport to the Agri-Park and to provide processing facilities for adding further value. These initiatives all have potential to support and be supported by the recommendations and findings of the Sinxaku Green Village Project.

The mandate of the Ministry of Cooperative Governance and Traditional Affairs (COGTA) is to support local governance by municipalities and traditional leadership. The Eastern Cape COGTA is a key player in bringing communities and traditional authorities in to the spatial planning process and avoiding them being side-lined in government initiatives such as those described above. COGTA makes important input into municipal IDPs and SDFs. According to Sisitka *et al.* (2017), COGTA stresses that communities and traditional authorities in communal areas must be central to all decision-making regarding land and resource use and management.

The private sector is also an important role player in catchment management. Environmental and Rural Solutions (ERS) is one such private sector organization based in the Mzimvubu catchment. They list a wide range of competencies on their web site, including sustainable natural resource utilization and management planning (holistic conservation through production) and development of proposals and

business plans for small development projects (ERS, 2017). They are active participants in the Umzimvubu Catchment Partnership Programme (UCPP). This programme "aims to conserve the full extent of the Umzimvubu River system … through sustainable restoration and maintenance of the catchment area in a manner that supports economic development and job creation for local people and enhance flow of benefits from ecosystem goods and services to people and nature." (UCPP, 2017). A related initiative is Meat Naturally Pty (MNP) which has been driven by Conservation SA (CSA) in partnership with ERS, the LIMA Rural Development Foundation (LIMA) and the Institute for Natural Resources (INR). The Sinxaku Project in the Tsitsa catchment is clearly aligned to the aims of the UCPP, ERS, CSA and MNP.

7.2.2 The DEA-NRM's catchment rehabilitation project (NLEIP)

The vision, structure and implementation of the DEA-NRM's rehabilitation project in the Tsitsa and NLEIP, the research-management nexus, has been described in Chapter 3 (Section 3.5). The learning from our Sinxaku experience that can be taken up by NLEIP is discussed here.

Two key questions underlying the outcomes of NLEIP and our own project are:

- How can the local community benefit from NLEIP?
- How can NLEIP benefit from community inputs?

Answers to these questions are proposed in Table 7.1 and discussed further below. Potential benefits from dam construction activities are also recognised but not discussed. Here the focus is rehabilitation.
From the start, our approach has been pragmatic as we have had to adapt to the response of the Sinxaku community to the research. Although the original intention was to integrate our activities with those of the NLEIP on-ground rehabilitation this has not been effective because of the stop-start nature of rehabilitation activities noted above. Instead we developed our own approaches to support future rehabilitation efforts as described in Chapter 2. These included water harvesting for food gardens and vetiver nurseries and improved livestock management. These have been described in more detail in Chapter 5; a summary of the main points is given here.

Table 7.1: Potential co-benefits between NLEIP and communities and progress achieved in Sinxaku villages

Village level activity	Potential NLEIP interaction	Progress to date
Direct income from rehabilitation activities	Employment through EPWP	Limited rehabilitation activity in the area
Improved garden productivity through water harvesting, contribution to soil and water conservation at a household scale	NLEIP assists with water harvesting activities (digging swales, redirecting water, advice on best practice – avoiding soils at risk)	Capacity building workshops with broader community, more focused workshops with the CWP garden groups in lower Sinxaku.
Income from vetiver nurseries	NLEIP assists with manual labour for water harvesting activities NLEIP purchases vetiver from households	Seven households identified who could be actively involved; specific plans made with one household to start in October.
Market opportunities through sustainable livestock management, contribution to soil and water conservation though improved veld condition	NLEIP supports livestock practices (e.g. fencing, employing rangers) Grazers keep livestock away from erosion control structures an rehabilitation areas	General agreement with livestock owners to proceed with planning the way forward; collaborative links established with the ERS and Meat Naturally; proposal to be taken to Tribal Council
Monitoring effectiveness of grazing and erosion control works	Employment through NLEIP	No activity to date due to lack of implementation of rehabilitation works.

A demonstration food garden is being developed with the Community Works Programme. The group has received training in the use of water harvesting techniques that can mitigate the effect of low and erratic rainfall. The diversion of storm runoff from roadways on to gardens achieves the dual aim of water harvesting and erosion reduction. Similar techniques are being advocated for establishing vetiver nurseries. NLEIP has been approached to assist with creating swales and water diversion furrows. Once the vetiver is established it can be sold to NLEIP/GIB for soil erosion control purposes.

Poor veld condition due to inappropriate grazing strategies is widely advanced as a primary cause of erosion and it is recognized that without improved grass cover over the whole catchment rehabilitation efforts will not be sustainable. It is also important that animals are kept away from rehabilitation activities for a period of time until ground cover is restored. Our aim has therefore been twofold: to promote more sustainable livestock management and to integrate grazing control with rehabilitation activities.

As explained in Chapters 5, we are currently promoting improved livestock management using a form of rotational grazing that is acceptable to the community of livestock owners. In the Sinxaku project this is being achieved through collaboration with ERS in Matatiele, who will advise on livestock practices, and Meat Naturally Pty, who have agreed to provide stock sale opportunities through auctions located in villages. For NLEIP, partnership with the ERS or a similar agency could facilitate uptake of improved grazing practice and veld condition in the wider catchment. In order to achieve sustainability there are start-up costs that will need external support as detailed in the business plan in Appendix B. We suggest that there is opportunity for NLEIP to meet some of these. Herders (Eco-rangers) are one example. Once trained, herders can also provide paravet services and monitor range condition and the effectiveness of rehabilitation measures.

To achieve the second aim (to integrate grazing control with rehabilitation activities), it is necessary for the rehabilitation implementers and the livestock owners to work together so that the recently rehabilitated sites are protected. This can be achieved through a combination of temporary fencing and Eco-rangers. To build capacity among livestock owners (and other village residents) to understand the purpose of the different rehabilitation practices we have developed a handbook explaining erosion processes, rehabilitation techniques and why livestock controls are necessary. This has been distributed amongst a number of livestock owners and the GIB teams and can be made available to a wider community. We have also facilitated meetings between the NLEIP implementers (GIB) and the livestock owners.

To date the livestock group in Sinxaku has developed an action plan that was outlined in Table 4.9. As can be seen, there are a number of points where NLEIP could provide support.

A number of practical lessons from our experience in Sinxaku can usefully inform NLEIP practice. These include the following aspects.

- Lack of water is the biggest constraint to livelihoods; water tanks are an effective solution for household supply, including garden watering. Once installed the owner is independent of any service provider, as long as there is enough rain to keep tanks full.
- Livestock are highly prized and remain an important asset.
- Local people acknowledge that the breakdown of control systems has contributed to degradation of grazing land.
- Rural people live in a cash society; their first priority from a project is employment.
- Many able bodied people of working age have left for urban centres
- Unemployed ≠ unoccupied.
- ALSO employment opportunities from outside funders does not provide security – funding and payment delays = frustration and lack of commitment from workers.
- Projects that rely on partnerships with external funders may flounder without good synchronicity of activities.

These last two points have special relevance to NLEIP rehabilitation activities that involve employment through the EWPW programme.

Principles for working with communities to achieve sustainable management, informed by our own experience as well as a number of practitioners, were given previously in Section 2.7.

7.3 Institutional arrangements for expanding landscape greening and business frameworks

Our initiatives (vetiver nurseries, water harvesting and livestock management) have been at the scale of the household, village group and administrative area. To achieve sustainable livelihoods at the catchment scale and more broadly within South Africa these need to be upscaled. Opportunities for upscaling are illustrated in Figure 7.2. The formal governance structure at the Tribal authority level varies from one authority to another, as has been found by researchers in the wider catchment (Monde Ntshudu, pers. com.). Figure 7.2 depicts the situation in Elangeni.

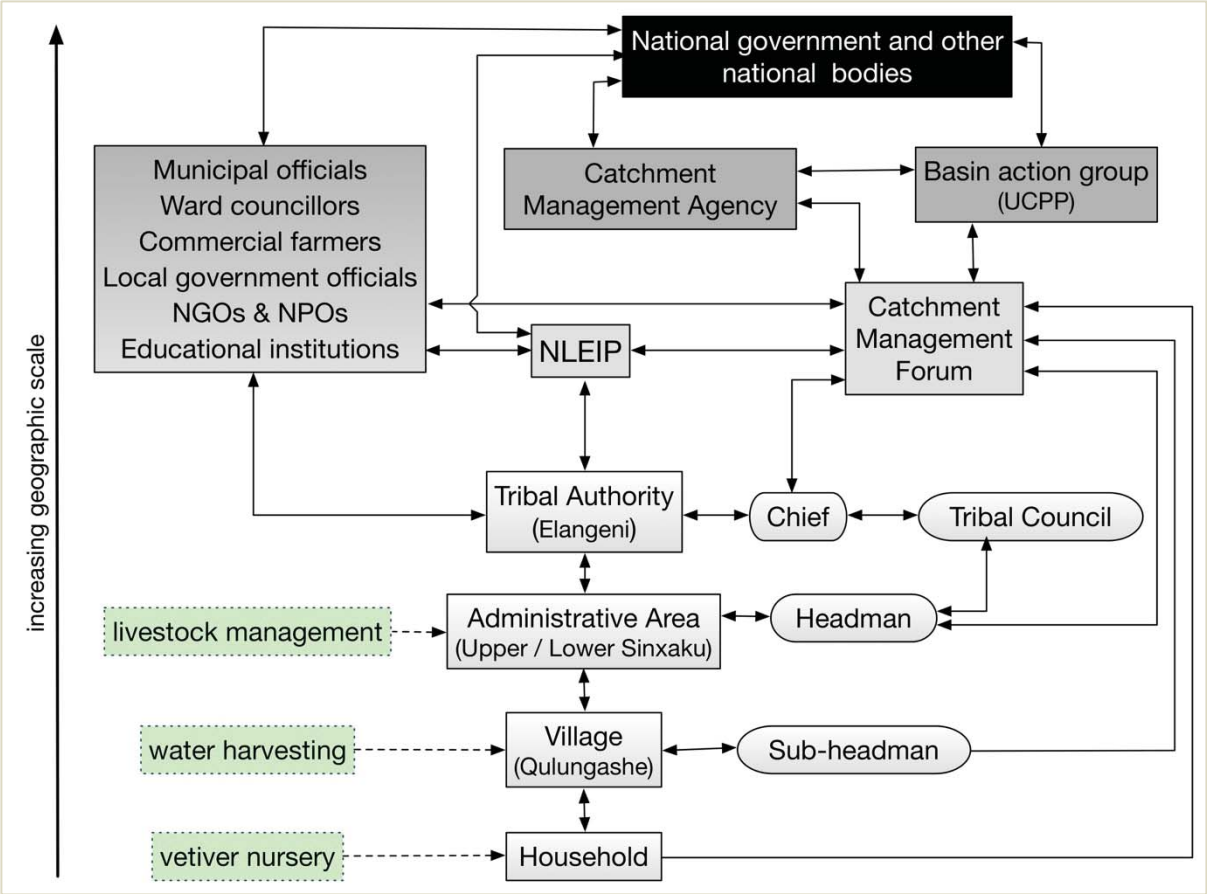


Figure 7.2: Upscaling from the household to the national scale. Local interventions are shown in green boxes. Darker shading indicates a higher level scale. Names in brackets refer to examples relevant to the Sinxaku Green Village project.

7.3.1 Household to Village scale

Water harvesting was targeted initially at the household scale though we ended up working with two groups of twelve gardeners through the CWP. At the village scale NLEIP/EPWP teams could assist with digging channels to divert water into gardens where it could be put to effective use rather than contributing to erosion. This would require careful planning with households to explain the benefits and the need for maintenance to prevent future problems. These activities should become part of a village scale micro-catchment rehabilitation plan as advocated by Braid and Lodenkemper (in preparation) (WRC project K5/2508).

Vetiver nurseries are advocated as a household scale business. The extent to which this can be duplicated within a village depends on the demand for vetiver from the NLEIP's rehabilitation activities. We initially identified seven households who would be interested in such a venture. DEA staff have indicated that vetiver will be used in conjunction with rehabilitation works.

Further support for village scale and administrative area activities need to go through the sub-headman and headman respectively.

7.3.2 Village to Tribal Authority

A number of community decisions, even if only taking place in one administrative area such as Upper or Lower Sinxaku, need to be sanctioned by the Tribal Council that represents all administrative areas in one Tribal Authority. One example is our support of better livestock management that includes a change in the rules for how many stock can be owned, where stock can graze and at what time, and penalties for non-adherence to rules. Working with the Tribal Council provides an opportunity for sharing ideas and experiences among different groups in the area and therefore of upscaling innovations. In the case of marketing cattle through auctions, many villages in the proximal area can participate even though the livestock association responsible for the auction may be from one local area.

At present there is no equivalent to the Village Resource Management Committee found in Malawi responsible for overseeing issues relevant to catchment restoration and sustainable land use management. If sanctioned by the local chief, such a committee could play an important role in governing natural resource management at the level of the Administrative Area. Their terms of reference and responsibilities would need to be carefully negotiated.

