COLLABORATIVE MONITORING IN ECOSYSTEM MANAGEMENT IN SOUTH AFRICA’S COMMUNAL LANDS

A thesis submitted in fulfilment
of the requirements for the degree of

MASTER OF SCIENCE

of

RHODES UNIVERSITY

by

COSMAN BOLUS

December 2009

Abstract

Internationally there is an increasing focus on involving local communities in natural resource management and monitoring. Monitoring methods which are professionally driven appear to be inadequate to deal with the monitoring of natural resource use and biodiversity conservation, globally. This is especially evident in areas such as South African rural communal land. Two community based natural resource management (CBNRM) programmes in areas which are communally governed in the Eastern Cape, South Africa, namely Nqabara and Machubeni, were used as part of this research study.

This thesis identified and tested potentially simple and cost effective monitoring methods related to the utilization of the local rangelands and indigenous forests. The criteria that were tested include 1) appropriateness and effectiveness in measuring change, and 2) contribution to building adaptive capacity among local land managers through learning. The criteria were assessed using a scoring system for each monitoring method in order to evaluate their strengths and weaknesses . This was done by using both quantitative and qualitative data. Contribution to building adaptive capacity was assessed by evaluating technical capacity gained, local ecological knowledge contributed and learning by participants. This was done using qualitative data.

The results show that the monitoring methods had different strengths and weaknesses in relation to the criteria, making them more appropriate for different priorities such as effectively measuring change or building adaptive capacity. It is argued that an adaptive approach is a useful component in the participatory monitoring process. An adaptive framework was developed from lessons learnt in this study for collaborative monitoring. Challenges such as low literacy levels and adequate training still need to be addressed to strengthen efforts towards participatory monitoring. Factors such as incentives, conflict and local values may negatively affect the legitimacy and sustainability of participatory monitoring and therefore also need to be addressed.

Acknowledgements

The journey travelled to undertake and complete this research study involved many valuable encounters with individuals and groups. Knowingly or unknowingly, these interactions influenced me significantly by contributing to my general life learning, and building life long relationships. Some already existed and some were new. At times the learning and relationship process was difficult, scattered with disagreements or conflict, however all these interactions were highly beneficial to building my experience and creating strong connections with colleagues, family and friends. I am sincerely grateful for all the advice, support and stimulated debate that I encountered with all those individuals and groups who were part of this process.

I would like to thank my supervisor Christo Fabricius, for his support in making this research study possible, by linking me with funding and a stimulating study environment. Christo Fabricius has challenged me throughout this process, and reminded me constantly of the value of pushing the envelope and owning ones journey. In this way he was able to assist me in maintaining and producing quality research, which is relevant to current global challenges.

I must thank the community of the Environmental Science Department, at Rhodes University. Charlie Shackleton, Georgina Cundill, James Gambiza and many more, created a stimulating and supportive academic environment to work in. I must also thank GTZ and the National Research Foundation for assisting me in my funding.

I have to especially thank the Machubeni and Nqabara land management organizations, the local communities and all the participants involved in the monitoring, for allowing me to conduct my research and giving me all the support I needed. In Machubeni I would like to thank Mrs Amanda Mbaliso, Mr Enoch Madywabe and Mr and Mrs Malidi for their assistance and kind heartedness. In Nqabara I would like to thank Mr Gia, Mr Xayi and the Sidlova family for their wonderful hospitality and generous warmth. I wish both land management organizations strength and prosperity for the future.

I must also thank Miss Putuma Dinwa for her expert and efficient assistance during my stay in Nqabara. Putuma played a major role in introducing me to local community members, touching up my *isXhosa* when it fell short, and making sure we kept a good work rate with her unmatched enthusiasm. In Machubeni I must thank

Sityilelo Malidi for his earnestness and welcoming personality. His positive approach to community problems is a major value to the local community's future.

To all the Glenthorpe farm community, I have to thank you for being my second family through this period, and playing pretty much the same role. Our days of alien plant clearing, swimming in the dam and hiking the local Oldenbergia conservation reserve have kept me inspired.

My family as always have played a crucial part in my life, supporting me in all aspects. To Rich, Pru and Oriole, I would like to thank you for reminding me about the important things in life and your loving support. And to Injairu, thanks for your continual inspiration.

Table of Contents

List of Figures

List of Tables

List of Plates

List of Appendices

List of Commonly Used Abbreviations

CBNRM	Community Based Natural Resource Management
DBH	Diameter at Breast Height
DEAT	Department of Environmental Affairs and Tourism
DWAF	Department of Water Affairs and Forestry
EMP	Environmental Management Plan
GTZ	German Society for Technical Co-operation
GPS	Global Positioning Satellite
LEK	Local Ecological Knowledge
LSU	Livestock Units
MEA	Millennium Ecosystem Assessment
NTFP	Non Timber Forest Products
PBR	People's Biodiversity Registers
PFM	Participatory Forest Management
RULIV	Rural Livelihoods
SES	Social-Ecological Systems
WfW	Working for Water

Plates From the Study Sites

The Nqabarana river meandering towards the ocean. The floodplain seen in the background was once an agricultural field but has since been invaded by *Acacia karroo* woodland

A homestead in Nqabara with a large pile of cut Acacia karroo for fuel wood

Young men in Nqabara transport cut *Acacia karroo* for fuel wood using an ox driven sledge

The Nqabarana river mouth. Coastal forest patches are interspersed between grasslands among the rolling hill

Indigenous timber harvested, from the local forests in Nqabara, is left in a pile at the entrance to the forest

Mr Ncedo Somdaka, a traditional healer in Nqabara, displays harvested medicinal plants from the local indigenous forests

The Machubeni dam with the Winterberg mountains in the background and rangelands in the foreground. Lapezi (*Euryops floribundus*) can be seen interspersed as the green bushy plant

Gulley erosion, in Machubeni, formed by overgrazing and bad farming practices. An agricultural field can be seen, in the top left, straddling the edge of the gulley

Cattle grazing inside a grazing camp in Machubeni. Bare patches of ground from overgrazing can be seen in the foreground

Cattle in Machubeni can be seen being ushered into the dip by local herdsmen

A community land management organization meeting, in Machubeni, with participants reporting back shown on the left

A herder looks over the mountain rangelands in Machubeni which are interspersed with Lapezi (*Euryops floribundus*) and grass species

CHAPTER 1: The Relevance and Need for Collaborative Monitoring in the Communally Managed Lands of South Africa

The need for reliable information to manage social-ecological systems in communal areas

The world is facing major environmental challenges. More information is needed to meet these challenges for interventions to be effective in social-ecological systems. Reliable knowledge on the planet's ecosystems is required to improve society's ability to manage existing natural resources sustainably (Allen *et al.*, 2001), reduce ecological impacts (Spellerberg, 2005; du Toit *et al.*, 2004) and improve human well-being through better management practices (Millennium Ecosystem Assessment (MEA), 2005). Major threats identified are biodiversity loss due to climate change effects (Heller & Zavaleta, 2009), land degradation and ecological impoverishment (Haberl *et al.*, 2004), habitat, population and species loss (Balmford *et al.*, 2003).

The Millennium Ecosystem Assessment (MEA) conducted a major review of the world's ecosystems and their services, with a focus on ecosystems and human well-being (Millennium Ecosystem Assessment (MEA), 2005). The key findings were that the change to ecosystems in the last 50 years has been more rapid than any other comparable period in the history of mankind. Although these changes have followed a massive increase in economic net gains and human well-being, it has also been achieved at the expense of ecosystem services, and increased the risks of non-linear changes and heightened levels of poverty in certain human populations (Millennium Ecosystem Assessment (MEA), 2005). Sub-Saharan Africa, being an area dominated by developing countries, is especially at risk due to the high levels of poverty, ecosystem degradation, ecosystem service reliance and the vulnerability of communities to change. If not addressed, these challenges could have major negative consequences for the future health of the earth's ecosystems and human well being, at both local and global scales.

Effective monitoring systems present an opportunity to collect data on natural resources and ecosystem components, in order to increase our knowledge so that effective action can be taken (Spellerberg, 2005). Biodiversity monitoring is becoming important for identifying priority conservation areas. The measurement of trends is, however, still limited (Balmford *et al.*, 2003). Monitoring is essential for effective environmental management (Spellerberg, 2005) and for directed management interventions (Sutherland *et al.*, 2004). Effective monitoring is also useful for directing policy interventions (Babu & Reidhead, 2000), creating baselines for assessing the effectiveness of global policy objectives and legislation (Balmford *et al.*, 2003; Convention on Biological Diversity, 2005). Additionally, it also serves a purpose in regulatory or audit functions, and detecting change as an 'early warning' (Hellawell, 1992). In this context, monitoring is a critical part of effective management of social-ecological systems at different scales.

Understanding the interrelatedness of societies and ecosystems has become increasingly important in recent research into sustainability (Fazey *et al.*, 2007; Armitage *et al.*, 2009). The interaction of these spheres is being understood through the complexity theory because of the multifaceted nature of these interactions and the need for integrated approaches in environmental management (Pahl-Wostl, 2007). As the major impacts of society on the natural world are becoming more evident, there is a growing acceptance that human society is a critical influence and part of the earth's ecosystems. Understanding environmental consequences and processes can no longer be separated from social processes (Christie *et al.*, 2005; Western, 2004; Liu *et al.*, 2007).

International initiatives which aim to collaboratively deal with both global and local challenges, such as the United Nations Millennium Development Goals (United Nations, 2008), attempt to address societal challenges such as poverty, health, education, gender equality in conjunction with environmental issues. Significant links and interdependence between the environment, development and rural livelihoods are being highlighted (Jones & Carswell, 2004). The World Conservation Union (IUCN) has promoted the importance of approaching the conservation of the environment through measures that understand the link between nature, culture and community (Brown *et al.*, 2005). Landscape is highlighted as a pivotal point. Brown *et al.* (2005: pg 3) substantiate this by stating that: “landscape can be seen as a meeting ground between nature and people, between the past and the present, and between tangible and intangible values”.

Ostrom (2008b) highlights the importance of the role of monitoring in meeting the future challenges of managing common pool resources. Common pool resources such as forests, oceans and grasslands are under threat globally from over exploitation (Ostrom, 2008c). Community managed areas are one type of many differently managed common pool resources worldwide. They make up a significant portion of global land and contain a substantial part of biodiversity natural resources globally (Capistrano *et al.*, 2005). Community based natural resource management (CBNRM) has specifically emerged in an attempt to engage with people who live in and influence their local landscape, by involving them in managing local natural resources (Blaikie, 2006). This management approach has been developed with the aim of promoting sustainable natural resource management by understanding the local, cultural and economic influences on environmental processes, and incorporating these understandings into effective locally based management systems.

Adaptive management has the potential to be a strong component in CBNRM because of its ability to deal with the challenges faced by communities in common pool resources (Ostrom, 2008a). These challenges include natural resource vulnerability due to rapid change and the need to consolidate knowledge about local natural resources through learning (Schreiber *et al.*, 2004). Learning is a critical part of adaptive management, and has the potential to contribute to social learning in communities (Armitage *et al.*, 2009). Monitoring is an important component of CBNRM because of its ability to track change and therefore has the potential to support local managers to adapt practices and strategies accordingly (Fabricius & Collins, 2007). Adaptive monitoring frameworks are advocated as a means to meet the challenges and needs of long term monitoring because of the potential benefits of adaptive and iterative processes in natural resource management and monitoring (Lindenmayer & Likens, 2009).

CBNRM is being encouraged in a number of countries in Sub-Saharan Africa, as an approach to improve local natural resource management (Fabricius *et al.*, 2004). These management systems are still in their early stages and monitoring systems to support them are still being tested in many instances (Danielsen *et al.*, 2005a). The challenge is to develop appropriate monitoring systems which are accessible to communities, useful for decision making and effective in promoting learning (Danielsen *et al.*, 2005a; Hartanto *et al.*, 2002) for building adaptive capacity (Fazey *et al.*, 2007). These challenges created the main impetus for this thesis. A critical understanding of the different approaches to monitoring and their strengths and weaknesses in relation to their implementation in CBNRM is required.

Professionally driven monitoring

Professional monitoring is not able to meet all ecological monitoring needs (Balmford *et al.*, 2003). As a result of this participatory approaches are being developed and tested to extend monitoring efforts (Danielsen *et al.*, 2005a). Different types of monitoring are categorized in terms of the type of participation promoted and the power dynamics between local participants and professional scientists (Danielsen *et al.*, 2009). This ranges from complete professionally driven monitoring on the one hand, to collaborative monitoring approaches, through to independent community-based monitoring as shown in (table 1.1.). Within the categorization of the type of participation promoted in monitoring approaches, the important aspects noted are the primary drivers or power dynamics of the monitoring, the primary data collectors and data analysers, and the primary users of the data (Danielsen *et al.*, 2009).

Table 1.1. The factors which show case the differences between professional, collaborative and independent monitoring, based on the categorization by Danielsen *et al.* (2009)

	Professionally driven I	II	Collaborative III	IV	Independent V
Data collectors	Professional researchers	Professional researchers and/or local people	Local people with professional advice	Local people with professional advice	Local people
Data interpreters	Professional researchers	Professional researchers	Professional researchers	Local people with professional research advice	Local people
Data users	Professional researchers	Professional researchers	Local people and professional researchers	Local people	Local people

Professionally driven monitoring by scientists (table 1.1) is commonly used in developed wealthy countries. It can involve no local people in the collection of data or use data collected by volunteers to be used by professional scientists. The data are used exclusively for external use by scientists outside from where it was collected. Some examples of monitoring which are professionally driven and where data are collected by professionals are remote sensing of forest cover done by the FAO (Food and Agriculture Organization of the United Nations) 2000 Forest Resources Assessment (Mayaux *et al.*, 2005) and water quality monitoring done by the United Nations Environmental Programme (United Nations Environment Programme (UNEP), 2009).

Professionally driven monitoring with local data collectors usually uses volunteers to assist in data collection. There are fewer volunteer programmes in developing countries than developed countries where there is a bigger culture of volunteerism (Danielsen *et al.*, 2009). Some examples in developed countries are riparian zone monitoring by volunteers in the United States of America (Fleming & Henkel, 2001) and the monitoring of habitat quality and changes in the dominant tree species found in forests of the mid western United States of America (Brandon *et al.*, 2003). In developing countries local monitors, such as rangers, staff on scientific expeditions, staff assisting volunteer tourists or hunter and fisher monitoring are usually paid (Danielsen *et al.*, 2009). An example of this in a developing country is the ranger based monitoring in Ghana done by employees of the Ghana Wildlife Division (Brashares & Sam, 2005). These employees often come from local communities and have limited training in animal identification and sampling methods. This program ran over 33 years where 40 wildlife species were surveyed monthly in nature reserves across Ghana. The data collected was able to show trends across scales, the patterns in the change in animal abundance over time and the forces driving these changes (Brashares & Sam, 2005). Another example of local monitoring can be seen in Southern Africa where the usage of the community game guard system is demonstrated in the work of the Torra Conservancy in Namibia. In this instance a long-term tourism venture was formed jointly with local communities in order to monitor game hunting (Nott *et al.*, 2004).

Advantages and disadvantages of professionally driven monitoring

Professional monitoring with professionally trained monitors has been preferred for national and international monitoring projects because the data collected is considered more accurate and precise (Spellerberg, 2005). This means that data can be used reliably at regional, national and international levels (Danielsen *et al.*, 2009). Even though this may be seen as the significant benefit of professional monitoring, this methodology still faces challenges (table 1.2) in adequately monitoring biodiversity and natural resources globally at different scales.

In the field of CBNRM, professional monitoring is often costly (table 1.2) and dependant on budget availability (Hockley *et al.*, 2005). This is because of the costs of employing scientists with the right analytical skills, maintaining field equipment, and running data analysis facilities (Spellerberg, 2005). The high costs involved in a monitoring programme can jeopardize the sustainability of that programme (Caughlan & Oakley, 2001).

Professionally driven monitoring can be considered irrelevant by project managers in CBNRM projects as it does not always align with local managers' needs and therefore has little to contribute to management decisions (Danida, 2000; Danielsen *et al.*, 2005b; Sheil, 2001). In addition to this, unequal power dynamics between scientists and local stakeholders can be a problem when monitoring objectives are externally driven. This can diminish the input of indigenous people in local land management (Blaikie, 2006). Professionally driven monitoring has also not yet been able to satisfactorily monitor a number of important aspects of biodiversity, such as the extent or condition of certain habitat types and the rate of delivery of certain ecosystem services. Therefore, only a minority of the world's biomes and a marginal level of the ecosystem services are being monitored at the regional or global scale (Balmford *et al.*, 2003). In the field of CBNRM, professional monitoring methods do not completely fulfil their function because of these limitations (Danielsen *et al.*, 2005a).

Table 1.2. A summary of the advantages and disadvantages of professionally driven monitoring in the communal land context

Advantages	o high accuracy and precision (Spellerberg, 2005) o data can be used at national and international levels confidently (Danielsen *et al.*, 2009)
Disadvantages	o high costs (Spellerberg, 2005), o not always relevant to local natural resource managers (Danida, 2000; Sheil, 2001; Danielsen *et al.*, 2005b) o unequal power dynamics between scientists and local stakeholders (Blaikie, 2006), o cannot monitor complete state of biodiversity and ecosystem services globally (Balmford *et al.*, 2003)

Independent community based monitoring

Independent community based monitoring on the opposite extreme involves no external input by scientists except for the continued endorsement of monitoring programmes. These programmes are totally independent and the data collected are analysed and used by local people for management (Danielsen *et al.*, 2009). Traditional monitoring done by local people uses methods such as catch per unit effort, body condition index, breeding success, population density sensing, communal hunts and noting unusual patterns in nature (Moller *et al.*, 2004).

Some examples of this way of working are the traditional monitoring methods used in customary conservation areas by the indigenous peoples of the Canadian Arctic, Alaska and New Zealand (Moller *et al.*, 2004). Body condition is an important indicator that features strongly in traditional monitoring. In the Canadian Artic, the Cree Indian fishermen monitor species composition of catch, size distribution and body condition as indicators of population health. In Alaska indigenous people have methods of monitoring fat content in caribou, *Rangifera tarandus* (Berkes 1999). In New Zealand the indicator of body condition is yet again utilised by the indigenous people, as well as the monitoring of harvest intensity and breeding habitats of the chicks of the ‘mutton bird’, *Puffinus griseus*. Monitoring of climate change is done by indigenous people who note unusual weather events and patterns in the Arctic (Krupnik & Jolly, 2002, in Moller *et al.*, 2004). Methods used in these contexts are varied and tend to focus on securing and managing natural resources for food security and survival. These traditional types of monitoring are devised over time through methods of trial and error, and are very similar to the adaptive management process (Berkes *et al.*, 2000).

Collaborative monitoring

Community based monitoring through collaboration is preferred in the context of CBNRM because it has the potential to overcome some of the challenges that professionally driven monitoring faces whilst generating other advantages. It is commonly used in developing countries through partnerships with local participants in communal areas, communal conservancy areas, and protected areas (Danielsen *et al.*, 2009).

In collaborative monitoring local people that are involved in data collection are paid or volunteer for free (Danielsen *et al.*, 2009). The primary users of the data are people from the local communities themselves as opposed to expert outsiders. Collaborative monitoring can happen in two ways depending on who interprets the data. The options are monitoring with external data interpretation or monitoring with local data interpretation (table 1.1). In collaborative monitoring with external data interpretation data are analysed and used by external scientists. However, the results of this analysis are also used by the local community for land management. The perspectives of local stakeholders may be diminished within this practice. Collaborative monitoring with local data interpretation on the other hand (table 1.1) maintains that all data collection and data analysis should be done by the local community with the advice of scientists. This type of monitoring is still considered to be in the pilot stages and is largely externally funded. It has been applied in developing countries for community based monitoring schemes in protected areas or community-managed areas, to improve conservation. This is because of the perceived benefits it has to local management effectiveness (Danielsen *et al.*, 2007) and the benefits of local participation in contributing to conservation in developing countries (Berkes, 2004).