7.3.3 Tribal authority to catchment

NLEIP is a catchment wide programme so there are immediate and continued opportunities for upscaling learning from the Sinxaku project.

A Catchment Management Forum (CMF) has the potential to be an effective governance structure through which local people can collaborate to contribute to decision making over the co-management of land and water at a catchment scale. According to the National Water Act of 1998, a CMF is a non-statutory body. However, it would still provide a platform for addressing local concerns and provide a conduit for information between the CMF and regional Catchment Management Agency (CMA).

Researchers from the Institute for Water Research (IWR) at Rhodes University are working through NLEIP on governance issues in the Tsitsa catchment, specifically to establish a Catchment Forum that embraces the wider catchment community. Through a two year NRF-GCSSRP grant extension, they aim to build local CMFs and civil society participatory capability, as well as fostering functional institutional relationships between CMFs and CMA at sub-catchment scale. The wide range of stakeholders indicated on Figure 7.2 would have the opportunity to become involved in the CMF. Tribal authority representatives would normally include the chief and headman (i.e. members of the Tribal Council) but others are not excluded. Community members from Sinxaku have been invited to two of these meetings, one held in the Sinxaku area and one held in Maclear.

The Maclear meeting, in June 2017, had the following objectives:

> *"To introduce and use the Adaptive Planning Process in order develop a sub-catchment vision and management strategy for the Tsitsa Catchment; to encourage the development of a Catchment Management Forum (CMF); to make clear the roles and relationship of CMFs and Catchment Management Agencies (CMAs)." (Workshop report provided by Margaret Wolff, July 2017)*

The two Sinxaku residents were among 26 attendees including representatives of the DEA, commercial and subsistence farmers, headmen, representatives of the Maclear Municipality, the Joe Gqabi District Municipality, representatives of the Ward Committees 6 and 16. Such meetings provide excellent opportunities for shared learning and, specifically in this case, to share learning about the Sinxaku Green Village Project.

Although village residents other than chiefs and headmen are not excluded from such meetings, it is perhaps not a viable structure for the voices from the 378 villages in the catchment to be heard. It has been proposed that the DEA-NRM investigate what is the most suitable level of governance for NLEIP so that this can feed into the CMFs.

The IWR sponsored a Mzimvubu Catchment Civil Society Learning Exchange Visits lead by Ms Conde-Aller in November 2017. The aim of the exchange was to strengthen the capability of rural communities, particularly small-scale farmers, to meaningfully engage in water governance and management in the Mzimvubu Catchment. Therefore, the participants were rural farmers from Sinxaku (Maclear) and Lutengele (Port St Johns) located in the Upper and Lower Mzimvubu Catchment areas respectively. The learning exchange visits focussed on critically analysing the social-ecological contexts of each sub-area, as well as catchment-wide upstream and downstream connections and linkages. The groups were exposed to sustainable and unsustainable land use practices, were alerted to the requirements, role and complexities of catchment forums (e.g. UCPP) and were provided with the opportunity to co-engage in mapping out the way forward to improve participation and voice in the CMA.

7.3.4 Catchment to river basin

The Tsitsa river is a tributary of the Mzimvubu. Sustainable management of the Mzimvubu catchment is the concern of the ERS and UCPP as discussed above. The ERS organizes sharing exchanges that provide opportunity for learning. Sinxaku residents have already attended such an exchange, which has to a great extent been the catalyst for developing improved livestock management that can lead to marketing opportunities.

CMFs should interact with a functioning CMA and provide input to the catchment management strategy. This cannot happen in the Tsitsa until such a body is in place.

7.3.5 River basin to national scale

The integration of entrepreneurship models into rehabilitation projects can be embraced at a national level through enabling policies that provide a supportive environment at the local level. This would include access to capital to start an initiative, assistance with skills development and a commitment from the rehabilitation implementers to engage with entrepreneurs in a meaningful and timely way. Although developing a sustainable community-based project can take time due to the nature of the engagement process, delaying promised input by external agencies can frustrate and even endanger a successful outcome.

7.4 Learning resources

Successful outcomes at all scales depends on building capacity to engage in relevant activities. Through the Sinxaku Project we have developed a number of learning resources. These include practical guidelines for landscape greening, water harvesting, integrated rehabilitation and grazing and a set of school resources linked to the primary school curriculum. These are given in Appendices C-E. We hope that these can be adopted and adapted by a wider community at all scales from individuals in household to national policy makers.

The set of school resources was developed with the teachers. The focus was on practical actions to improve the school grounds and achieve food security, while supporting learning outcomes contained in the curriculum. As these resources are specific to the local context, the information related to the curriculum is more applicable, interesting and accessible. The addition of photos and maps of the local area supported such locally relevant learning. Discussions held with teachers indicated that they had been useful and supported effective learning in the classroom.

These teaching and learning resources will be taking into formal teacher education and training in 2018. AURECON, as part of the WRC project regarding the developing integrated catchment management guidelines and toolkit (K5/2508), plans to facilitate a Fundisa for Change course with Social Science (Geography) teachers from the Tsitsa catchment. The course is SACE endorsed and accredited through Rhodes University. The learning resources, together with the AURECON's integrated catchment management tool-kit, will support the implementation of the teachers' curriculum requirements as well as contextually relevant environmental learning activities for senior phase learners.

Mention should also be made of a set of nine "How to" booklets on Integrated Water Resource Management (IWRM) that have been produced by the IWR at Rhodes University as part of the WRC project K5/2248 – Practicing adaptive Integrated Water Resources Management (IWRM) in South Africa: Towards Practising a New Paradigm. These have relevance to working in catchments and to the catchment management planning that should be an integral component of IWRM.
These booklets are available from https://www.ru.ac.za/iwr/howtohandbooks/

7.5 Spreading the word

Selected, proved and tested best practices should be demonstrated and shared through hard copy or electronic media to local extension officers and other technical officials from the Eastern Cape Provincial Department of Agriculture, local Municipality Environmental officials and DEA at district and provincial level. Tsolo College of Agriculture should also be included as a locally relevant educational institute. Exchange visits (Look-and-learn) should be encouraged with agricultural technicians, farmers, LandCare officials from other local municipalities, districts and provinces. Training workshops and demonstrations could also be included as part of provincial and national capacity building.

Valuable lessons learnt from the Sinxaku experience should find their way to provincial and national Sustainable Land Management (SLM) Policies and Strategies. Elundini Municipality's Spatial Development Framework (SDF) is to be aligned with the Spatial Planning and Land Use Management Act (no. 16 of 2013) (SPLUMA) so there is opportunity for integrating new thinking around catchment rehabilitation. Aspects critical for Sustainable Land Management, such as Area Wide Planning or Catchment Wide Holistic Planning, creating sustainable small-scale enterprises (e.g. vetiver nurseries), technical standards for water harvesting and diversion channels, should be captured in policies and strategies at provincial and national level. Suggestions from project level on sustainable funding mechanisms/incentive schemes should also be up-scaled to provincial and national level.

Lastly, best practices and success stories should be captured and shared in Country Reporting as part of international obligations towards conventions like UNCCD, Biodiversity and so on. Initiatives such as Land Degradation Neutrality by 2030 and AFR100 should also take note of these best practices and lessons learned and promising technologies and approaches should be documented as such.

CHAPTER 8. CONCLUSIONS

8.1 Overview of project aims

The aims of this project were to:

1. Identify drivers of poverty, opportunities offered by natural ecosystem, and develop community-based vision of a Green Village using a bottom up approach.
    - Our response to this objective is described in detail in Chapter 3. Poverty is an outcome of a landscape that is prone to erosion and where high rainfall variability puts it at risk to drought and floods. For example, in 2015, 2016 and 2017 summer rains were delayed until January. Opportunities lie in improved garden productivity through more reliable access to water, improved livestock management, and opportunities to work with the rehabilitation project. Community members see erosion as a risk that they want to address; they also look for employment opportunities as a priority.

2. Through integration of indigenous knowledge, green innovations, research, and technology, develop a tool box of green solutions that can address the impact of climate change and help communities or sectors to adapt to climate change.
    - This was the focus of the project in Okhombe and is described in detail in Volume 2 of this report.

3. Identify and develop a business (economic) framework that poor and local communities can use to improve their livelihoods without furthering land use degradation.
    - Proposed business opportunities are described in Chapter 5. This looks in detail at two proposals: livestock and vetiver nurseries. Business plans are presented in Appendix A and B.
    - The first proposal is to establish vetiver nurseries in home gardens (Appendix A). These would be owned and managed by individual households. Vetiver propagules would be sold to the DEA-NRM's rehabilitation project. The DEA have indicated that they will use vetiver in erosion control works and have agreed in principle that vetiver can be sourced from local growers. The details of transactions still need to be agreed; the business plan presented in Appendix A can be used as a basis for negotiation. The business plan demonstrates that growing vetiver is a viable proposition for a household and provides limited temporary employment. How many households can be involved depends on the demand for vetiver from the DEA rehabilitation. At present we have identified seven households who would be interested but are piloting the plan with one household.
      The plan is to support vetiver growth with water harvesting using swales along the contour. Sufficient soil moisture is especially important in the early stages of propagation. Other crops grown alongside vetiver can also benefit from additional moisture availability as has been demonstrated already in one garden.
    - The second proposal is to promote improved livestock management using rotational grazing, linked to a marketing system to allow profitable offtake of surplus stock (Appendix B). Rangers can be employed to herd stock. They could also be responsible for monitoring stock and veld condition and acting as paravets. If funding can be found for the capital investment in infrastructure such as handling pens, mobile electric fencing, and initial employment costs of rangers, the system can become financially self-sustaining in the long-term through levies on stock. There is considerable interest among influential livestock owners but there has also been a negative response to the proposal by some

individuals. As livestock are grazed on communal land it is important that at least the majority of livestock owners join the scheme willingly. The proposal needs to be backed by clear rules for grazing and stock maintenance, with agreed penalties for when rules are broken. Environmental Rural Solutions and Meat Naturally Pty have agreed to give assistance in advising the Sinxaku community and introducing village auctions.

- Our third proposal is to use rainwater harvesting to improve garden productivity as a livelihood support. We have not attempted to develop this into a business plan as garden produce is primarily for home consumption. Through integrating rainwater harvesting with water diversion from tracks and pathways in the village areas we can support both catchment rehabilitation and livelihoods. The settlement areas contribute significantly to storm runoff and many gullies run out from the housing areas.

4. Develop and test practical and appropriate mechanisms, manuals and guidelines for landscape development and management that will protect the infrastructure and improve ecosystem services.
    - Guidelines for landscape greening were presented in Chapter 4. These included recommendations on erosion control practice and emphasised the difficulties faced when dealing with the dispersive soils that are widespread in Sinxaku. Recommendations were also made for community-based monitoring of the impact of erosion control efforts on sediment loss. These recommendations have been shared on an ongoing basis with the NLEIP team responsible for developing the adaptive management and restoration plan (NLEIP, 2017) and the research team of WRC Project K5/2508, which has the objective of developing guidelines for village scale catchment management.
    - Training materials on rainwater harvesting have been compiled and translated into Xhosa (Appendix C).
    - A manual in English and Xhosa has been produced that explains the function of the different erosion control measures that will be used in the DEA-NRM rehabilitation project (Appendix D). This has been shared with a wide range of managers and practitioners as well as community members from Sinxaku.

5. Train communities (mainly the youth) on appropriate skills/capacity necessary to sustain the businesses and ecosystem services that transform the poor community to be more self-sufficient.
    - Training has been given on rainwater harvesting and garden- and micro-catchment-scale soil and water conservation. Initially this was through the Green Village Committee and later through the CWP garden group.
    - Workshops have been held with the livestock group on the link between grazing practices, soil erosion control and improved veld and stock condition. Individuals have attended a Sharing Exchange workshop held in Matatiele and two auctions organised by Meat Naturally Pty.
    - A school programme on environmental learning, “Sinxaku for Life”, has introduced learners at the Lower Sinxaku Primary school to more sustainable ways to live in the environment (Chapter 6). Learning resources were made available to teachers (Appendix E) and an eco-club was initiated – the Green Farmers.
    - The demographic analysis in Chapter 3 shows that there are few young people above primary school age still resident in Sinxaku. A significant number of secondary school learners are resident in cities such as Cape Town, living with employed family members. School leavers depart from the area to look for employment elsewhere. It has therefore been difficult to engage many young people in our activities. Where it has occurred, the engagement has been short lived as the individual has left the area soon after.

6. Integrate the green solutions tool box and business framework with core line function government departments in order to ensure sustainability of the intervention and to forge partnerships with all key stakeholders.

AND

7. Develop models on how to expand the green tool box of solutions and business framework utility, from household/village to the national or country-wide scale.
    - These two objectives are covered in Chapter 7. The NLEIP project, outlined in Chapter 3, provides an appropriate framework both for integration with core line function government departments and for upscaling from the village to the catchment, basin and national scale. NLEIP is designed as a research and management partnership. The DEA is its primary funder but the programme provides a platform for involvement by a wide range of stakeholders from local and national government, NGOs, research institutions and private individuals.
    - NLEIP is a catchment-wide project, which provides the Sinxaku Green Village project with an immediate opportunity for upscaling solutions through continued exchange with others involved in NLEIP. This includes the DEA and other government departments who attend the biannual NLEIP forums. We have made a significant contribution to the adaptive management and restoration plan (NLEIP, 2017). Through this project we have been able to demonstrate to NLEIP how livelihood opportunities can be derived directly from the rehabilitation activities.
    - NLEIP has been the main outlet for demonstrating the outcomes of the Sinxaku Green Village Project, both through sharing experiences at the biannual forums and by contributing to on-ground planning. Other opportunities for engaging with government institutions and upscaling are outlined in Chapter 7.
    - An important non-government partnership has been with ERS and Meat Naturally Pty, based in Matatiele. As core members of the UCPP this provides opportunity to share experiences with the wider Mzimvubu community.

8.2 Contributing to the Green Village Lighthouse

Chapter 1 listed the desired strategic objectives, outcomes and actions of the WRC's Green Village lighthouse. The Sinxaku Green Village project has contributed to a number of these.

Strategic Objectives were given as:

- Develop an integrated framework for rural development that benefits communities with minimal risks to environment
- Improve livelihoods through measurable healthy living conditions
- Improve water ecosystems, and food and energy security
- Improve human health and dignity through adequate sanitation and solid waste management
- Build a knowledgeable society with improved competency for integrated catchment management and development
- Support job creation, local economic empowerment and development.
- All these have been addressed to some extent except the objective relating to sanitation and solid waste management. This was outside the scope of this project.

Outcomes were given as:

- A community receiving basic needs, transformed and greatly self-sufficient living in harmony with the environment

- Adaptable framework outlining how community traditions, government policies, and business principles in collaboration can result in improvement of livelihoods
- Tested guidelines for the integration of research products, and green technologies leading to economically viable job creation and markets
- Social, economic and environmental learning which leads to resilient systems and green rural societies

The first outcome represents a long term vision and we cannot claim to have achieved this but, hopefully, have put in place some of the necessary building blocks. We have made some progress with addressing the other three outcomes, as described above.

Actions were given as:

- Initially focus on the research portfolio and analysis level in an attempt to establish needs/possible tools for solutions
- Secure developmental models and scenarios
- Identify possible science and technology interventions
- Demonstrate what the integrated approach can achieve, and market the idea to implementers/funders
- Develop models for up-scaling the framework for implementation
- Look for innovative solutions at a small scale with potential for IP/beneficiation

Our research objectives were directed at all of these activities, leading to the development of an integrated business plan that could be supported by external funders, including the DEA. What we have been able to achieve has been within the limits of the 33 months available for engaging with the Sinxaku community and researching potential opportunities. More time is needed to investigate the uptake of our proposals and the risks involved to investors. Other opportunities should also be followed through discussion with people on the ground. Once people can see the benefits that arise from taking up a proposal there should be more interest in developing further ideas.

The first outcome of the Green Village Lighthouse is given above as “A community receiving basic needs, transformed and greatly self-sufficient living in harmony with the environment.” Before this can take place a community needs to live in harmony with itself. As our work progressed in Sinxaku it became clear that there were serious divisions that led to a breakdown of trust. It will be hard to move forward until these divisions are mended. As researchers we may be able to identify some of the barriers and provide a forum in which to facilitate a way forward but it is not our role to dictate the direction a fragmented community should take. Strong and effective leadership, locally, regionally and nationally, is required before this can happen.

8.3 Ways of working

Trust is stated by many researchers to be at the core of successful community engagement. Our own experience bears this out. In the context of this research trust has been a five-way process. Firstly, there is the trust between community and researchers. This has to build up slowly as the research proceeds. It was important from the start to be open about our agenda and not to be seen as a development agency. Secondly, there is trust between different community members and community groups. The longer we worked in Sinxaku the more we came to realise that the ‘community’ is not a homogenous, well-knit group and there is widespread mistrust. Some of this is probably politically inspired and seemed to get worse towards the end of the project as politics heated up at the national level. Thirdly, there is trust within the WRC project research team and, fourthly, between the local project researchers and the NLEIP community.

If researchers and managers do not trust each other there will be lack of communication, miscommunication and limited progress. Our own research team came from different disciplinary backgrounds as does the NLEIP community. Finding a common jargon free language is as important as using isiXhosa in a village context. Lastly there is trust between the village community and the rehabilitation implementers. Implementers need to build the capacity of the community members to engage with and take responsibility for rehabilitation activities.

8.4 Going forward; further research

If an externally imposed rehabilitation project is to be sustainable there must be direct benefit to both the implementers and local communities living in the rehabilitation area. In the case of the DEA-NRM rehabilitation project, the driving motivation for the government implementers is to reduce sedimentation to the proposed dams. Local communities can receive both short term and long term benefits. In the short term there are employment opportunities, which have already been welcomed by Sinxaku residents. Frustrations have arisen from the stop-start nature of employment but these should lessen once the DEA-NRM project gets over teething problems. The project was also welcomed as a means to tackle erosion, which is perceived by many as a threat to livelihoods and infrastructure. Erosion control and sediment retention can also be linked to increased spring flow and the construction of small-scale water storage areas such as sand dams. These rehabilitation outcomes address longer term benefits. We held one workshop early on in the project in which participants identified their main concerns and selected their rehabilitation priorities; findings were shared with the rehabilitation implementers but due to lack of on-ground activity we did not take this further. It is important that the implementers engage the local residents in a meaningful way, explaining the reasons for activities and coming to agreement on priorities. It is especially important that livestock owners work with the rehabilitation team to allow time for sites to recover. It is our hope that the erosion control manual (Appendix B) will facilitate engagement and learning.

Other benefits come from integrating rehabilitation with livelihood or income generating opportunities. Those investigated in this project include improving groundcover, livestock productivity and income through controlled grazing linked to market opportunities and integrating soil and water conservation with increased garden productivity and vetiver nurseries. Vetiver is to be sold to the rehabilitation project, thus providing an income earning opportunity and directly assisting the rehabilitation project.

In a short project such as this one there has been limited opportunity to take the selected options to fruition or to investigate further possibilities. Further research of a technical nature is needed to support the grazing plan. In particular, it will be necessary to do an on-ground assessment of the present grazing capacity, make an inventory of present stock numbers and ownership and develop an agreed grazing strategy. The latter two actions should only take place once there is agreement by the community that this is what they would like to do.

For water harvesting linked to gardens to become an effective erosion control activity it will be necessary to upscale from one garden to the micro-catchment or village scale with the help of the rehabilitation implementers. In this way one of the key source areas for runoff and sediment can be tackled to the benefit of village residents. This will require careful planning, firstly to identify runoff and sediment pathways, secondly to identify areas of unstable, dispersive soils which should not be receiving areas for runoff water and, thirdly, to identify households willing to become part of the project. The Catchment Management Guidelines of K5/5608 (Braid and Lodenkemper, in preparation) provides an appropriate framework to implement rehabilitation at the village scale. We strongly urge the DEA to promote the application of these guidelines.

Economic opportunities arising from increased garden productivity can also be investigated further. Sales of vetiver to the rehabilitation project is one option but there are also other vetiver products that can be developed. Specialised skills training would be needed to enable local people to produce the baskets and mats illustrated in Figure 5.15.

Whilst we have explored various options independently, it is necessary to integrate these into one catchment plan that considers how improved grazing, rainwater harvesting and other potential interventions can become a key part of the rehabilitation. This was illustrated in Figure 5.17. These approaches could, for example, be incorporated into the WRC's Amanzi for Food programme, bringing together livestock and food productivity.

Long term sustainability of the rehabilitation and continued improvement of livelihoods in the Sinxaku villages, and similar rural areas, depends on today's children becoming adults who respect the environment and have the knowledge and capacity to build on our small endeavours. This is what the school learning initiative aimed to achieve. The WRC project K5/2508 will build on this and, hopefully, extend the project to more schools in the area. There are also opportunities for the rehabilitation implementers to engage with local schools and show them nearby rehabilitation activities.

Our project provided a number of opportunities for sharing knowledge with people outside the immediate area. School leavers visited Hogsback in the Amatola District, livestock owners participated in a sharing exchange in Matatiele, Green Village committee members attended catchment forum meetings in Maclear and people from Sinxaku participated in a learning exchange with others from Port St Johns in the lower Mzimvubu. Sharing knowledge through these exchanges is both informative and empowering. It is recommended that provision is made for further activities of this nature.

This report has not made explicit the links to climate change. However, water harvesting and improved veld condition both add to increased resilience against climate shocks. Soil carbon stocks can also be improved, mitigating increased atmospheric carbon. This presents an opportunity for entry into the carbon offset market. Payment for Ecosystem Services is another option that can be explored. Putting an economic cost to soil carbon and ecosystem services was beyond the scope of this project but could be followed up with advantage. Research has been initiated by the University of Fort Hare that looks at current carbon stocks in the basin around the Ntabelanga Dam (Ngesi, in preparation). This can provide a baseline against which future conditions can be assessed.

Research can reveal opportunities for improved livelihoods and entrepreneurship but for these to become a reality there needs to be a fundamental shift in both the supportive environment and the aspirations of people. Further research is needed to uncover impediments to or catalysts for change. In a community where the young and enterprising have tended to leave for opportunities elsewhere, what can motivate those that stay behind to adopt new practices? What are the barriers within a community that prevent positive change? Are the recommended changes in fact positive? We do not want to repeat the negative consequences of Betterment Planning. These are not new questions but we still need answers.

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Appendix A: A Business Plan for a Household Vetiver Nursery

1 KEY DATA SUMMARY

1.1 Brief concept

Vetiver is commonly used in soil erosion control and can be sold to the DEA' rehabilitation project to be used to strengthen structural interventions and to control soil loss from hillslopes.

1.2 Contribution to Ecosystem Services and social well-being

Use of vetiver in the DEA-NRM's catchment scale rehabilitation will reduce soil erosion and sediment input into the Ntabelanga Dam. This is a key ecosystem service.

Income creation will be at a household scale, with some additional employment opportunities.

1.3 Finance and assistance required

Funding:

(1) R20 000: Start-up funds for purchasing slips.
(2) R12 000: Employment of temporary labour to get nursery established.

Assistance: Guidance on propagation and marketing.

Potential job creation: Table 5.1.

Table A1 Potential job creation

Year	Job	Job type	Person-days	Total Annual earning potential (R)
1	Nursery assistants	Part time	120	13 200
2 … n	Nursery assistants	Part-time	95	10 450

2 OPPORTUNITY

2.1 Problem and solution

2.1.1 Problem worth solving

Vetiver will be required for the DEA rehabilitation but at present there is no local nursery. Transporting from a distant nursery increases the cost.

Local nurseries reduce transport costs and provide income to local households.

2.1.2 Our solution

Vetiver grown in a local nursery managed at the household level will meet the needs of the DEA-NRM at an affordable cost and will provide income to the householder.

2.2 Target market

The target market is the DEA-NRM's rehabilitation project. As this extends to the rest of the Tsitsa catchment the market will expand.

2.3 Competition

Competition comes from other nurseries but these are all distant from the site.

3. EXECUTION

3.1 Marketing and sales

Marketing will be done by the head of household/gardener in collaboration with the DEA. As more nurseries become established it may be necessary to form some sort of co-operative.

3.2 Operations

3.2.1 Location and Facilities

Nurseries will be established in home gardens as these are fenced and can be watered by hand at the initial stages of propagation. A water source is required in the first stages of propagation.

3.2.2 Technology

No advanced technology is required for this business.

3.2.3 Equipment and Tools

The only tools required are garden tools, already owned by most home owners.

3.2.4 Other inputs

Slips or young plants are needed to start the nursery.

3.3 Company: Ownership and structure

The nursery will be owned by the individual household.

3.4 Team

3.4.1 Management team

The nurseries will be managed by individual households.

3.4.2 Advisors

The vetiver network provides information and guidelines on growing and using vetiver. Roley Knöffke from Hydromulch, Brakpan, has offered to visit the site and give advice.

3.4.3 Sales team

The sales team would consist of individual households.

4. FINANCIAL PLAN

4.1 Forecast

4.1.1 Key assumptions

The financial plan depends on a number of assumptions that are built into the model. Input values may be adjusted over time as conditions change. Model inputs include:

Plant numbers

- **The area of available land**. Seven households have been identified as being available for nurseries. The figures here are for using part of a typical quarter hectare garden.

- The land available for vetiver is 35 metres across the slope, 30 metres down slope. This allows for nine swales three meters apart. Swales are used to harvest runoff water and augment soil moisture.

- **The planting density**. Slips are planted at 12 slips per metre, plants at 8 to 10 plants per metre. This equates to a planting density of 8 plants per square metre of the garden. Vetiver should be planted within the swale and immediately below to maximise water availability.

- **The offtake rate.** Between 15 and 30 new propagules can be harvested from each plant at the end of the first year (Nöffke, pers. com.). This equates to between 100 and 200 plants per square metre.