An example of collaborative monitoring with external data interpretation (table 1.1) is community data collection of key species such as water birds, a locally endemic lemur and natural resource use in Madagascar (Andrianandrasana *et al.*, 2005). In this case study, the Alaotra wetlands which are the largest in

Madagascar were monitored. These wetlands are shallow, highly productive, have high biodiversity and are vulnerable to degradation. The collaborative monitoring involved the Durell Wildlife Conservation Trust, the local government, non-governmental organizations and the local community in collecting data. Participants from the local community were chosen according to their knowledge of the wetlands and their literacy levels. They were paid $2 a day. Group discussions were held on the site where caught fish were measured and identified. Observation counts were done along with fixed canoe transects where lemurs and water birds were observed. A major positive outcome of the monitoring was the transfer of marsh management to the local community and a strengthened collaboration between stakeholders.

An example of collaborative monitoring with local data interpretation (table 1.1) where all data collection and data analysis was done by local people in a CBNRM programme, is ranger monitoring on community conservancy areas in Namibia (Stuart-Hill *et al.*, 2005; Nott *et al.*, 2004). This has been successfully done in a number of communal conservancy areas in Namibia, such as the Torra Conservancy, with positive results such as substantial increases in wildlife numbers and sustainable natural resource practices being put into place (Nott *et al.*, 2004). A joint venture between the national government, non-governmental organizations and rural communities which manage the conservancy areas occurred. An event book system was developed and used in 30 communal conservancies consisting of a total of seven million hectares, as a main component of the monitoring programme. This system was developed for easy data collection and data analysis for local monitors (Stuart-Hill *et al.*, 2005). The event book system allowed the community to decide on what needed to be monitored while scientists assisted in developing and designing the monitoring methods. Monitoring of a number of different variables such as wildlife numbers, economic returns, patrolling records and the infringement of rules were done in the conservancy areas. The communities then analysed the data and used it for management decisions.

Advantages and challenges of collaborative monitoring

There is potential to develop collaborative monitoring by involving local people and professional scientists in designing effective monitoring systems for CBNRM (Fabricius *et al.*, 2004). Advances in participatory monitoring approaches are significant (Danielsen *et al.*, 2005a; Van Rijsoort & Jinfeng, 2005). Collaborative monitoring is usually cheaper than professionally driven monitoring (Danielsen *et al.*, 2005a). This is largely because of the reduced costs of involving local data collectors (Danielsen *et al.*, 2005a). Costs of monitoring are generally highest during the data collection phase (Caughlan & Oakley, 2001). Local people may be paid for monitoring or volunteer for free. However this is usually substantially less than professional monitoring costs. An example of this is community based monitoring of natural resource use and forest quality in the Montane forests and Miombo woodlands of Tanzania (Topp-Jorgensen *et al.*, 2005). Researchers involved in this project found that the running costs of the community based monitoring were low enough in this instance to be financed by revenue that had been generated from local natural resources. External funding was only required for the development stage of the monitoring project. This gave the community the potential to sustain monitoring projects internally which potentially added to their sustainability.

Simple monitoring methods are required for collaborative monitoring (Holck, 2008). An example of the use of simple monitoring methods, is the event book system developed for community conservancy monitoring in Namibia (Stuart-Hill *et al.*, 2005). In the Namibian conservancies the event book system was used in data collection and analysis. The system developed visual material to aid participants. This was an important addition to making the monitoring methods practically easy as local participants may have low formal education and little formal training, therefore necessitating the need for simple and easy methods. In addition to this, local monitoring methods are constantly interrogated about the accuracy and precision of data collected because participants commonly have low literacy levels (Danielsen *et al.*, 2005a). However in this instance it was shown that simple methods within collaborative monitoring could be developed in order to collect reliable data. Another study in Tanzania, in the Uluguru mountains, found that habitat loss and forest disturbance could be assessed accurately by local participants without formal scientific training, using simple monitoring techniques (Holck, 2008). With reliable data, participatory monitoring can contribute to national and global monitoring systems (Danielsen *et al.*, 2005a).

The benefits of participation have been shown in various participatory environmental management approaches (Muro & Jeffrey, 2006; Stenseke, 2009; Sultana & Thompson, 2004). Participatory approaches can contribute to improved livelihoods in local communities by being relevant to local needs. For example, in a Watershed Development Programme in India the inclusion of local people at a grassroots level in conserving the local watershed has increased the local people's ability to use natural resources more efficiently and contributed to uplifting the lives of individual farmers and the community as a whole (Ranganath *et al.*, 2006).

Collaborative monitoring has the potential to have more equal input of external scientists and local people in bridging different knowledge systems (Moller *et al.*, 2004). It can also contribute to the validity of local knowledge systems in local communities by incorporating useful local ecological knowledge (Fabricius *et al.*, 2006). This has been done, for example, through the program of the People's Biodiversity Registers (PBRs), where formal means of maintaining local ecological knowledge are developed and new contexts for ensuring their continued existence are created (Gadgil *et al.*, 2000). A major outcome of the PBRs was the collaboration between external stakeholders, practical ecologists and local resource users in developing the PBRs.

A major challenge in developing effective and legitimate collaborative monitoring is the merging of different knowledge systems so that participatory monitoring methods are considered legitimate by local people and scientists. Scientific methods have still not been sufficiently bridged with local knowledge in many instances (Moller *et al.*, 2004), and local people are often not truly participating equally with scientists (Blaikie, 2006). Power relations between professional scientists and local people do not always occur on an equal footing in collaborative situations (Blaikie, 2006). Different knowledge systems can often be in contrast and cause conflict. For example, scientific knowledge comes from a more logical positivism approach with the belief that the observer is independent of the observed. Local knowledge on the other hand is embedded in its environment and social histories and is continuously negotiated on site (Blaikie, 2006). Local knowledge in participatory monitoring also has weaknesses such as it is sometimes too fine grained and small scale to be useful for tracking large scale trends. Also it can be influenced by external forces such as religion or superstitious beliefs (Fabricius *et al.*, 2006). Therefore bridging local knowledge and scientific knowledge is a significant challenge for collaborative monitoring.

Local communities can be empowered and capacity can be built through participatory processes in which the participants are involved in decision making and contribute to the assessment and management of their natural resources (Danielsen *et al.*, 2005b; Wiber *et al.*, 2009; Fabricius & Collins, 2007). An example of where capacity has been built in communities involved in collaborative monitoring is in Madagascar. With the help of the Durell Wildlife Trust, local people were trained and involved in monitoring and capacity building. This led to the facilitated transfer of marsh land and management to the local community so that the local community could continue benefiting from ecosystem services and have greater ownership (Andrianandrasana *et al.*, 2005), thereby empowering local people. Participants involved in monitoring can learn skills and gain environmental awareness (Andrianandrasana *et al.*, 2005; Lawrence *et al.*, 2006; Spellerberg, 2005). An example of learning during monitoring of biodiversity was in the monitoring of forests in Nepal (Lawrence *et al.*, 2006). Participants discussed different perceptions of the value of different types of vegetation and learnt about different views on biodiversity through the process. There is also the potential for social learning to occur through a monitoring process (Sinclair *et al.*, 2007) as has been found in participatory environmental management (Sims & Sinclair, 2008).

Collaborative monitoring can be more relevant to local needs than professionally driven monitoring because local perspectives are incorporated through participation (Sheil, 2001). The participation of local people supports the assessment of local natural resource management by improving the levels of, project management and process planning, promoting learning, understanding different stakeholder perspectives through direct participation and ensuring greater accountability (Vernooy & McDougall, 2003). Examples where collaborative monitoring has been relevant locally and has lead to increased management interventions is a community based management programme in the Philippines (Danielsen *et al.*, 2005b). Before this, monitoring scheme started there was little collaboration between the local people and the park authorities and assessments were only done on the quantity of the timber extracted. The biodiversity monitoring scheme which was developed then involved 97 park rangers and 350 community volunteers over an area of one million hectares of Philippine's protected land. As a result of the monitoring 156 conservation management interventions took place on terrestrial, marine and fresh water ecosystems. Ninety percent of these were implemented by the local people without external assistance. These interventions were done together with the local managers of the parks. This showed that the monitoring was relevant to local monitors and that the involvement of local monitors bolstered the sustainability of the programme. As a result, more socially acceptable and effective management rules were developed.

Table 1.3. A summary of the advantages and challenges of collaborative monitoring, in the context of communally managed lands

Advantages	o low costs (Andrianandrasana *et al.*, 2005; Danielsen *et al.*, 2005a) o monitoring methods are simple (Stuart-Hill *et al.*, 2005) o more legitimate and relevant to local natural resource managers needs (Danielsen *et al.*, 2005b) o more equal input from scientists and local people and bridges different knowledge systems (Moller *et al.*, 2004) o includes local ecological knowledge (LEK) (Fabricius *et al.*, 2006) o contributes to empowerment and capacity building (Andrianandrasana *et al.*, 2005; Wiber *et al.*, 2009; Fabricius *et al.*, 2007; Danielsen *et al.*, 2005b) o stimulates learning and environmental awareness (Lawrence *et al.*, 2006; Andrianandrasana *et al.*, 2005; Spellerberg, 2005) o potential to enhance social learning (Chambers, 1994; Sinclair *et al.*, 2007; Sinclair *et al.*, 2007; Sims & Sinclair, 2008) o improves local management and management interventions (Danielsen *et al.*, 2009; Vernooy & McDougall, 2003)
Challenges	o low accuracy and precision in data collection o low literacy levels among participants (Danielsen *et al.*, 2005a) o merging different knowledge systems (Blaikie, 2006; Moller *et al.*, 2004) o local knowledge is influenced by religion and superstitious belief and can be too fine grained (Fabricius *et al.*, 2006)

Research needs

Collaborative monitoring methods have not been sufficiently developed and tested in specific communal areas. This compromises the credibility they require to be effective, reliable and legitimate tools (Danielsen *et al.*, 2005a). Simple methods are still required and need to be tested with local participants so that the reliability of data collected, effectiveness of monitoring methods and benefits to participants can be assessed. They can potentially be valuable as data sources for communities and/or outside stakeholders for improved management interventions (Danielsen *et al.*, 2005a).