- **Product costs**
  Cost per plant R3
  Cost per slip R1
  This is based on the cost of transport from the nursery in Keiskamma Hoek

Labour costs

- Digging swales to establish the nursery: 36 person-days @R110
- Watering to establish young plants and maintain growth: 50 person days.
- Harvesting: 50 person days
- Labour equates to 160 person days in year 1 and 100 person days once the garden is established.

Other costs

- Water – at present the householder buys water delivered from the river at a cost of R500 per 5000 litres. This cost could be greatly reduced if an efficient rainwater harvesting system was installed. River water would be used in emergency situations (prolonged drought) only
- Fertilizer – not costed

Expected sales

- Plants will be sold to the DEA's rehabilitation project.

4.2 Financing

4.2.1 Use of funds

Funding is required to purchase/acquire the initial stock of plants and to dig the swales. Some households will require water storage facilities (rainwater tank or constructed pond). (Note that if plants are brought from the DEA's nursery at Keiskamma Hoek the cost will be for transport to the site.)

1.1.2 Source of funds

Government departments responsible for rural development through agricultural innovation (e.g. DAFF, DRDLR).

Government Departments responsible for catchment rehabilitation (e.g. DEA); costs of digging swales can be built in to the employment benefits of rehabilitation.

International funders through development aid.

Table 1 Annual Revenue

SLIPS	Annual Revenue (R)	Annual expenses (R)	Net profit/loss (R)
Year 1	45 360	35 880	9 480
Year 2 and subsequently	45 360	15 490	28 870
PLANTS	**Annual Revenue (R)**	**Annual expenses (R)**	**Net profit/loss (R)**
Year 1	68 040	43 810	24 230
Year 2 and subsequently	68 040	15 490	52 550

4.3 Statement of annual income and expenditure

Table 2 Summary of costs, expenditure and income

(Yellow cells indicate inputs that can be varied, blue cells are calculations based on inputs)

	no of rows	slips per row	plants per row	cost per row (slips)	cost per row (plants
Length of row		35	35		
Planting density /m		12	8		
Plants per row	1	420	280	420	840
Plants per field	18	7560	5040		
cost per field	18			7560	15120
initial cost per plant	3	selling price plants	1.5		
initial cost per slip	1	selling price slips	0.5		
Off take per plant per year		20	10		
Survival rate		0.6	0.9		
Survival rate – plants per field		4536	4536		
Off take per plant per year		20	10		
No. plants for sale		90 720	45 360		
Watering costs	price per 2.5 KL	litres/1000	net cost	litres/1000	net cost
		Year 1		Year 2	
Watering (filling jojo tank) slips	250	151.2	15120	113.4	11340
Watering (filling jojo tank) Plants	250	50.4	5040	37.8	3780
Labour cost	daily rate	no of days	no of people	total cost	person days
year 1 labour					
digging swales	110	3	12	3960	36
planting	110	2	12	2640	24
watering	110	60	1	6600	60

Total year 1				13200	120
Annual labour year 2…year n					
watering	110	45	1	4950	45
harvesting	110	50	1	5500	50
total labour year 2…n				10450	95
Annual costs				slips	plants
Total costs year 1	slips/plants; labour for swales, planting, watering & harvesting; water			35880	43810
Total costs thereafter	labour for watering & harvesting			15490	15490
WATER REQUIREMENTS (l)		water per week per slip (l)	water per week per plant (l)	no. weeks year 1	no. weeks year 2
Water requirements (l)		0.5	0.25	40	30
		Year 1		Year 2	
		slips	plants	slips	plants
Water volume (l) (all plants)		151200	50400	113400	37800
Income at year end		slips	plants		
Gross income		45 360	68 040		
Expenditure year 1		35 880	43 810		
Expenditure year 2		15 490	15 490		
Net income year 1		9 480	24 230		
Net income year 2		29 870	52 550		
Capital outlay					
Jojo tank ®	5000				

Appendix B: A Business Plan for Managed Grazing

1 KEY DATA SUMMARY

1.1 Brief concept

Livestock management includes adoption of rangeland stewardship practices following managed grazing principles. Stock sales take place both within the village and to outside buyers through auctions arranged by Meat Naturally Pty.

1.2 Contribution to Ecosystem Services and Social Well-being

By developing a managed grazing system both the vegetation cover and condition of the stock are expected to improve. Bringing back a good ground cover is one of the most important outcomes for a rehabilitation project that aims to reduce erosion. By introducing a marketing outlet, the stock owners benefit from increased income and employment opportunities are created through reinstating a herding system.

1.3 Finance and assistance required

Funding:

(1) R300,000: Start-up capital for physical infrastructure: shearing sheds, handling pens, electric fencing.

(2) R240,000: Employment of eco-rangers in first two to three years while the system gets established

Assistance: Developing the grazing plan and training eco-rangers.

Potential job creation: Table 1.

Table 1 Potential job creation

Job	Job type	Number of jobs	Monthly earning potential (R)
Eco-ranger	Full time	4	2,383
	TOTAL	4	9533

2 OPPORTUNITY

2.1 Problem and solution

2.1.1 Problem worth solving

Uncontrolled livestock movements are believed to be responsible for increased erosion in Sinxaku (and other communal areas of the Tsitsa catchment). Improved grazing systems can contribute to sustainable rehabilitation in the catchment and improved income from livestock.

2.1.2 Our solution

Adoption of managed grazing practices under a rangeland stewardship programme, coupled with local auctions, will increase income earning opportunities from livestock without impacting negatively on the rangeland.

2.2 Target market

The target market is local cattle breeders and butchers who will buy through the auctions. Local sales of stock within the Sinxaku villages will also continue.

2.3 Competition

Competition for external sales will come from other stock farms, especially the commercial sector. These farms, however, can also be a target for sales as they buy stock for fattening up.

3 EXECUTION

3.1 Marketing and sales

Marketing within the villages will be done by word of mouth as the need arises. Marketing and sales through auctions will be carried out by Meat Naturally Pty.

3.2 Operations

3.2.1 Location and Facilities

Livestock will be grazed on communal lands in Sinxaku. The community will have to reach agreement as to whether Upper and Lower Sinxaku are managed separately or as one unit. Managing as one unit would be more sustainable as it would enable a larger are to be used for grazing and resting. The area available to Lower Sinxaku is small and will be considerably reduced if the Ntabelanga dam goes ahead. Our costings are for the combined area.

A number of improved facilities are required to support livestock farming. These include a handling pens, watering points in all camps and a shearing shed. Restoration or relocation of dipping tanks may also be required.

3.2.2 Technology

No advanced technology is required for this business; however, a mobile phone could be of assistance to communicate with Meat Naturally Pty and other potential buyers and to provide mobile banking ability. Most people in the villages already have mobile phones.

3.2.3 Equipment and Tools

Mobile electric fencing is recommended to help herd livestock into the small areas required for managed grazing. Where possible, this will be powered by solar panels located close to homesteads. Cost estimates vary from R1500 per unit for cattle to R2 500 for sheep and goats.

3.2.4 Other inputs

Additional inputs include veterinary costs (annual inoculations and other incidental costs) and salt licks. There is also the expense of shearing sheep if not done by the owner.

3.3 Company: Ownership and structure

Livestock are individually owned but grazed on communal land. The management structure must therefore be 'housed' within the community.

3.4 Team

3.4.1 Management team

Rules and penalties linked to grazing would agreed with the relevant tribal authorities and overseen by a Livestock Association.

3.4.2 Advisors

Meat Naturally Pty. and Environmental Rural solutions have agreed to provide mentoring and training of herders with the assistance of external funding.

3.4.3 Sales team

The sales team would consist of individual livestock owners acting collectively to organise auctions.

4 FINANCIAL PLAN

4.1 Forecast

4.1.1 Key assumptions

The financial plan depends on a number of assumptions that are built into the model. Input values may be adjusted over time as conditions change. Model inputs include:

Livestock numbers

- The area of available grazing land. The total area of Upper Sinxaku is ~2900 ha and Lower Sinxaku ~1000 ha. The area of houses and gardens is approximately 170 ha and 100 ha respectively, leaving a maximum grazing area of 2750 ha and 940 ha respectively. If it is assumed that gullied areas do not provide grazing the area is further reduced to ~2400 ha and ~840 ha for Upper and Lower Sinxaku respectively. These figures are used to estimate possible income from livestock. They do

not take into account loss of grazing land due to inundation by the dam. This would further reduce the available area to ~1650 ha and ~430 ha respectively.

- The grazing capacity. Figures from rangeland scientist Dr Tony Palmer indicate a grazing capacity for the area to be in the region of 0.17 large livestock units (LSUs) per hectare. This assumes an average annual biomass of 1400 kg/a, a herbage requirement per LSU of 9 kg/day and a use factor of 0.4. The adoption of an improved grazing regime should increase the grazing capacity. Here we assume a 50% increase to 0.26 LSUs/ha. Under optimum conditions and in good rainfall years the numbers could undoubtedly be higher.
- Stock numbers. Given the available land area and its grazing capacity, stock numbers range from 554 LSUs under present conditions to 830 LSUs under 'improved' conditions. Given the present distribution of stock between cattle, sheep and goats this translates as follows:
    - Present-day conditions: cattle 270, sheep 800, goats 1070
    - 'Improved' conditions: cattle 410, sheep 1200, goats 1600
- The offtake rate. For a sustainable system the offtake should equal surviving young plus new stock bought. We are assuming a 20% offtake, which is probably well above the current rate. This includes local sales and sales through the auction.

Product costs

- Prices of annual inputs (salt licks, inoculation, shearing).
    - Salt licks – R120 per lick, one lick in each of twelve camps.
    - Inoculation – R60 per young animal, R8 per head of cattle, R4 per sheep and goat (annual)
    - Shearing – R8 per sheep

Labour costs

- Four eco-rangers are to be employed. We assume that each eco-ranger works 5 days per week at a wage of R110 per day (in line with EWPW). Two rangers would work for seven days in the field with stock, two for three days doing maintenance work, monitoring, etc. This assumes all animals are herded together. If smaller herds are preferred will need more rangers at a higher cost.
- Six eco-rangers would be employed once the grass condition improved and an increased carrying capacity allowed higher stock numbers.

Expected sales

- Sales prices. Cattle sold in the village fetch between R10,000 and R13,000, sheep for closer to R1000 and goats for R1300. Cattle are the main animal used in traditional ceremonies. There is a trend towards buying sheep for non-traditional ceremonies because of the lower cost. Prices at auctions for cattle vary from R6,000 to R12,000 depending on the quality of the animal. Auctions provide an opportunity to sell of older stock but at a lower price. An average price of R9,000 for cattle, R1,000 for sheep and R1,500 for goats is used in our calculations.
- The price of a fleece has been set at R200

Table 2 Annual Revenue (total for the two Sinxaku communities)

	Annual Revenue (R)	Annual expenses (R)	Net profit/loss (R)
Present-day conditions	999 834	154 932	844 902
Improved conditions	1 499 751	174 478	1 325 273

This is based on the following net income per animal.

Table 3 Net income per animal

Unimproved		
Cattle	Sheep	Goats
1520	358	258

It is not possible to translate Table 3 directly to an average household income across Sinxaku because it is not known how many people own stock and in what numbers. Table 4 gives the predicted incomes for the stock owners who attended the January workshop. Income under improved conditions assumes that the number of stock increases by 50% in line with improved rangeland condition. The figures assume that all stock owners follow the same offtake figures, which is not realistic. There is a wide range of income depending on stock numbers and composition. Income will also vary year by year depending on rainfall.

Table 4 Annual income by livestock owner, Upper Sinxaku

Stock numbers (present-day)				Annual income (R)	
Cattle	Sheep	Goats	LSUs	Unimproved conditions	Improved conditions
7	67	34	22.2	43 423	65 135
0	11	7	2.7	5 747	8 621
0	0	6	0.9	1 549	2 324
3	12	20	7.8	14 025	21 037
2	21	18	7.9	15 211	22 816
27	22	16	32.7	53 081	79 622
0	0	16	2.4	4 131	6 196
12	12	15	16.1	26 424	39 636
4	95	30	22.8	47 856	71 784
4	0	28	8.2	13 313	19 970
15	10	50	24.0	39 307	58 961
0	0	15	2.3	3 873	5 809
9	0	15	11.3	17 563	26 344
2	0	30	6.5	10 787	16 181
4	7	15	7.3	12 464	18 696

Stock numbers (present-day)				Annual income (R)	
Cattle	Sheep	Goats	LSUs	Unimproved conditions	Improved conditions
11	0	15	13.3	20 605	30 908
7	0	37	12.6	20 200	30 300
0	0	15	2.3	3 873	5 809
12	50	16	21.9	40 293	60 439
5	0	0	5.0	7 606	11 409
Average				20 067	29 347

4.2 Financing

4.2.1 Use of funds

Funding is required to provide infrastructure (dipping tanks, handling pens, electric fencing, shearing sheds). The total is estimated at R300 000. Funding is also required in the first two to three years to employ eco-rangers (R230 000) to herd stock, for vaccinations and salt licks. Thereafter a levy per large stock unit that can be increased incrementally will contribute to annual costs until the system becomes fully sustainable.

4.2.2 Source of funds

Government departments responsible for rural development through agricultural innovation (e.g. DAFF, DRDLR).