This research project intends to develop collaborative monitoring methods by identifying and testing them in relevant CBNRM contexts in South Africa's communal areas. The research aims to:

1. Develop criteria to assess the effectiveness of participatory monitoring methods in a) measuring changes in natural resources, b) building the adaptive capacity of local people.

2. Test and adapt selected participatory monitoring methods in two CBNRM study sites, namely Machubeni and Nqabara in the Eastern Cape, South Africa.

3. Assess the effectiveness of selected natural resource monitoring methods in a) effectively measuring change and b) building adaptive capacity through learning.

4. Using lessons learnt, develop a framework for collaborative monitoring as a part of adaptive and collaborative management in the Eastern Cape, South Africa.

CHAPTER 2: Introduction to the Study Sites

Introduction

The two study sites identified to test the participatory natural resource monitoring methods are Machubeni (31^{o}34'S; 27^{o}11'E) and Nqabara (32^{o}19'S; 28^{o}46'E) (fig. 2.1) in the Eastern Cape Province, South Africa, in the area formerly known as the Transkei. The first annexation of the Transkei from the Cape Colony occurred after 1878. It was later to be brought together as the United Transkeian Territories in 1903. These districts were again united as the Transkei in 1963 when the territories were given the opportunity of 'self governance'. This eventually culminated in the 'independence' of the Transkei as a 'Bantustan' from 1976 to 1994. The South African government, through the racially divisive Apartheid system, defined Bantustan territories as a way of gaining political control over 'black' South Africans (Bundy, 1988). 'Black' South Africans were relocated and restricted to these areas. At the end of Apartheid rule in 1994 the Transkei was incorporated back into South Africa after democratic elections (Palmer *et al.*, 2002).

Machubeni and Nqabara were chosen as study sites because of their shared social and economic history. They also have complex challenges which are shared with numerous other CBNRM contexts in South Africa and abroad. These communities are poor, and are highly dependent on natural resources which contribute significantly to the welfare of rural households (Barrett *et al.*, 2001; Carter & May, 1999; Shackleton *et al.*, 2001). The communities also experience social and governance problems which are partly a result of historical interferences from the Apartheid and Colonial eras (Ikhwezi Development, 2003; De Klerk, 2007; Manona, 1995).

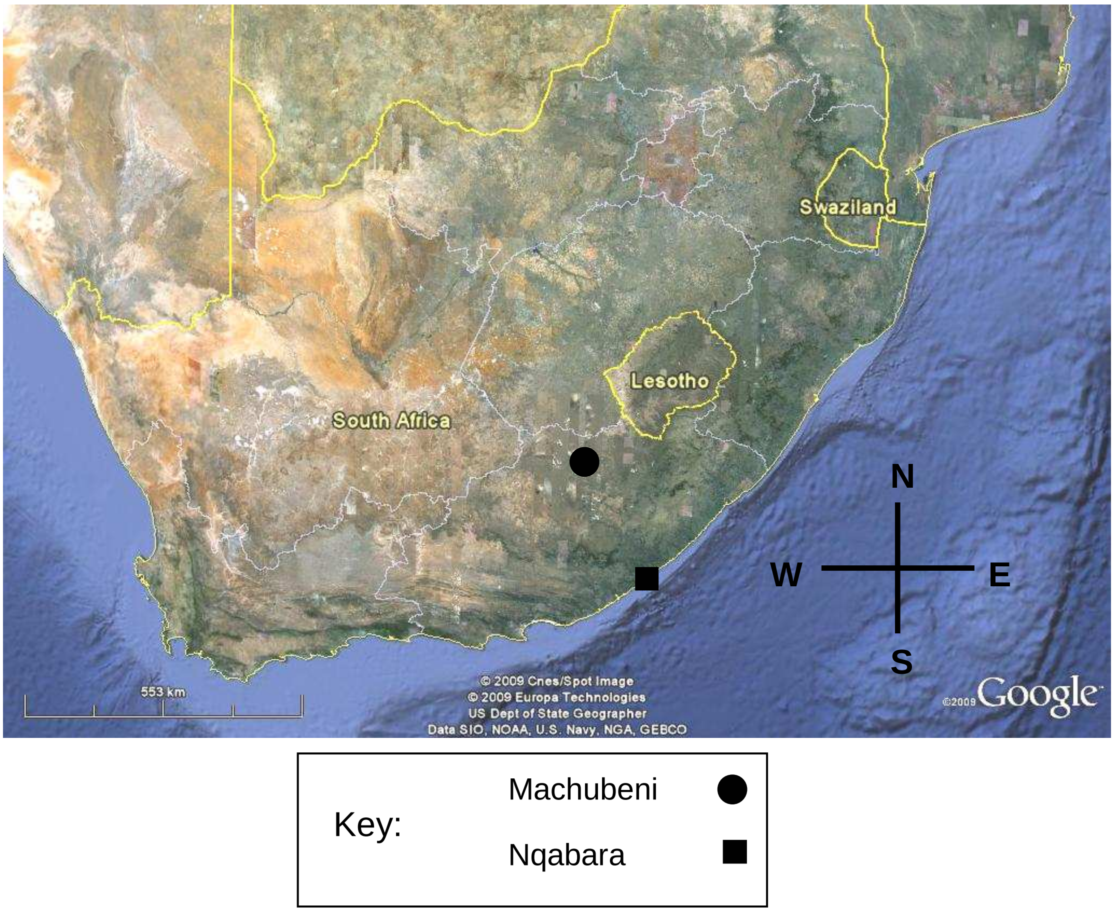

Fig 2.1. The location of Machubeni and Nqabara, in the Eastern Cape, South Africa

Community based natural resource management (CBNRM) projects have been implemented in these two sites to strengthen land management and improve the natural resource base (Fabricius & Collins, 2007). One of the main implementing agents in this project is GTZ Transform (German Society for Technical Co-operation), an ‘international cooperation enterprise for sustainable development with worldwide operations’ (GTZ Transform, 2009). This body worked in partnership with the Department of Environment and Tourism (DEAT), the Department of Water Affairs and Forestry (DWAF), Rural Livelihoods (RULIV) and Rhodes University in Grahamstown. The aim of the projects in both sites was to ‘promote sustainable natural resource use, and improve the contribution of natural resources to rural livelihoods, through a participatory land use planning process’ as stated by Ikhwezi Development (2004a) and Mafa Environment & Development cc (2005). As a result of these interventions there has been much progress toward the organization of interest groups with the intention of land management in collaboration with the

GTZ Transform projects. The local land management organizations consist of a community trust in Nqabara and a section 21 company in Machubeni.

Both sites have communal land tenure (Fabricius & Collins, 2007) and their inhabitants are dominantly Xhosa speaking with a traditional system of governance still in place. As with most communal areas of South Africa, the chiefs and headmen still have large influence over decision making in the communities (Cundill & Fabricius, 2008). Additionally, there are ward councillors assigned for each community who represent the local government municipality and can also influence decision making. Other local government officials such as agricultural extension workers and DWAF officials also have duties in the area (Ikhwezi Development 2004b, De Klerk 2007).

Boundaries and units of study

This study engages in both the human and spatial dimensions of the study areas defined. The study area requires definition from different perspectives (Ainslie, 1998). Because the dwelt in landscape consists of multiple overlapping places which are defined through action, it poses several challenges to defining the bounded units of the, study area (Robbins, 2003). Therefore, a better approach to the human spatial interface is to assume ‘that people’s lives are lived around and extend from centres rather than being contained by boundaries’ (De Klerk, 2007: pg 22). For example perceptions of the landscape do not end at the defined boundaries of an administrative area, they are influenced further by interests which may cross these boundaries. Furthermore, the village (*ilali*) definition is also important to bear in mind as it represents centres of dwelling, centres of livelihood, neighbourhood, or a locality by the local people. The homestead (*Umzi*) as a unit is also useful in understanding consumption and production patterns, decision making and spatial organization of tenure within a village (McAllister, 2001; McAllister, 1979). These are not static entities and need to be considered carefully when interpreting social data (De Klerk, 2007). The participants who take part in this study are placed as accurately as possible within this dynamic spatial and social context of rural communal areas, to give a clearer background to their views and actions.

The Machubeni area is situated in the upper reaches of the Cacadu catchment area, in the Eastern Cape Province, South Africa. It is 40km South West of Indwe and 20 km North of Lady Frere. It falls under the Emalahleni Local Municipality, which is part of the Chris Hani District nodal area and comprises of 16150 ha of land (Shackleton & Gambiza, 2008). According to Ikhwezi Development (2004), there are 14 villages (*iilali*) defined in the area which include approximately 700 households and a population of 7800 with an annual growth of 0.6 percent (Ikhwezi Development, 2004b). This was recently readjusted to include an extra three villages to make a total of 17 villages, defined by the community.

The Nqabara administrative area (AA) is situated in the Willowvale district which is in the southern coastal part of the former Transkei region, Eastern Cape Province, South Africa. This area is also known as the Wild Coast. The area is under the Mbashe Municipality jurisdiction and its boundaries are the Nqabara River on the east and the Nqabarana River on the west. It stretches approximately 10kms inland from the coast. This covers a total area of approximately 7581 ha. According to Mafa (2005) there are 11 defined villages (*iilali*) with 836 homesteads and a population of 3369 (Statistics SA, 2001).

Biophysical context

Machubeni

Machubeni is characterized by a catchment basin which is surrounded by mountains with cultivated lands found on the arable lands next to the Cacadu river. The Cacadu River drains into the Machubeni dam and supplies the Emalahleni local municipality (Fabricius & Collins, 2007). The Machubeni catchment receives erratic rainfall with frequent droughts. According to the

Lady Grey rainfall station, close to Machubeni, the mean total average annual rainfall is approximately 711mm from data collected from 1888 to 2007. This rainfall is concentrated in the summer months between October and March which is received in the form of convectional cloud. The temperature ranges from a mean maximum of 12.5 degrees Celsius in July to 20 degrees Celsius in December (Weather SA, 2006b).