Government Departments responsible for catchment rehabilitation (e.g. DEA); eco-ranger costs can be built in to the employment benefits of rehabilitation.

International funders through development aid.

4.3 Statement of annual income and expenditure

Table 5 Summary of costs, expenditure and income (unimproved conditions)

(Yellow cells indicate inputs that can be varied, blue cells are calculations based on inputs, purple numbers come from another spreadsheet and are based on the grazing capacity.)

	no.	price per unit	cows	sheep	goats	LSU
Stock numbers			299	740	959	554
START UP COST						
Electric kraaling cattle(R)	1	1 500	1 500			
Electric kraaling sheep (R)	1	2 500		2 500		
Electric kraaling goats (R)	1	2 500			2 500	
handling pens	1	7 500	7 500			
Shearing sheds	1	150 000		150 000		
dipping tank	1	no data				
watering points	6	no data				
Total			9 000	152 500	2 500	164 000
		Increase in capacity				
Grazing capacity LSU/ha	0.17	1				
ANNUAL COSTS						
veterinary costs	299	8	2 391			
additional year 1	740	4		2 960		
	959	4			3 838	
veterinary costs	299	8	2 391			
	740	4		2 960		
	959	4			3 838	
veterinary costs – young stock cattle	60	60	3 587			

veterinary costs – young stock sheep	148	60		8 881		
veterinary costs – young stock goats	192	60			11 514	
salt licks	4	120	480	480	480	
shearing (annual)	740	8		5 921		
branding (cattle)	299	no data				
herders annual wage	4	28 600	61 744	22 930	29 727	114 400
TOTAL ANNUAL COST						
Annual cost year 1			70 594	44 132	49 396	164 122
Annual year 2…n			68 202	41 172	45 558	154 932
Cost per LSU			280			
Cost per animal			280	42	42	
ANNUAL INCOME						
offtake	0.20					TOTAL INCOME
cattle	60	9 000	538 073			
sheep	148	1 000		148 018		
goats	192	1 500			287 840	
wool	740	200		148 018		
TOTAL			538 073	296 036	287 840	1 121 949
Income per stock unit			1 800	400	300	
Net income per stock unit			1 520	358	258	967 017

Table 6 Summary of costs, expenditure and income (improved conditions)

(Yellow cells indicate inputs that can be varied, blue cells are calculations based on inputs, purple numbers come from another spreadsheet and are based on the grazing capacity.)

	no.	price per unit	cows	sheep	goats	LSU
Stock numbers			448	1 110	1 439	831
START UP COST						
Electric kraaling cattle(R)	1	1 500	1 500			
Electric kraaling sheep (R)	1	2 500		2 500		
Electric kraaling goats (R)	1	2 500			2 500	
handling pens	1	7 500	7 500			
Shearing sheds	1	150 000		150 000		
dipping tank	1	no data				
watering points	6	no data				
Total			9 000	152 500	2 500	164 000
		Increase in capacity				
Grazing capacity LSU/ha	0.26	2				
ANNUAL COSTS						
veterinary costs	448	8	3 587			
additional year 1	1 110	4		4 441		
	1 439	4			5 757	
veterinary costs	448	8	3 587			
	1 110	4		4 441		
	1 439	4			5 757	
veterinary costs – young stock cattle	90	60	5 381			
veterinary costs – young stock sheep	222	60		13 322		

veterinary costs – young stock goats	288	60			17 270	
salt licks	4	120	480	480	480	
shearing (annual)	1 110	8		8 881		
branding (cattle)	448	no data				
herders annual wage	6	28 600	92 615	34 395	44 590	171 600
TOTAL ANNUAL COST						
Annual cost year 1			105 650	65 959	73 854	245 463
Annual year 2…n			102 063	61 518	68 097	231 678
Cost per LSU			279			
Cost per animal			279	42	42	
ANNUAL INCOME						
offtake	0.20					TOTAL INCOME
cattle	90	9 000	807 109			
sheep	222	1 000		222 027		
goats	288	1 500			431 760	
wool	1 110	200		222 027		
TOTAL			807 109	444 055	431 760	1 682 924
Income per stock unit			1 800	400	300	
Net income per stock unit			1 521	358	258	1 451 246

Appendix C: Water Harvesting Handbook

Umdibaniso wobuchule obbahlukahhlukeneyo wokuqokelela amanzi emvula kwindawo ebaleka amanzi isuku ku

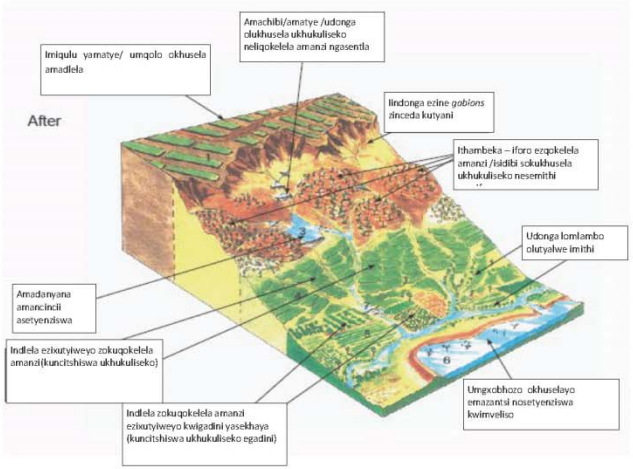
Compiled by Laura Conde-Aller
Translation by Monde Ntshudu

Water Harvesting and conservation methods

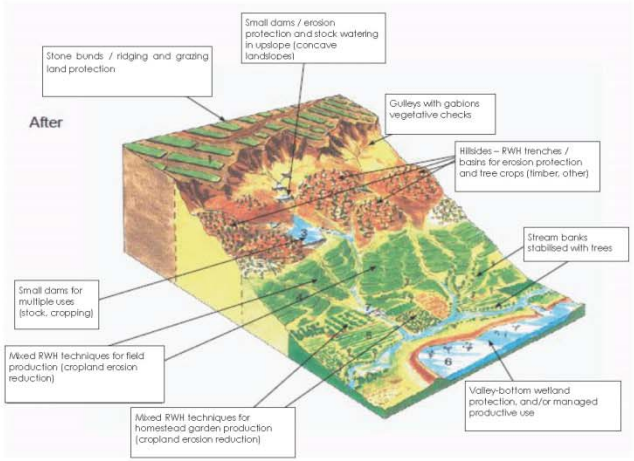
2017

Material presented in this handbook is based on Denison, J., Smulders, H., Kruger, E., Ndingi, H. and Botha, M. (2011). Development of a Comprehensive Learning Package on the application of water harvesting and conservation . WRC Report No.493/11. Water Research Commission. Gezina. Pretoria.

Umdibaniso wobuchule obahlukahlukeneyo wokuqokelela amanzi emvula kwindawo ebaleka amanzi isuka ku



Water Harvesting & Conservation Methods



Inkcazelo Ngokuqokelela Amanzi Emvula

- "...ukuziswa, ukuqokelelwa, nokugcinwa kwamanzi emvula abaleka emhlabeni. La manzi angenzelwa ukuselwa ngabantu, angasenziselwa izinto zendalo kuquka nakwimveliso njengokulima" (Oweis et al., 2001).

- Kukho ezizinto zilandelayo Kuqokelelo Lwamanzi Emvula (Kahinda et al., 2008):
  - i***catchment*** indawo apho amanzi aqokelelwa khona. Isenokuba luphahla lwendlu, indledlana, indlela, nethafa, njl.njl.
  - **Indawo yokugcina** into okanye indawo apho amanzi aqokelelwe emvuleni agcinwa khona. Indawo yokugcina isenokuba ngaphezo okanye ngaphantsi komhlaba.
  - **Indawo aqokelelwa yona** le yindawo la manzi azakusetyenziselwa kuyo. Le ndawo isenokuba ngumzi, igadi, izityalo, imfuyo, ushishino njl.njl.
  - Ukwenza inkqubo **Yokulawula** ukuqokelelwa amanzi emvula.

- Xa oku kusenziwa, ukuqokelela amanzi emvula kubandakanya indlela yokuthi amanzi
  a) *uwajike* okanye uwabambe;
  b) *uwacothise* ukwenzela angahambi nento yonke le ephambi kwayo;
  c) *ukuwasa* apho ufuna aye khona; uwa
  d) *gcinele* ukuwasebenzisela emhlabeni, ngaphantsi kwawo okanye kwitanki nokuba ngamagubu (DWAF, 2010).

Water Harvesting & Conservation – Definition and Features

- "...the concentration, collection, storage and use of rainwater runoff. RWH can be developed for human consumption, environmental purposes and a number of productive activities such as agriculture".

- RWH has the following components:
  - A **catchment** area where water is harvested. It can be a rooftop, path, road, communal land, etc.
  - A **storage** facility or conveyance system where water harvested in the catchment area is stored. The storage can either be a reservoir (surface and subsurface water infrastructure), the soil profile, etc.
  - A **targeted** area where the harvested water is used. The targeted area can be households, crops, plants, animals, enterprise, etc.
  - The **management** of the RWH systems created.

- In practice, RWH involves applying methods and techniques in a way that water is
  a) *intercepted* or captured;
  b) *slowed down* so it doesn't flush away everything in its path;
  c) *channeled* to where it is needed; and
  d) *stored* for use either directly into the soil profile, groundwater or/and in tanks or containers.

iForo Ejika Amanzi

Zisetyenziswa	
Eziga dini	✓
Emasimini	✓
Emadlelweni	

Iforo ejika amanzi ithatha amanzi kwindonga, kumathafa okanye kumhlaba oqinileyo (njengendlelana okanye iindlela) iwase kwindawo elinyiweyo okanye kwindawo yokugcina amanzi njengentanki. Ukuba le foro yokujika amanzi ikwindawo ehanjwa kakhulu ngabantu, inokugaleiwa uhlalutyi njengamatye amancinci ukuze abanto bangatyibiliki kuyo.

Ifoto 1 Iforo ejika amanzi iwasa kwidanyana

Ifoto 2 Iforo ejika amanzi iwasa kwibhedi zemiseleni

Ifoto 3 Iforo ejika amanzi iwasa kwibhedi zemisele

UKUCEBELA UKUYENZA

Umhlaba	Thambeka	Imvula	Izntozokusebenza kunye nezixhobo
Noba ngumhlaba onjani Apho umhlaba kulula ngawo ukukhukuliseka, okanye uthambeke kakhulu, le foro ijika amanzi kufuneka ingathambeki kakhulu ukuze umhlaba ungakhukuliseki	Naliphi na Ithambeka Kwindawo ezithambeke kakhulu, kufuneka inkathalo ukuze kunqandwe ukhukuliseko lomhlaba	Nayiphina Imvula Kwindawo ezina imvula kakhulu, kufuneka kubekwe imilanganiselo yokunqandwa kokhukuliseko lemvula	Umhlakulo, izinti ezincinci nomtya we Freyimi ka-A

Diversion Furrows

also called:	used in:	
• feeder channels • trenches • run-on ditches • ex-field RWH	gardens	✓
	fields	✓
	grazing land	

A ***diversion furrow*** directs rainwater runoff from gullies, grasslands or hard surfaces (such as paths or roads) to a cropped area or to a storage tank. If a diversion furrow is in an area of heavy foot traffic, it can be filled with a porous material such as gravel so that it does not become a tripping hazard.

Figure 1 Diversion furrow leading to a catchpit

Figure 2 Diversion furrows leading to trench beds

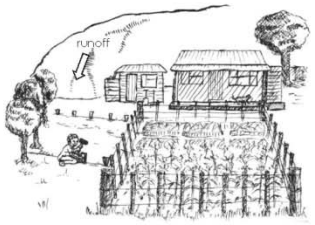
Figure 3 Diversion furrow leading to a trench bed

PLANNING

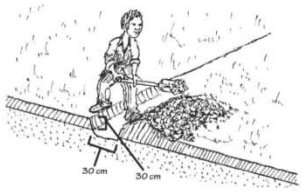
Soil	Slope	Rainfall	Tools & Equipment
Any soil. Where soils are easily erodible or hillside slopes are steep, the diversion furrow should slope gently downwards so as to avoid erosion.	Any slope. On steeper slopes, care must be taken to prevent erosion.	Any rainfall. In higher rainfall areas, measures to prevent erosion may be needed.	spade pegs and string A-frame

INDLELA YOKUYENZA

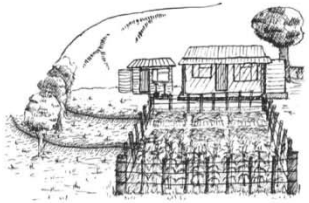
1. Jonga emhlabeni njengoko imvula isina ukuze ubone apho abaleka khona amanzi emvula, uze uthathe isigqibo sokuba ngawaphi amanzi ofuna ukuwajika. Phawula indlela azakuyihamba la manzi xa uthe wawajika mhlambi uwasa egadini, emasimini okanye kwitanki yemvula.



2. Rhumba umgxuma onokuba zisentimitha ezi-30 ububanzi ne-30 ubunzulu. Wubeke umhlaba kwicala elisezantsi lethambeka leforo.