The categorized mountainous terrain varies in height from approximately 1300 m.a.s.l. to 2100 m.a.s.l. with valley floors and villages found at approximately 1500 m.a.s.l. The mountains surrounding the catchment are steep and the underlying geology is a mosaic of mudstones and sand stones with dolerite intrusions (Shackleton & Gambiza, 2008). Shallow litho sol soils are found on grazing areas with deeper duplex soils found next to the river where the arable lands are. The duplex soils are highly erodable and most soils in the area show signs of sheet or gulley erosion (Ikhwezi Development 2004b.

According to Low & Rebelo (1996) the area is part of the South-eastern Mountain Grassland vegetation type,, and is more specifically called the Tsomo grassland (Mucina & Rutherford, 2009). It is described as grassland with high basal cover but with low grazing potential. The dominant grass species are *Elionurus muticus, Festuca* species*, Heteropogon contortus, Themeda triandra* and a number of forb species. *Elionurus muticus,* and *Aristida species* usually dominate overgrazed grasslands. Overgrazing and farming on erosion prone lands has been highlighted as a contributor to erosion and land degradation.

Nqabara

Nqabara is found between the temperate south coast and the subtropical east coast of the South African coastline. The winters rarely see frost and the summers are generally humid, with some cool windy days (Palmer *et al.*, 2002). The temperature ranges from a mean maximum daily temperature of 21.5 degrees centigrade, rising to 24 in summer between the months of October and March (Cawe 1994). Winter is cool and dry while summer receives most of the rain in the months from October to April with mean annual rainfall at 1069mm (Weather SA, 2006a), which is well above the regional average (Palmer *et al.*, 2002).

Nqabara is characterised by rolling hills which run parallel to rivers flowing to the ocean. These are covered by grasslands with forests occurring in the valleys between the hills. The hills reach approximately 320 m.a.s.l. Its terrain has a number of variable slope features which make a mosaic of hills, valleys, cliffs and a flood plain. Different moisture regimes are associated with this mosaic due to the aspect, slope and altitude. There are a variety of micro climates which occur across short distances in the area and are spatially determined by differences in soil moisture (Palmer *et al.*, 2002).

The soils are similar to those of Dwesa described by Palmer *et al* (2002) and they are derived from the Beaufort and Ecca series of the Karroo system. They have many dolerite intrusions which are seen from cliffs that have become exposed through erosion in the valleys. Glenrosa, Mispah and Swartland soils lie over the shale and sandstone, and have high permeability. This means they are prone to desiccation in winter (Palmer *et al.,* 2002). Soil fertility is highest on the dolerite intrusions and on the river flood plains.

The area falls under the Tongoland-Pondoland Regional mosaic which is a species rich area displaying a variety of vegetation types (Low & Rebelo, 1996). This is described as the Transkei coastal belt. The dominant vegetation is Eastern Thorn Bushveld with interspersed patches of coastal forest (Mucina & Rutherford, 2009). The landscape can therefore be described as *Acacia* shrubland and grasslands, with patches of coastal forest in between rolling hills (Acocks 1988). In the nearby Dwesa nature reserve, five major plant communities have been described by Moll (1974). These are dune vegetation, estuarine fringe and mangroves, grassland, and scrub and forest. Scrub includes the species *Acacia karroo, Maytenus heterophylla* and *Diospyros* species. Mckenzie & Cowling (1979) added to the vegetation description of the area by defining wooded grassland as a type of grassland and a vegetation unit. The species in wooded grasslands are identified as forest pioneers (Mckenzie & Cowling, 1979). Wetland vegetation was also identified. Their conceptualisation of the vegetation in the area was one of a succession spectrum from tall grassland, wooded grassland and then to forest.

Forest and woodland cover has increased substantially since 1974 in Nqabara (Chalmers & Fabricius, 2007). Key determinants in the ecosystem are fire and grazing, but also to a lesser degree climate and soil (Low and Rebello 1996). In addition to this, it is likely that people have had a significant influence on system dynamics, as there is high natural resource use and grassland burning by members of the community. Colonial foresters described indigenous forest as the dominant vegetation type before the colonial period. This was said .to have been destroyed by human induced grassland fires. Despite this, archaeological evidence shows that grasslands have been dominant even pre-hominid times (Mentis, 1992).

The historical context of human settlement, livelihoods and land administration

The coastline of the former Transkei, named the Wild Coast, was first inhabited by Khoi-Khoi groups. Shell middens which are scattered along the coastline are evidence of Khoi-Khoi's use of intertidal resources. The Khoi-Khoi resided in the Dwesa area, near Nqabara approximately 4500 years ago (Lasiak, 1992). They were also herders (Palmer *et al.*, 2002). The San on the other hand inhabited the inland areas of the Transkei before the arrival of Bantu groups from eastern Africa (Bundy, 1988). The Bantu migration and settlement in the former Transkei occurred in three stages between 700 and 1500 AD (Cronin, 1982; Derricourt, 1977). In the sixteenth century the remaining Khoi-khoi were absorbed into the Bantu groups. The Bantu from these areas, were semi sedentary pastoralists who did little crop cultivation (Peires, 1976). A Xhosa speaking group called the amaGcaleka inhabited the eastern area of the Transkei from the Kei River to the Mbashe River, including Nqabara. The eastern part of the Kei River tended to have less involvement in the ensuing frontier wars during the 19th century than those West of the Kei River (Mostert, 1992). Herschel, an area in the North of the Transkei and approximately 100km from Machubeni was first settled by Bantu groups in 1830 who were refugees from the mfecane wars*.* The mfecane wars describes the wars initiated by King Shaka of the Zulu's which led to mass resettlements of local people. The population was further populated by Sotho peoples and a large Xhosa speaking group called the Mfengu (Bundy, 1988).

The Transkei had an agricultural boom, from 1900 to 1930, which was called the black agricultural revolution by Bundy (1988). The agricultural boom occurred due to an increase in technologies that had been learnt and bought, such as ox drawn ploughs. An increased demand for agricultural products from the inland diamond rush also contributed to the boom (Mostert, 1992). Some of the highest cattle numbers were recorded between 1920 and 1930, and at the same time homestead wealth grew in size due to migrant labour income, cash crops and an investment in cattle. The main agricultural produce during the agricultural boom were maize followed by other products such as tobacco, wool, sorghum, wheat, barley, oats, hay, hides, skins, fruit trees and coffee.

The wealth accumulated from agriculture was not evenly spread among the community and some households did better than others (De Klerk, 2007). Migrant labour also increased rapidly during this period from 21 to 45 percent for the male population between the ages of 15 and 64 years old, from 1910 to 1960 (Muller & Mpela 1994, in De Klerk 2007). Homesteads depended on migrant labour wages to pay taxes and continue investing in local agriculture (Palmer *et al.*, 2002). They also began to receive monetary income from the pension grants of migrant pensioners in their household in the 1970's (De Wet, 1995).

Large changes have occurred in agriculture in the communal areas of the Transkei since the agricultural boom of the early part of the 20th century. The decline of agriculture for Xhosa farmers in the Transkei occurred mainly due to competition with white farmers, discriminatory support for white farmers by the Apartheid government in South Africa, as well as rigid government control over land tenure (Palmer *et al.*, 2002). The Native Land Act of 1913 formalized the Native Reserve system within the Union of South Africa so that these ‘reserves’ could be inhabited by black people exclusively. The Native ‘reserves’ were termed homelands. This process was further consolidated by the Native Trust and Land Act in 1936 which sought to buy out existing white owned land in the reserves. The Native Administration Act of 1927 which formed the Native Affairs Department and later became the Bantu Affairs Department was responsible for implementing strategies that undermined the economic potential for agriculture in the Transkei (De Wet, 1995).

Agriculture is still important to Xhosa farmers and contributes to homestead livelihoods. Cultivation has become more intensified in recent years in rural areas in the Transkei and crops are being diversified in some cases. At the same time, the organization of labour has changed due to declining production areas, and also the impact of age and gender imbalances due to migrant labour trends (McAllister, 2001).

There has been large external interference in land tenure in the Transkei. The formation of the Native Trusts and the Land Act of 1936 increased the powers of magistrates away from traditional authorities for local land administration. This meant that power in essence shifted away from the village. As a consequence applications for new homesteads became more difficult as strict criteria were set up by the local magistrates (Palmer *et al.*, 2002). Betterment-induced resettlement in the 1960’s and 1970’s was a significant process which also contributed to interference in local communities in the homelands. The aim of Betterment was to centralise communities into concentrated villages as a strategy for decreasing ecological degradation in newly created homelands. It was also a strategy to gain political control. This occurred in both Machubeni (Ikhwezi Development, 2004b) and Nqabara (De Klerk, 2007).

In relation to the management of the indigenous forests of the Transkei, the Transkeian Forestry Department intervened in local land tenure and declared certain forests to be state forests while others were declared ‘headman’s’ forests. People from local rural villages were not allowed to use the state forests for forest products and needed a permit to use the ‘headman’ forests (Palmer *et al.*, 2002). After the first democratic elections which were held in 1994 and to date in post-Apartheid South Africa, the government still retains ownership of the state forests while headman forests are owned by the community. The permit system used to govern ‘headmen’ forests has nevertheless collapsed. The system of management for headman forests is now being negotiated between the local communities and the government for co - management in some communities such as Nqabara (Cundill & Fabricius, 2008).

Social-economic and environmental challenges in Machubeni and Nqabara

Presently, there is a low level of formal employment in Machubeni and this means that there is also a low level of cash generation into the area. Almost fifty percent of household income generation in the area is the result of welfare grants. Reliance on livestock sales and income from family members working in other areas amounts to 14.2 % of households in the area. Only five of the 14 villages have access to electricity at the household level, while only two villages have bulk water supply through communal stand pipes. Other villages have to collect water from rivers and streams (Ikhwezi Development, 2003).

In Machubeni, livestock (25.3 %) and agricultural crops (7.5 %) are the dominant livelihood strategies in households. One third of households are estimated to own some form of ruminant livestock. Other activities such as construction, mining, retail, crafts and sewing, and general services contribute to only six percent of the households’ livelihoods. Up to 64.9 percent of households have no local livelihood strategies at all (Ikhwezi Development, 2004b). Livestock as a livelihood strategy is the most dominant practice in this area, and is also a significant feature elsewhere in rural South Africa (Shackleton *et al.*, 2001). Livestock has a large economic potential because of its commercial value, by-product value, use value, and cultural value. Livestock densities are estimated to be between 300 – 600 percent over recommended stocking rates, with approximately 10000 sheep, 5000 cattle and 5300 goats in the area (Ikhwezi Development, 2004a). Despite these numbers there is little trade in livestock as they are used mostly for savings.

The major environmental threat in Machubeni is rangeland degradation. Overstocking as well as the break down in grazing regulation institutions are considered to be contributing to high levels of erosion in grazing areas and agricultural lands. Subsistence agriculture is a valued livelihood activity in the area with maize being the main crop. However, the prevalence of soil erosion has meant that some agricultural lands need to be taken out of cultivation to save the soils (Ikhwezi Development, 2004b). Large erosion gulley's, also known as dongas, are being formed in many areas due to uncontrolled erosion. Irregular and low rainfall is a major factor for farmers as rainfall affects the grazing potential and consequently the health of cattle and other livestock. As a consequence of degraded grazing lands, cattle health is also in jeopardy. Lapezi (*Euryops floribundus*) is considered a threat to grazing potential in Machubeni by local livestock farmers because it is perceived to be invading the rangelands and diminishing valuable grazing land. However removing it may have negative consequences for grass diversity in the area (Shackleton & Gambiza, 2008).

In Nqabara, according to Mafa (2003), local rural livelihoods and economic activity are still based on a combination of state pensions and remittances, income from family members working in the cities and local natural resource use. Monetary economic activity is low with 50 percent of households receiving less that R5500 (US$ 550) per annum. This is however balanced by natural resource use as a contribution to livelihoods. Formal education is also very low in the area with the average literacy level being the equivalent to Grade five. In addition to this, the majority of household leaders are illiterate (Mafa, 2003).

In Nqabara the grasslands are important to local communities as they provide invaluable grazing for cattle, which are an important part of Xhosa culture and livelihoods (De Klerk, 2007). Grasslands also provide low cost thatching material for building (Johnson, 1982). The indigenous forests which have a total of 170 woody species (Acocks, 1988) are intensively used for medicinal plants, fuel wood and construction timber. *Acacia karroo*, a major part of the wooded grassland, is an important source of fuel wood.

Major environmental threats faced in Nqabara relate to uncontrolled harvesting of indigenous forest products, and the expansion of *Acacia karroo* woodlands on agricultural fields and forest edges. There is little management of timber and medicinal plant harvesting in the headman or state forests of the community. This is a potential threat to the health of the indigenous forests. *Acacia karroo* stands are considered to be expanding rapidly in the community area on arable lands, grazing lands and on indigenous forest edges forming wooded forests (De Klerk, 2007; Dane, 2006; Chalmers & Fabricius, 2007). This is considered to be a threat to farmer livelihoods as grasslands are used for cattle grazing and many arable lands are now wooded over. Alien invasive plants are also found in numerous areas in the community and may be a threat to water sources and biodiversity in the area.

The value of monitoring in Machubeni and Nqabara

In Machubeni, more accurate information on the state of grazing lands is required. This will assist in the focus of rangeland management regarding camp rotation. The extent of erosion on agricultural lands and rangelands needs to be assessed so that dongas and potential dongas can be fixed. If adequate interventions are made, cattle health can be improved as well as the livelihoods of those in the local community who depend on this resource. The fixing of dongas on arable lands can also improve the agricultural potential for crop farmers (Ikhwezi Development, 2003).

In Nqabara, collaborative monitoring of indigenous forests can assist the management of this resource by the local community. Information about forest health will allow the community to make informed decisions about required measures to protect over harvested forests by closing off degraded forests for recovery (Mafa, 2005). Information about the rate at which *Acacia karroo* (De Klerk, 2007) and alien invasive plant stands are expanding is also required to make decisions about where to focus clearing efforts such as water courses where alien invasive plants may be dominating. This will allow the community to manage forests, grasslands, arable lands and water courses more effectively.

CHAPTER 3: Methodology

Introduction

This chapter explains the research approach and process, used to address the research questions (cf.Chapter 1). The methods to assess the monitoring methods and the monitoring method descriptions are given in specific detail in chapter 4 and 5.

With a background in biological sciences, I commenced to take on a research project which would require an ability to integrate social and biological sciences. This I anticipated would require a broad scope, a willingness to understand the origins of alternative methods and the use of both qualitative and quantitative data collection methodologies.

The interaction between the different data sources and the observer relevant to this study can be broken into two main philosophical approaches. The first is positivist science, which is based on observational verifiability (French, 2007). The second approach is relativist self-reflexivity and relates to descriptive, qualitative research (Duncan & Ley, 1993). Biophysical research comes from a more positivist approach. Its focus is to study the physical components and processes of the natural world. For example, it can be used to study water flow, species abundance or species interactions with physical variables over time. Methods are largely quantitative using empirical measurement in field methods such as transects and quadrants (Ford, 2000). Social research focuses on the study of society and people. It uses largely qualitative methodologies such as interviews and participant observation. Social research can be defined as ‘the systematic observation of social life for the purpose of finding and understanding patterns among what is observed’ (Babbie, 1992). As in all science, social research is centred on the activities of theorizing, collecting data and interpretation to re-inform theory. The methods which are used to elicit these social patterns include questionnaires, interviews, participant observation (Babbie, 1992; Yin, 2003) and the re-analysis of existing statistics.

Integrating biophysical and social research

Many fields of study use interdisciplinary approaches for research so that both physical and social patterns can be explored and explained. Such examples are human ecology (Martin, 2001), political ecology (Robbins, 2004) and political geography (Boateng, 1978). When combining biophysical and social research it is important that data can be compared across different epistemes and also that the results can be understood by researchers who come from different knowledge systems.

An important first step in the research process of both biophysical and social research is to build a conceptual framework for the research process (Babbie, 1992; Ford, 2000). Social research begins with theory then deduction, observation and induction to re-inform the theory (fig 3.1) in the wheel of science (Babbie, 1992). Scientific methods for ecological research begin with theory then analysis, data and synthesis to re-inform theory. In essence, they are variations on the same theme of theorizing, interacting with data sources, analyzing it and then re-informing the theory through reflection. This was the process which was undertaken during this study. The details of each stage are shown in figure 3.1. Reflection on the findings in relation to the theory and key questions was a critical part of the process to re-inform the theory.

I considered the combination of social and biophysical approaches to be complementary for the research problem faced because of the complex nature of the system to be studied, and the inclusion of both social and ecological aspects in the research questions. I used the field methods from both social and biophysical research practices, which were considered to be relevant to various parts of the research process, and then used triangulation (Jick, 1983) to elicit conclusions from the different data sources. Triangulation is commonly used in interdisciplinary research and implies that different methods and perspectives are used for a common subject of focus.

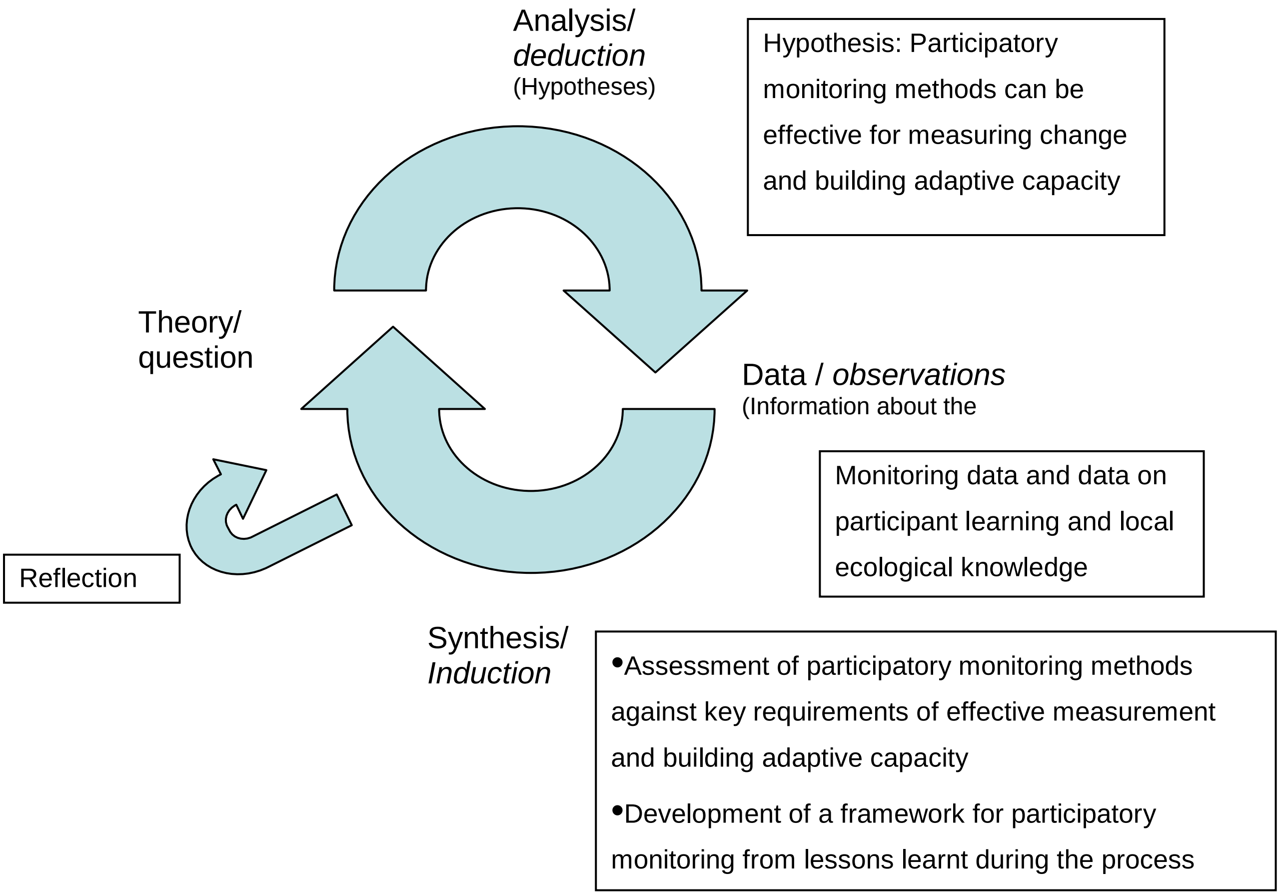

Fig 3.1. The cycle of scientific investigation for social and ecological research adapted from (Ford, 2000) and (Wallace, 1971) in (Babbie, 1992), and including the details of the research process shown in the boxes