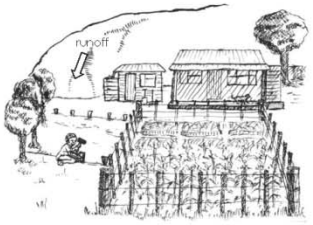


3. Qiniseka ukuba iforo yakho ikhokelela kwindawo ofuna amanzi emvula aye kuyo emasimini okanye egadini. Kwimeko yetanki, iforo yakho izakuthumela amanzi emvula kumgxunyana ozakkuthi wona ubambe umhlaba nezinto ezimdaka ukuze zingangeni etankini.

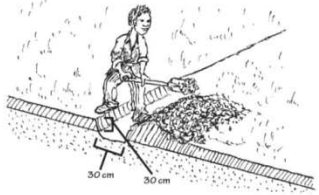


METHOD

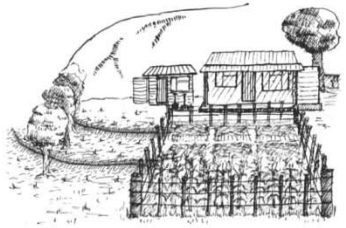
1. Look at the ground when it rains to see where the storm water runs, and decide which of this water you want to divert. Mark out a route for your furrow which will intercept this water and carry it to the garden, field or storage tank.



2. Dig a trench approximately 30 cm wide and 30 cm deep. Place the soil on the downslope side of the trench.



3. Ensure that the furrow leads into the rainwater harvesting method being used in the field or garden. In the case of a tank, the furrow will typically lead into a small catchpit which traps sediment and debris so that it does not enter the tank (see Figure 1).



Ibhedi Eziyimisele

Zisetyenziswa	
Ezigadini	✓
Emasimini	
Emadlelweni	

Ibhedi eziyimisele zidala umhlaba otyebileyo kakhulu ethambileyo omfumamfuma kwaye uyakwazi ukugcina ukufuma. Imisele isoloko isetyenziswa kunye nemijelo ezisa amanzi (iforo ezithwala amanzi) ezibangela amanzi ahamba kwiindledlana nakwindlela aye kwimisele eyenziweyo.

Umhlaba oginileyo/indlela

iiforo/imisele ezisa amanzi

UKUCEBELA UKUYENZA

Umhlaba	Thambeka	Imvula	Izntozokusebenza kunye nezixhobo
Imisele yeneye yendlela ezimbalwa zokutyala ukutya xa umhlaba wakho unamatye umbi kwaye ungenakuwugrumba ub nzulu. Nakubeni imisele inokuphucula umhlaba, imisele imeleyenziwe apho izinto ezityaliweyo zinokukhula khona.	Ukuba iploti isethambekeni, ubude bomsele bumele busoloko buhambelana nekhonto (bunqamleze ithambeka) oku kukhusela umhlaba ukuba ungakhukuliseki Xa ithambeka livuma, ubude bomsele bumele buqale empuma ukuya entshona	Ilungele zonke iindawo ezifumana imvula. Kwindawo ezomileyo, ukunkcenkceshelw a kwayo kuzakuba yimfuneko. Kwindawo apho imvula ixhaphakileyo khona, ukusetyenziswa kwemisele ezisa amanzi kumele kuliganiselwe	Umhlakulo,Ifolokhwe,umtya , ipali encinci,izinto ezibolayo, umgquba, ikiriva

Trench Beds

also called:	used in:	
• deep trenching • trench bed gardening • fertility trenches	gardens fields	✓

Trench beds create highly fertile soils which are soft and loamy and have a very high moisture-holding capacity. Trench beds are often used in combination with feeder channels (diversion furrows), which enable runoff from hard surfaces such as paths and roads to run into the trenches.

Figure 4 Trench beds in a vegetable garden

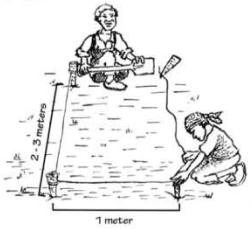
hard surface / roadway

furrows/feeder channels

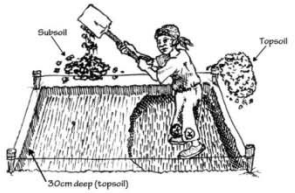
PLANNING

Soil	Slope	Rainfall	Tools & Equipment
Trenches present one of the few options for growing food when you have very shallow, poor or rocky soils. Although trenching will improve any soil, trenches should be placed where the soil is best for growing vegetables.	If the plot is on a slope, the length of the trenches should always be along the contour (i.e. across the slope) to prevent the soil being washed away by rain. Where slopes allow, the length of the trenches should run from east to west.	Suitable for all rainfall areas. In dry areas, additional watering of plants will be required. In high rainfall areas, the use of feeder channels may need to be limited.	spade fork string sticks organic material compost wheelbarrow

INDLELA YOKUYENZA



1. Khetha indawo efanelekileyo yokutima izinto zakho kwaye ususe onke amatye, amahlahla okanye ingca. Zigcine ezi zinto ogqiba ukuzisusa ukuze uzisebenzise ekuvaleni imsele yebhedi zakho nsakufumeni.

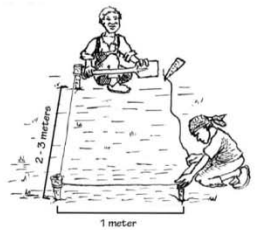


2. Phawula ibhedi zakho zemisele usebenzisa izinti okanye umtya. Ibhedi yakho isenokuba nde kangangoko kodwa ayimele ibe banzi ngaphezi kwemitha e-1 ukuze igadi yakho ibe nendledalan. Ibhedi yomsele wakho efanelekayo imeleibe nobubanzi obuyimtha e-1 nobude obuphakathi kwemitha ezi-2 ukuya kwezi-3.

3. Susa lomhlaba ulapha phezulu(kangange sentimitha ezingama-30) uze uwubeke ecaleni kwale ndawo uyigrumbileyo. Phnda ugrumbe lo ungaphantsi umhlaba de umsele wakho ube yimitha e-1 ubunzulu nawo lo mhlaba uwubeke kwelinye icala le bhedi. Sukudibanisa lo mhlaba ubuwukhuphe kuqala nalo uwukhuphe emva.

4. Sebenzisa ifolokhwe ukuze wemze umhlaba okumsele ezantsi ungabambanani. Beka izinto ezibolayo emazantsi uze ugqume kangange centimitha ezili-10 ngomhlaba ubuwukhe emva kowokuqala. Sebenzisa ifolokhwe ukuxuba yonke into osele uyigalele, ze ugalele amanzi kakuhle.

METHOD



1. Choose a place suitable for growing vegetables and clear the ground of any rocks, bushes and grass. Keep this plant material to use for mulching and filling trench beds.

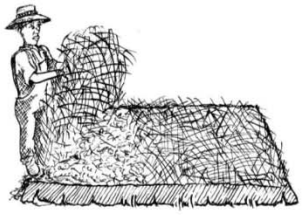
2. Mark out the trench bed using sticks and string. The bed can be any length but should not be more than 1 metre wide so that all gardening can be done from the pathway. A good size for a trench bed is 1 m wide by 2-3 m long.

3. Dig out the **topsoil** (about 30 cm deep) and place it on one side of the bed. Then dig out the **subsoil** so that the trench is 1 metre deep and place it on the other side of the bed. Do not mix the topsoil with the subsoil.

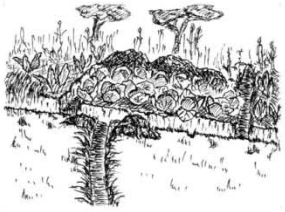
4. Use a garden fork to loosen the ground at the bottom of the trench. Put a 20 cm layer of coarse organic material at the bottom and cover it with about 10 cm of subsoil. Use a fork to mix these layers together, and water well.

5. Qhubeka usongeza izinto ezibolayo (kanganga sentimitha ezingama-20) nomhlaba owukhe emva kowokuqala (kanganga sentimitha ezili10) de umsele wakho uzale. Qho ugqiba ukongeza ngkwesentimitha ozixelweyo nkcenkceshela ngamanzi.

6. Thatha la mhlaba buwukhuphe kuqalauwubeke ngaphezulu komsele. Ukuba unawo umgquba yongeza ngawo kulo mhaba wangaphezulu uze uwuxubisise kakuhle(mayibe zibhakethi ezi-ukuya kwezi-3 ngomsele) Sebenzisa iharike okanye into esicaba ukwenza ibhedi ibe sicaba.



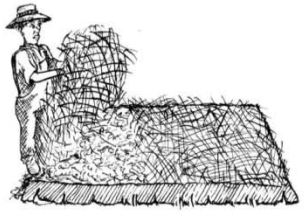
7. Gquma ibhedi ngezinto ezifumisayo uze uyiyeke kangangeveki okanye ezi-2 phambi kokuba utyale kuyo. Ukuba ufuna ukutyala ngokukhawuleza kuyo, yongeza umgquba weenkuku kwibhedi) ibe yilitha e-1 yomgquba ngebhedi ukuze unyuse umkhhamo wenatrogini emhlabeni.



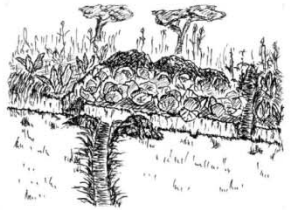
8. Grumba iforo ezizakuzisa amanzi(ingabi yimisele enzulu) yigrumbe kwindawo eziqinileyo njengendledlana kunye nendlela zisiya kwibhedi zemisele ukuze imisele ifumanae imvula xa kunetha.

5. Continue adding layers of organic material (approximately 20 cm)and subsoil (10 cm) until the trench is full. Water each layer well.

6. Place the topsoil on top of the trench. If you have compost or manure, add this to the topsoil and mix it together well (2-3 buckets per trench). Use a rake or flat piece of wood to make the bed flat.



7. Cover the bed with a layer of mulch and leave for a week or two before planting. If you want to plant immediately, add chicken manure to the bed (1 litre of manure per bed) to increase the nitrogen content of the soil.



8. Dig diversion furrows (shallow trenches) from hard surfaces such as paths and roads to the trench beds so that the trenches will receive runoff when it rains.

Ukufumisa Umhlaba

Zisetyenziswa	
Ezigadini	✓
Emasimini	✓
Emadleiweni	

Ifoto 4 Izinto ezifumisayo zibekwe phezu kwebhedi yeztyalo

Ukugcina ukufuma luqheliselo lokusasaza izityalo nezinye izinto ezibolayo njengomgquba, isivundisi, amagqabi nengca eyomileyo, nentsasa zenkuni phezu komhlaba, oku kudla ngokwenziwa kwindawo enezityalo ezininzi.

Ukufumisa konga amanzi, amanzi ayangena aze ahlale akakhawulezi ome emhlabeni. Ukufumisa kukhusela umhlaba kukhuliseko, kunciphisa amandla amathontsi emvula abetha emhlabeni, kugcina amaqondo ubushuhu bomhlaba elingana, kukwakhusela nokuphuma kwekhula.

Ifoto 5 Ingca yokufulela ingasetyenziswa ekufumiseni

Njengoko ukufumisa kuyakubola kwenza umhlaba utyebe. Oku kuphucula ukukhula kwengcambu, kunyusa umkhamo wokungena kwamanzi emhlabeni kuphucule namandla omhlaba okugcina amanzi. Izinto ezibolayo zingumthombo wesondlo kwizityalo kwaye zivula amathuba amahle okuba imibungu nezinye izirhubuluzi eziluncedo ziphile. Ngenxa yokuba imvula enkulu isenokukhukulisa ukufumisa, kudla ngokusetyenziswa nezinye indlela ukuncedisana nokufumisa azinjebhedi zeforo nemingxunya ekutyalwe izityalo kuyo.

UKUCEBELA UKUYENZA

Umhlaba	Thambeka	Imvula	Izntozokusebenza kunye nezixhobo
Noba ngumhlaba onjani. Kumhlaba oludongo okanye nawuphina umhlaba ekungelula ukungena kwamanzi kuwo, ukufumisa kufuneka kungabi ngaphezu kwe-10 cm.	Naliphi ithambeka	Nayiphi imvula	izinto ezibolayo (umzkl. Ingca eyomileyo, amagqabi umggquba, isivundisi, amaqokobhe eqandas) Ifolokhwe nekiriva

Mulching

used in:	
gardens	✓
fields	✓
grazing land	

Figure 5 Mulch placed on a plant bed

Mulching is the practice of spreading plant and other organic material such as compost, straw, manure, dry leaves, dry grass clippings and wood chips onto the surface of the soil, usually concentrated around plants.

Mulching conserves water by increasing infiltration and reducing evaporation. Mulch protects the soil from erosion, reduces compaction from the impact of heavy rains, maintains a more even soil temperature, and prevents weed growth.

Figure 6 Thatching grass can be used as mulch

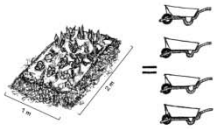
As mulch slowly decomposes it provides organic matter to the soil. This improves root growth, increases water infiltration and improves the water-holding capacity of the soil. The organic matter is also a source of plant nutrients and provides an ideal environment for earthworms and other beneficial organisms. Because significant runoff will wash mulch away, this method is almost always used in combination with other WHC techniques such as trench beds and planting pits.