Epistemological concerns emerged when I was faced with the challenge of integrating data sources from different disciplines. This is a concern commonly faced by researchers who have to integrate knowledge from different and sometimes isolated disciplines (Scoones, 1999). This is especially prevalent in human ecological studies. The interdisciplinary approach which would be required to assess both social processes and empirical data meant that I would have to also consider the epistemological and ontological contradictions of the various data sources. Difficulties emerge where different knowledge sources may compete with each other to explain the same context (De Klerk, 2007; Scoones, 1999; Burns *et al.*, 2006; Ericksen & Woodley, 2005). In addition to this, different disciplines have a long history and method of building knowledge. This therefore requires critical awareness, as the context of how the data is produced becomes important when analysing it (Jick, 1983). This was addressed by treating each data source and method of its collection within the context of the particular episteme in which it was collected. This meant the data was analysed according to the methodology and discipline used to collect it. The data were analyzed according to their contribution to the research questions, from the perspective of their episteme, and were given appropriate validity in accordance with their particular relevance to the research questions. This can be understood as using different vantage points, where relevant, to address the research questions.

Minimizing the researchers influence and observer bias

My influence on the research process was considerable, even though I attempted to minimize it as much as possible. Therefore I had to be especially aware of this during the process. I was aware that:

1. I had influence on the direction of the research at the beginning of the study, by framing relevant problem questions and the research direction.
2. I had influence on processes during the research, such as in guiding the community meetings, group discussions and interviews.
3. I also had influence on the interpretation of the data collected by local participants on natural resources through my assistance and training.

Interpretation of the data collected could not be considered unbiased from my perspective, as I had conscious and unconscious influences on the process. This is highlighted by (Hornborg 1996, in De Klerk 2007), who states, knowledge cannot escape being a product of negotiated relationships between contextualized, embedded or a situated researcher with her or his environment. It was therefore important for me to explain and be aware of the parts of the research which may not have been acknowledged, certain subconscious assumptions, specific emphases, the episteme of different authors used and the role that I played in the data collection (Dupre, 2007). Therefore I attempted to ensure the best objectivity during the research by being aware during the research process of my influence in directing the research, the participatory processes, data collection, data interpretation and the conclusions that where drawn from these.

As the researcher I realized that I was coming from a very different context to that of my intended study areas. The patterns of data which I was collecting were seen through a ‘conceptual window’ constructed from my own personal and epistemological history. Therefore both the social and ecological contexts had to be considered when interpreting results.

The adaptive process

The adaptive monitoring cycle

A defined monitoring process was important during the research process (Kouplevatskaya-Yunusova & Buttoud, 2006; Spellerberg, 2005) as this led the process toward reaching desired outcomes such as informed decision making, evaluation of the monitoring results and adaptation in response to lessons learnt. An adaptive monitoring process should ideally have an iterative nature so that the monitoring programme can be continually adapted in relation to new data collected and new questions about the state of natural resources (Lindenmayer & Likens, 2009). A participatory cyclic monitoring process (fig 3.2), adapted from Kouplevatskaya-Yunusova & Buttoud (2006), shows the crucial steps that could lead to informed decision making and evaluation through an iterative and adaptive process. The process involved continual learning at all stages of the cycle for participants and for the researcher. The research process went through three phases (fig 3.3) and the monitoring cycle was used during phase II (Scoping) and phase III (Rigorous testing). This was done to identify relevant monitoring methods for identified threats, collecting data, analysing and interpreting data, evaluating the results and discussing possible management actions. Finally, the monitoring process was tailored from lessons learnt by removing or adapting monitoring methods; using key requirements to assess them; and reflecting on the relevance of key questions for monitoring in Nqabara and Machubeni.

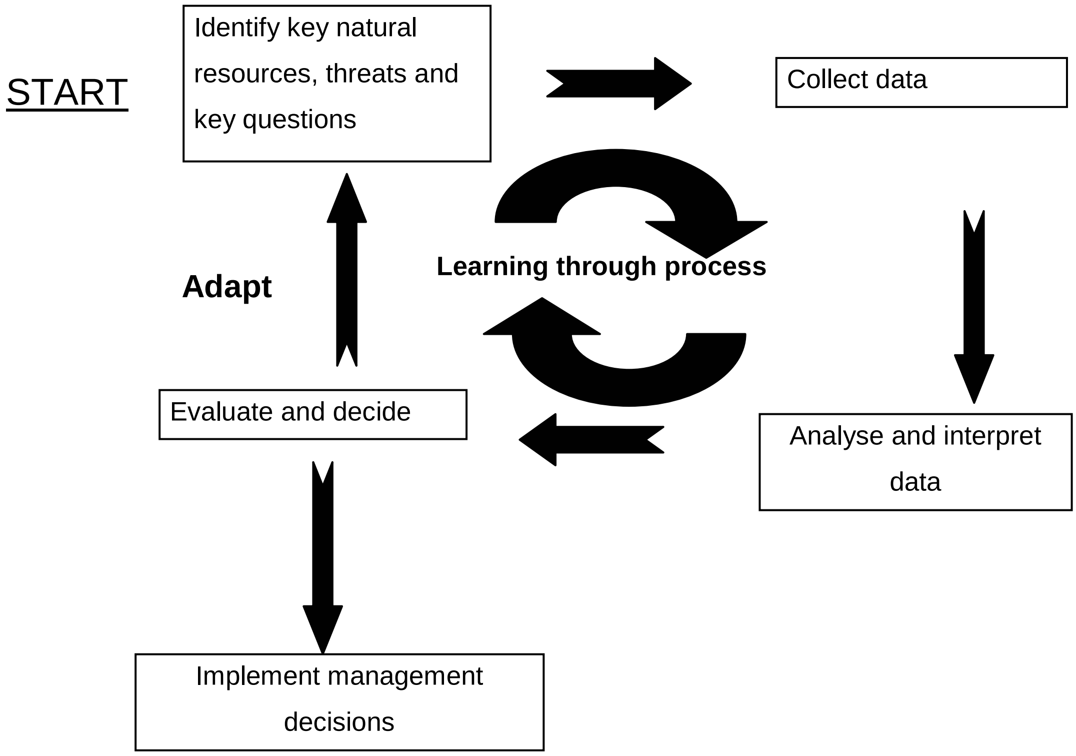

Fig 3.2. The adaptive monitoring cycle framework that was identified as relevant to the research process, adapted from Kouplevatskaya-Yunusova & Buttoud (2006)

The adaptive research process

An adaptive approach was used for the research process. This was used to specifically adapt identified monitoring methods and identify key requirements for good collaborative monitoring by reflecting on lessons learnt during the process (Danielsen *et al.*, 2005a; Holte-McKenzie *et al.*, 2006). The conceptual framework for the research process (fig. 3.3) is shown and was based on the adaptive monitoring cycle (fig 3.2).