PLANNING

Soil	Slope	Rainfall	Tools & Equipment
Any soil type. On clay soils or soils prone to waterlogging, mulching thickness should be limited to less than 10 cm.	Any slope.	Any rainfall.	organic material (e.g. dry grass, leaves, compost, straw, manure, egg cartons) fork wheelbarrow

INDLELA YOKUYENZA

1. Jonga le ndawo oceba ukuyifumisa qikelela ukuba ngumfumiso ongakanani owudingayo (malunga nekiriva ezi-2 kwiskwe mitha segadi).

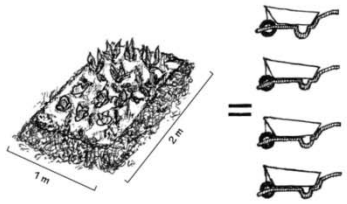


2. Qokelela izinto ezibolayo oceba ukuzisebenzisa ekufumiseni, uzisasaze kakuhle phezu komhlaba, uzijikelezise kwizityala uzifake naphakathi kwazo.

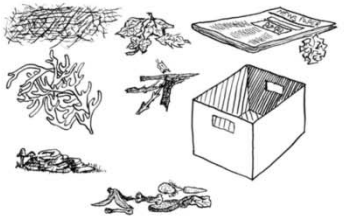
3. Xa ubeka isifumiso, qiniseka ukuba sikude kangangesentimitha ezimbalwa kwisiqu sesityalo ukuze ungalungiseleli indawo imibundana elutshaba lwezityalo.

METHOD

1. Look at the total area you plan to mulch and estimate how much mulch you need (about 2 wheelbarrows of mulch per square metre of garden).



2. Collect the organic materials you plan to use as mulch, and spread it carefully over the soil, around and between plants.



3. When placing the mulch, ensure that it is a few centimetres away from all trunks and stems so that you don't provide a place for insects or diseases to begin attacking the plants.

iSwales

Zisetyenziswa	
Ezigadini	✓
Emasimini	✓
Emadlelweni	

Iswales yindawo enomhlaba oqokelelweyo neyakhiwe ngokuhambisana nekhonto eneforo phezulu kwithambeka. Umphezulu womhlaba kulwe *swale* wenziwa sicaba ukuze kutyalwe. iSwale ijika amanzi emvula abalekayo, ize iwanabisele nakwezinye indawo lento inceda amanzi angene kakuhle emhlabeni. Le ndlela njengoko ichaziwe ngasentla yenzelwe kakhulu xa utyala izityalo kungekhona amadlelo. Ngokuqhelekileyo, izityalo ezithatha ixesha elide(njengemithi yeziqhamo) zidla ngokutyalwa apha ngezantsi kwalomgca we *swale*, ngoxa izityalo zexeshana(njengemifuno) zidla ngokutyalwa phakathi kwe *swale*. Ngokuhamba kwexesha imbewu kunye nezinto ezibolayo ziye zande apha kumntla we *swale*, lo nto ibangele imifuno ikhule, ntoleyo ebangela umnta we *swale* uzinze. Kanti, enye into umntla lo we *swale* unakho ukutyalwa izityalo eziphila ixesha elide njenge *comfrey, marigolds, nasturtiums* okanye ingca. Umntla lo we swale unako ungaphindeka kabini uze usetyenziswe njengendawo yokuhamba njengendleldlana.

Ifoto 6 iSwales zilungiselwe ukutyala

Ifoto 7 Imifuno ikhula kwiswale

UKUCEBELA UKUYENZA

Umhlaba	Thambeka	Imvula	Izintozokusebenza kunye nezixhobo
Nawuphina umhlaba. Xa umhlaba uyisanti, iswale imele ibe banzi okanye ivuleke. Kumhlaba oludongwe zinokuba nomphakamo zize zibe mxinwa kuba udonge ludibene kakuhle.	Malibe kwi 5 – 25%	iSwales kufuneka uzilumkele xa uzisebenzisa kwindawo ezinetha imvula kakhulu (imililitha ezili-1200 nangaphezulu) njengoko oku kunokubangela kudame amanzi ze kungalimeki.	Umhlakulo, iA-Frame, nezinti ezincinci

Swales

also called:	used in:	
• bunds • contour ridges • berm 'n basin • contour ditches	gardens	✓
	fields	✓
	grazing land	

A ***swale*** is an earth bank constructed along the contour with a furrow on the up-slope side. The top of the earth bank is levelled off to allow planting. The swale intercepts runoff, spreads it out and helps it infiltrate deep into the ground. The method as described here is used mainly for crop production and not pastures. Typically, permanent crops (e.g. fruit trees) are planted just below the ridge of the swale, while seasonal crops (e.g. vegetables) are planted between the swales. Over time, seeds and organic matter accumulate on the ridge of the swale, causing vegetation to grow, which stabilizes the ridge. Alternatively, the ridges can be planted with long-living plants such as comfrey, marigolds, nasturtiums or grasses. The ridge of a swale can also double as a raised accessway such as a footpath.

Figure 10 Swales prepared for planting

Figure 11 Vegetables growing on the swales

PLANNING

Soil	Slope	Rainfall	Tools & Equipment
Any soil. The sandier the soil, the thicker the swale should be. In clayey soil, swales can be a bit higher and narrower because the clay holds together well.	5-25%[22]	Swales should be used with caution in areas with high rainfall (1200 mm or more) as waterlogging can occur.	spade A-frame or line level pegs/stakes

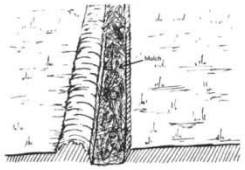
INDLELA YOKUYENZA

1. Yenza isigibo ngendawo ofuna ukutyala kuyo izityalo uze uphawule imigca yekhonto eshiyana phakathi kwayo ngemitha ezi-5. Ukuba ithambeka likekele kakhulu imigca ingenziwa isondelelane (kangangemitha ezi-3).

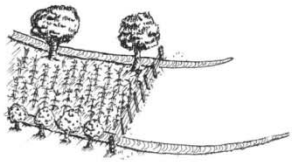
3. Sebenzisa umhlaba owugrumbileyo udale isiduli(sibe zisentimitha ezingama-30 ukuya kwezingama-40 ukuphakama ze sibe zisentimitha ezingama-50 ububanzi) kwicala elingezantsi le foro. Sebenzisa iA-Frame ukwenza umgangatho walapho isiduli siphela. Hamba phezu kwesiduli ugangathe umphezulu womhlaba ukuze umhlaba uqine.

5. Tyala izityalo ezihlala ixesha elide(umzki. Imithi yeziqhamo, namahlahla) kanye ngezantsi kwesiduli se *swale* tyala imifuno phakathi kwe *swale*. Ukuba yimfuneko, grumba iiforo eziziza amanzi okanye unabise *iswale* khonukze uzise amanzi ongezelelekileyo kule ndawo utyale kuyo.

2. Grumba iforo engekho nzulu apha ecaleni kwemigca yekhonto(ibe nobunzulu obuzisentimitha ezingama-30 ukuya kwama-4- uze ubeke umhlaba emazantsi kwethambeka leforo.



4.Zalisa iforo ngezinto ezibolayo(ezona zivunda msinya zibeke ngaphantsi).



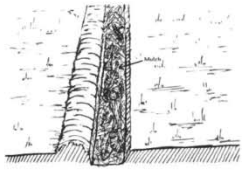
METHOD

1. Decide where you want to grow your crops and mark out contour lines which are 5 metres apart. If the slope is steeper the lines can be made closer (up to 3 m apart).

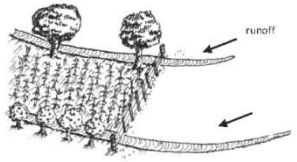
3. Use the soil you have excavated to create a ridge (30-40 cm high and 50 cm wide) on the downslope side of the furrow. Use an A-frame to make the top of the ridge level. Walk along the ridge and stamp on the soil to compact it.

5. Plant permanent crops (e.g. fruit trees and shrubs) immediately below the ridge of the swale and seasonal crops between the swales. If necessary, dig diversion furrows or extend swales to bring additional surface runoff into the planting area.

2. Dig a shallow furrow along each contour line (30-40 cm deep and 50 cm wide) and place the soil on the down-slope side of the furrow.



4. Fill the furrow with mulch (place the coarsest mulch at the base).



Appendix D: Rehabilitation Handbook

Healing our land for a better future

Ukuphilisa umhlaba wethu ukwakha ikamva elingcono

Ukuphilisa umhlaba wethu ukwakha ikamva elingcono

Healing our land for a better future

Text by Kate Rowntree

Photographs by Kate Rowntree and Jappie Buckle (pages 15 & 16)

Translation by Monde Ntshudu and Monde Duma

Catchment Research Group, Rhodes University

October 2017

Prepared as a contribution to Water Research Commission Project K5/2423

Improving socio-economic conditions of the Tsitsa river catchment and Okhombe communities through landscape greening and integrated green innovations

Preface

This manual has been compiled as a guide to assist rehabilitation efforts in the Tsitsa catchment and other similarly degraded areas. It is aimed at community members and other stakeholders who would like to understand why land degradation occurs and to learn some of the ways that degradation can be addressed by active interventions. Most examples given are based on current conditions and activities prevailing in and near the Sinxaku villages in which the WRC project was based. It is hoped that the manual will give those involved in the day-to-day rehabilitation activities on the ground some insight into the reason for the work that they are assisting with. Those who use the land should understand better why they need to respect and protect rehabilitated areas. It is not aimed at officials guiding such activities. More technical manuals are available for this purpose.

Kate Rowntree
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Isikhokelo

Le ncwadana incedisa ukunika ingcaciso malunga nokuvuselela ezo ndawo ezikhukulisekeliyo kwezo ndawo zentili yaseTsitsa, kwakunye nezinye iindawo ezifana nayo. Le ncwadana izama ukuncedisana noluntu nabanye aba bandakanyekayo ukucacisa ukuba kutheni umhlaba uphulukana nokuvelisa, kwaye iyintoni enokwenziwa ukulwisana noko. Imizekelo esetyenziswe kule ncwadana ibonakalisa oko kwenzekayo eSinxaku. Sithemba ukuba le ncwadana ingakwazi ukukhokela ukubeni abo basephulweni bezama ukuvuselela umhlaba oqobekileyo bafunde ukuba zeziphi izinto ezinokwenziwa ukuncedisana nomhlaba ukuze ukuvuseleleke. Le ncwadana ke izama ukubaxhobisa ngenkcazelo yokwenzekayo ukuze kuphuhle ukuqonda kakuhle lo msebenzi bawenzayo. Abantu abasebenzisa umhlaba kuyimfuneko ukuba bazi ukuba kubalulekile ukuba bahloniphe kwaye bakhusele ezondawo zazikhukulesekileyo zaze zavuselelwa. Le ncwadana yenzelwe uluntu kuphela, hayi amagosa azingcaphephe okuvuselela umhlaba.

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What is land degradation?

- a reduction in the productivity of the land, crops are poor and livestock less healthy
- the land can support fewer people
- soil erosion causes land degradation

What is soil erosion?

- soil is washed from the land surface by flowing water
- streams cut into the hillslope to form dongas
- underground tunnels collapse to form dongas

Why is erosion a problem?

- fertile soil is lost
- seeds are lost
- fertiliser is lost

Why are dongas a problem?

- dongas take away land
- dongas are a danger to livestock and children
- dongas make it difficult to drive or walk across the land
- dongas dry out the soil next to them

1

Kuyintoni ukonakala/ukomoshakala komhlaba?

- Kuxa ukuchuma komhlaba kwehlile kukhokelele kwizityalo nesivuno esibuthathaka, kwanemfuyo engekho mpilweni (ebuthathaka)
- Kuxa umhlaba uxhasa abantu abambalwa ngenxa yokwehla kokuchuma
- Ukhukuliseko lomhlaba lwehlisa ukuchuma komhlaba

Luyintoni ukhukuliseko-mhlaba?

- Kuxa umhlaba ukhukuliswa ngamanzi emvula aqukuqelayo
- Amanzi aqukuqelayo emathambekeni agrumba iindongaa
- Imisele engaphantsi komhlaba iyadilika kwenzeke iindonga

Kutheni ukhukuliseko-mhlaba luyingxaki?

- Umhlaba ochumileyo umka namanzi
- Iimbewu nazo ziyemka namanzi
- Izivundisi mhlaba nazo ziyemka

Kutheni iindonga ziyingxaki?

- Iindonga zicutha umhlaba osebenzisekayo
- Ziyingozi kwimfuyo nakubantwana
- Ngenxa yokuba apho zikhona kukho imihonyo, kubanzima ukuhamba-hamba okanye uqhube imoto apho zikhona
- Iidonga zifunxa amanzi kumhlaba ongqonge zona

2

What causes erosion?

Heavy rain falling on hard soil cannot soak in so it runs off as a sheet of water.

Runoff from roads carries soil with it

Runoff from the hill slopes collects in dongas and flows as a fast moving stream that can erode the banks.

Lwenziwa yintoni ukhukuliseko-mhlaba?

Imvula enamandla newela kumhlaba owomileyo ayikwazi kungena kuwo ngoko amanzi athi aqukuqele ngaphezulu

Amanzi abaleka ezindleleni akhukulisa umhlaba

Amanzi abaleka emathambekeni naqokelelana ezindongeni aze abaleke ngamandla njengomlanjana anokukhukulisa amadonga omlanjana

Why do livestock cause erosion?

- they reduce the vegetation cover so that there is more bare soil and increased runoff
- they follow tracks that become hard and turn into water ways
- they can compact the surface of the soil, making it hard for water to soak in

How can grazing management reduce erosion?

- livestock can be kept off an area of land for some time to allow the grass to grow back and protect the surface
- grazing for shorter periods encourages the grasses to grow thicker
- animals should be stopped from using the same paths all the time
- animal tracks can be managed so that runoff is better controlled

Kutheni imfuyo ibangela ukhukuliseko-mhlaba?

- Zinciphisa utyani olugqume umhlaba, zenze umhlaba ube ze, oku kwenze amanzi aqukuqele kumhlaba oze
- Zilandela iindledlana zazo eziye ziqine zibe yimijelo yamanzi
- Zigangatha umhlaba, ziwenze uqine ungakwazi ukufunxa amanzi

Lungakunciphisa njani ukhukuliseko-mhlaba ulawulo lwamadlelo?

- Imfuyo isenokugcinwa kude kwindawo yomhlaba othile kuvunyelwe ingca ikhule ukukhusela umhlaba
- Kusevunovunyelwa imfuyo itye okwexeshana elifutshane oko kuzakunceda ingca ikhule ize yomelele
- Imfuyo imele inqandwe ekusebenziseni umgaqo omnye wendlela ngalo lonke ixesha
- Iindledlana ezivulwa zinkomo zinokulawulwa ukuze amanzi emvula angenzi unothanda

How can we stop erosion?

- add compost and manure to fields
- increase the vegetation cover
- use erosion control structures

Why add compost & manure?

- adds nutrients
- keeps moisture in the soil for longer
- reduces the rate of erosion

Why increase the vegetation cover ?

- protects the soil surface from erosion processes
- helps water to soak into the soil
- reduces surface runoff
- makes the soil stronger

How can we increase the vegetation cover?

- control livestock grazing
- sow grass seeds
- plant vetiver, aloes, reeds

- A cover of straw or other plant material can also be used to protect the soil

Singaluqanda njani ukhukuliseko-mhlaba?

- Ngokugalela umgquba nesivundisi kumasimi akho
- Ngokukhulisa utyani olwaneleyo okanye ingca ukugquma umhlaba
- Ngokusebenzisa imiqobo yokunqanda ukhukuliseko-mhlaba

Kutheni kufuneka uchumise ngezivundisi nomgquba nje?

- Zongeza izondlo emhlabeni
- Zigcina umhlaba ufumile ixesha elide
- Zehlisa izinga lokhukuliseko-mhlaba

Kutheni kufuneka kukhuliswe utyani olwaneleyo ukugquma umhlaba?

- Utyani okanye ingca zikhusela umhlaba kukhukuliseko-mhlaba
- Zinceda umhlaba ukwazi ukufunxa amanzi
- Zinciphisa ukubaleka kwamanzi
- Ingcambu zotyani zomeleza umhlaba ngokuwuhlanganisa ube luqilima

Singalukhulisa njani utyani okanye ingca ukugquma umhlaba?

- Ngokuqingqa amadlelo emfuyo
- Ngokutyala imbewu zengca
- ngokutyala ingca eyi*vertiver*, amakhala, imizi, njalo njalo.
- Ukusebenzisa iindiza ukugquma umhlaba okanye ezinye izityalo ukukhusela umhlaba kukhukuliseko-mhlaba

What are erosion control structures?

- ponds and swales
- barriers
- blankets
- re-sloping
- large structures

Digging ponds

Grass growing in a pond

A newly dug swale in a garden to be sown with maize or vegetables

Why do we use ponds and swales?

- they trap water flowing down the slope
- they reduce erosion downslope of the pond or swale
- they increase soil moisture in the pond or swale
- they increases plant growth
- grass seeds should be sown in ponds or below swales
- trees can be planted
- DO NOT use in dispersive soils

Vetiver growing downslope of a swale

Yintoni imiqobo esetyenziswayo ukunqanda ukhukuliseko-mhlaba?

- Amachibi okanye amadanyana kunye nemijelo ethomalalisa ukubaleka kwamanzi *(swales)*
- Imiqobo yokunqanda ukhukuliseko-mhlaba
- Ingca okanye iindiza zokugquma umhlaba (blankets
- Imiqobo emikhulu

Ukugrumba amadanyana okanye amachibi

Ingca ikhula kwichibi okanye idanyana

Umjelo osandula ukugrunjwa egadini ezakufakwa imbewu yombona

Kutheni sisebenzisa amachibi okanye amadanyana kunye nemijelo (*swales*)?

- Zibamba amanzi ahla ngethambeka
- Zinciphisa ukhukuliseko-mhlaba emazantsi echibi okanye indanyana nomjelo *(swales)*
- Zandisa ukufuma komhlaba kwichibi okanye idanyana nakumjelo *(swales)*
- Zandisa ukukhula kwezityalo
- Imbewu yengca imele ityalwe kumachibi okanye amadanyana nasezantsi kumjelo *(swale)*
- Imithi isenokutyalwa

i*Vetiver* ikhula emazantsi omjelo (swale)

What are barriers?

- silt fences
- sausages
- stone lines and stone packs

Why do we construct barriers?

- they trap soil and water above the barrier
- they reduce erosion downslope of the barrier
- they increase soil moisture at the barrier
- they increase plant growth at the barrier
- grass seeds should be sown above the barrier
- vetiver or aloes can be planted along the barrier to make it last longer

A silt fence traps soil and helps plants grow

A stone pack stabilising a donga headcut

A stone line traps soil in a shallow donga

Zintoni izinto ezingaba zizithinteli okanye imiqobo?

- Imiqobo ebamba ohlalutye lomhlaba
- Isausages
- Isivevane samatye – Udonga olukhiwe ngamatye (*stone lines and packs)*

Kutheni sisakha imiqobo okanye izithinteli?

- Zibamba umhlaba namanzi ngentla komqobo lowo
- Zinciphisa ukhukuliseko ngezantsi komqobo lowo
- Zandisa ukufuma komhlaba kwindawo enomqobo lowo
- Zandisa ukukhula kwezityalo kwindawo enomqobo lowo
- Imbewu yengca imele ityalwe ngasentla komqobo lowo
- I*vetiver* okanye amakhala asenokutyalwa ecaleni komqobo ukuze sihlale ixesha elide

Icingo lohlalutyi lomhlaba libamba umhlaba kwaye linceda izityalo zikhule

Udonga olwakhiweyo lunceda ukunqanda iindonga zingandi

Umqobo wamakhala unceda ukubamba okanye ukuqinisa umphezulu wedonga leendonga

What is a blanket?

- an open-weave cloth or cover of branches (brush pack)placed over an area of bare soil
- protects the soil from heavy erosive rain
- used to protect gullies that have been re-sloped
- soil surface is first loosened and grass seeds planted before being covered
- blankets are often used with other structures

Hessian blanket protects exposed soil

Brush pack and silt fence stabilise a shallow donga

Brush pack and silt fences in a reshaped donga

Mulch provides a protective blanket in a vegetable garden

Brush pack and silt fences alongside a road

Yintoni le ngxowa (blanket)?

- Lilaphu elinemingxunya, amahlahla okanye iindiza ezigquma kwindawo enomhlaba oze
- Ikhusela umhlaba kwimvula ezinkulu nezikhukulisayo
- Isetyenziswa ukukhusela iindonga ezidilizwe zalaliswa
- Umhlaba wenziwa uthambe ze kutyalwe imbewu yengca ngaphambi kokuba ugqunywe
- Ezi ngubo zisoloko zisetyenziswa neminye imiqobo

ihessian blanket ikhusela umhlaba ongagqumekanga

Amahlahla apakishiweyo nocingo lohlalutye lomhlaba kwiindonga eziphinde zalungiswa

Amahlahla apakishiweyo kunye nodonga lwamatye ziqinisa iindonga ezingenzulu

Amahlahla apakishiweyo kunye nocingo lohlalutye lomhlaba ecaleni kwendlela

What is re-sloping?

- the steep walls of a donga are reshaped to give a gentler, more stable slope
- re-sloping is used in small to medium size gullies used to protect gullies
- the reshaped walls must be protected to prevent erosion
- grass seed should be planted on the new slopes
- the floor of the donga is protected using blankets and silt fences

Re-sloping a small donga. The side walls and head cut are dug away to give gentler slopes. The widened donga is protected with a blanket and silt fence.

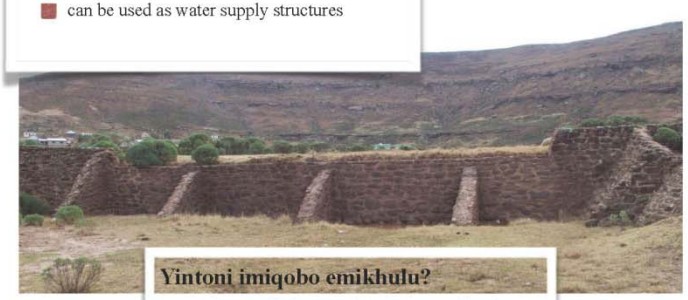
Yintoni uthambekiso-mhlaba?

- Ukudilizwa kweendonga ukuzama ukunciphisa ukuthambeka okugqithileyo
- Oku kwenziwa kwezo ndonga zingekho nkulu kakhulu.
- Zithi xa zidiliziwe, umhlaba lowo ukhuselwe kukhukuliseko ngokutyala ingca
- Umhlaba othambekileyo ugqunywa ngale ngxotyana enqanda ukhukuliseko.
- Umfuleni weendonga kuye kufakwe isihluzi-mhlaba - ingxotyana enqanda ukhukuliseko-mhlaba (ihluza amanzi ibambe umhlaba ukuze kukhule kuwo ingca).

Udilizo-ndonga lokunciphisa ukuthambeka kwendonga engekho nkulu. Iindonga ziyezigrunjwe, zidlilzwe uze umhlaba usasazwe ukunciphisa. Kuthi kwakugqitywa ke apho umhlaba wambathiswe ngxowa ekhusela ukhukuliseko.

What are large structures?

- placed in larger dongas to trap soil
- need an Environmental Impact assessment
- need skilled labour
- cost a lot of money to build
- can't afford to build many
- must be looked after once build
- wetlands and grazing areas can form upstream
- can be used as water supply structures



Yintoni imiqobo emikhulu?

- zenziwa kwiindonga ezinkulu ukuze zibambe umhlaba
- ngokomthetho kufuneka kwenziwe Uhlolo Lwendlela Indalo Ezakuchaphazeleka ngayo
- kufuneka abasebenzi abanobuchule
- zibiza imali eninzi ukuzenza
- akukwazeki ukuzakha zibeninzi
- zimele zinyamekelwe emva kokuba zakhiwe
- imigxobhozo nendawo zokudla imfuyo zingadaleka ngasentla kwale ndawo
- zingasetyenziswa njengendawo zokubonelela ngamanzi

How do we look after erosion control structures?

- ☑ Keep livestock away until a good vegetation cover had grown back.
- ☑ Keep fires under control; don't start fires near silt fences, sausages or blankets.
- ☑ Don't damage any structures or take away any materials.
- ☑ Report any damage that you see to the rehabilitation work team.

Siyinyamekela njani imiqobo eyakhiwe ukunqanda ukhukuliseko lomhlaba?

- ☑ Imfuyo mayityele kude kuzo, de ingca ibe kanti ikhule kakukhle.
- ☑ Lawula umlilo wamadlelo; sukuqala umlilo kufuphi nendwao enocingo lohlalutyo lomhlaba, i*sausage* okanye iingubo.
- ☑ Musa ukonakalisa le miqobo okanye uthathe nantoni na (musa ukuphatha.
- ☑ Xa uthe wabona umonakalo okhoyo nokuba unjani, nceda wazise iinkokheli zeli phulo okanye nabani oli lungu elibandakanyekayo.

Appendix E: Learning Resources

Learning resources for landscape regeneration

Compiled by Helen Fox for use in Lower Sinxaku Primary school.
The source of material used is indicated in the reference list for each resource.

The following resources are available from the enclosed DVD. At the beginning of each resource the links to CAPS are indicated with respect to the most relevant subject area, topics, grades and terms. Each resource may be relevant to more than one grade depending on the subject area where it is used. Linked resources and key themes are also indicated.

The resources

Accelerating succession
Biodiversity – key to landscape regeneration
Companion planting
Diversity
No dig gardening
Raised beds
Soil glossary
Soil health and human health
Soil – key to landscape regeneration
Using biological resources
Water – key to landscape regeneration
What governs the health and fertility of soils?