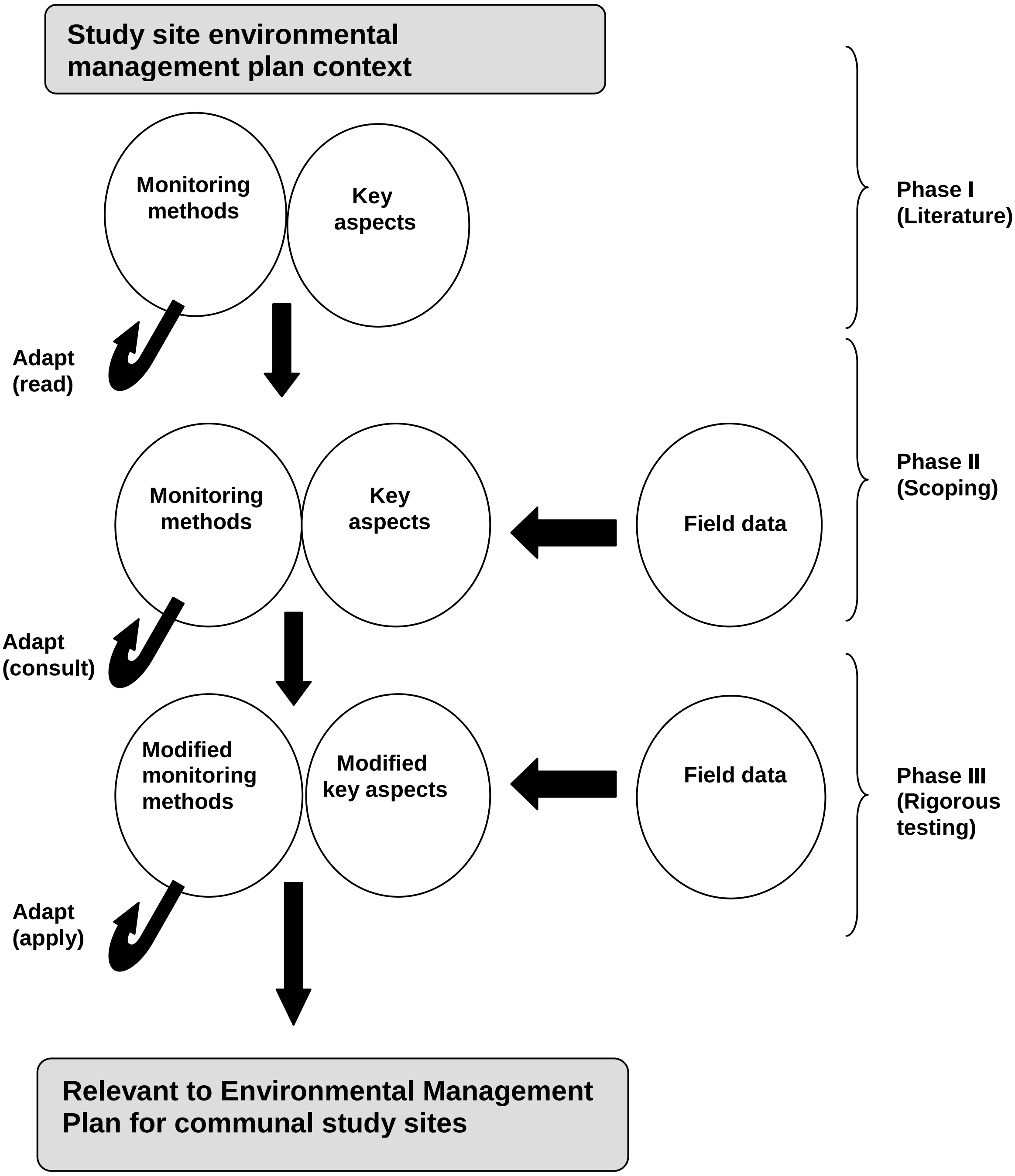

Fig 3.3. A flow diagram shows the conceptual framework for the research process, with the interaction of the study site environmental management plan, field data, key requirements, monitoring methods, and their adaptive cycles

The monitoring methods were tested during three different phases where they were adapted. Key requirements were defined in phase I to test the strength and weaknesses of the monitoring methods and adapt or remove them accordingly (fig 3.3). The key requirements were used as criteria to assess the monitoring methods throughout the research process. During phase I (fig

3.3), the initial adaptation of monitoring methods occurred from a literature review that identified possible monitoring methods relevant to the environmental management plan context. During phase II, also called the scoping phase, provisional monitoring methods identified in phase I were assessed qualitatively for their strengths, weaknesses and any critical shortcomings. This was done through ‘consultation’ with the local community organizations in the study sites, by reflecting with them, on the key requirements for good collaborative monitoring. Monitoring methods with critical shortcomings were removed, and those without were further tested in the rigorous testing stage (phase III).

During phase III the monitoring methods were adapted by being ‘applied’ in the field. This was done using lessons learnt from the scoping phase, in a more rigorous approach in the study sites, and also tested against the identified key requirements for good collaborative monitoring. Field data were collected to inform the strength and weaknesses of the monitoring methods in phase II and III (fig 3.3). The final desired outcome of the process was a set of monitoring methods which had been adapted and refined in relation to the study site context and environmental management plan.

The key requirements were defined so that the monitoring methods could be assessed against the key requirements for good collaborative monitoring found in the literature. These were broken into the two areas of effectiveness in measurement and building adaptive capacity through social learning. This was defined through a literature review during phase I. A summary of the key requirements and the relevant literature which highlights their importance is shown in table 3.1. for effective measurement of change and table 3.2 for building adaptive capacity.

Key requirements for assessing the effective measurement of change in participatory monitoring

The key requirements for effective measurement enable the monitoring methods to detect change in a relevant, reliable and practical way. They are defined as follows:

Appropriateness

If monitoring methods are appropriate this suggests that they are legitimate. Local legitimacy is an ultimate goal for the monitoring process and methods. This is because legitimacy through consensus among local participants of a community (van den Hove, 2006) can ultimately contribute to medium to long term sustainability of monitoring in a local community. If participants and the community consider the monitoring methods to be relevant and useful this indicates the potential for medium to long term commitment. Important areas to assess for legitimacy are;

- o the relevance (Berkes, 2004; Danielsen *et al.*, 2005†),
- o usefulness to local needs,
- o sensitivity to change,
- o ease of measurement,
- o and potential future uses of monitoring as perceived by participants (Danielsen *et al.*, 2005; Smith *et al.*, 2003).

The monitoring methods must be relevant to the threat being managed, and resource management domain. This means that in a CBNRM context attention needs to be given to local livelihoods, as these are commonly natural resource dependent (Danielsen *et al.*, 2005b). They also need to be sensitive to change at the relevant spatial and temporal scale (Babu & Reidhead, 2000; Salafsky & Margoluis, 1999). The spatial and temporal scale required should be identified at the beginning stage of a monitoring process when the focus of the monitoring is being defined. Indicators are essential to detect change and need to be sensitive to change (Dale & Beyeler, 2001). Indicators can be identified from local ecological knowledge or from scientifically backed literature (Barrios *et al.*, 2006). The participatory process of identifying indicators can build empowerment and legitimacy for the process and the validity for the monitoring results (Danielsen *et al.*, 2005a; van den Hove, 2006). Also indicators must be easy to measure so that data can be frequently and accurately collected (Spellerberg, 2005).

Reproducibility and data reliability

The monitoring methods used must be able to be repeated so that collected data can be compared over space or time. Data collected must be reliable so that change can be detected and informed decisions can be made (Spellerberg, 2005). In addition to this, having reliable data collected means credibility. Data can be confidently shared with other stakeholders when assistance in land management is required, for example from officials and professional ecologists (Danielsen *et al.*, 2005a; Bennun *et al.*, 2005). This can have added benefits of linking to formal national and global monitoring programs attempting to monitor biodiversity trends (Bennun *et al.*, 2005), natural resource use, climate change impacts and vulnerability (Janssen & Ostrom, 2006; Heller & Zavaleta, 2009). At the same time, land management institutions in communities can potentially benefit from reliable and credible data. This can improve their management of local natural resources, build relationships with stakeholders and source funding for monitoring or land management (Agrawal & Gibson, 1999; Danielsen *et al.*, 2005a).

Cost effectiveness

Financial cost is a key requirement, as the expenses of monitoring need to be within the financial capabilities of the relevant monitoring organization for the long term sustainability of a monitoring programme (Caughlan & Oakley, 2001). This is especially critical in CBNRM where sourcing funding can be difficult for the local community. Dependence on external funding opens the monitoring organization to financial vulnerability and therefore financial self-dependence is preferred. Cost considerations in monitoring usually include equipment, labour and running costs (Spellerberg, 2005). The speed of monitoring for each method is also important to limit its impact on labour costs. The monitoring process must be quick enough to detect changes and make informed decisions so that mitigation actions can be taken.

Practicability

The practical ease of the monitoring is a key requirement because participants need to be able to carry out the monitoring confidently on their own (Stuart-Hill *et al.*, 2005; Danielsen *et al.*, 2005a). Training and teaching methods are important to enhance the skills of the participants. Therefore the combination of the ease of the monitoring method and the quality of training should contribute to the capacity of participant monitors. Key questions which guide an effective participatory monitoring programme are:

1. What is the need for monitoring?
2. What should be monitored (Lindenmayer & Likens, 2009)?
3. When and where should monitoring take place?
4. What indicators will be sensitive to change?
5. Which scale and frequency will enable valid comparison of data (Spellerberg, 2005; Jones, 1986)?
6. Are the data collected by participants reliable (Brandon *et al.*, 2003; Holck, 2008)?
7. Are the costs within the financial capacity of local land management institutions?
8. Is the speed of monitoring consistent with the time available to monitor (Danielsen *et al.*, 2005a)?

Table 3.1. A summary of the four identified key requirements for effective collaborative monitoring, within the category of effective measurement of change. These were sourced from relevant monitoring and management literature

	Key requirements	Description	References
1	**Appropriateness**		
	Threats	Monitoring must assesses the relevant threats or resource management domains (RMDs)	(Salafsky & Margoluis, 1999; Babu & Reidhead, 2000)
	Scale	Monitoring must assesses the threat at the relevant scale	(Spellerberg, 2005)
	Indicator sensitivity	Indicators must be sensitive to change and relevant to threat and scale	(Dale & Beyeler, 2001; Barrios *et al.*, 2006; Spellerberg, 2005)
	Relevance to local livelihoods	Monitoring methods must be relevant to local livelihoods	(Danielsen *et al.*, 2000)
2	**Reproducibility and data reliability**		
	Replicablity	Data collection must be repeatable so that it can be compared	(Spellerberg, 2005)
	Reliability of data	Data collected must be reliable and accurate	(Danielsen *et al.*, 2005a; Spellerberg, 2005)
3	**Cost effectiveness**		
	Financial costs	Monitoring costs must be affordable	(Caughlan & Oakley, 2001; Spellerberg, 2005)
	Time costs: opportunity cost to labour	Monitoring must be time efficient	(Danielsen *et al.*, 2005a)
4	**Practical ease**	Participants must be able to confidently and properly monitor	(Danielsen *et al.*, 2005a; Stuart-Hill *et al.*, 2005)

Key requirements for assessing the contribution to adaptive capacity through social learning

Building adaptive capacity was identified as an important goal for enhancing local participants' ability to deal with local social-ecological challenges in their context (Fazey *et al.*, 2007). Social learning is a key component of adaptive capacity. Social learning is a broad term which relates to the learning processes and changes that occur among individuals and social systems (Pahl-Wostl *et al.*, 2008). More specifically, it can refer to learning that happens to individuals when observing others or social interactions within groups. It assumes an iterative feedback process with learners and their environment. Learners affect their environment and the changes in turn affect the learner (Bandura, 1977) therefore assisting in building adaptive capacity. Technical capacity for monitoring is also important as it builds the capacity of the local participants' ability to monitor natural resources (Danielsen *et al.*, 2005b; Stuart-Hill *et al.*, 2005). The contribution of local ecological knowledge is also an important requirement as it can contribute to the sharing of knowledge among local participants and thereby also contributing to learning (Berkes *et al.*, 2000) . It can also empower local participants as they engage in a more equal collaboration with scientists where local knowledge is given a more equal role (Moller *et al.*, 2004). Some of the potential benefits to involving the local community in monitoring through participatory engagement are learning, (Pahl-Wostl *et al.*, 2008; Wolfenberg *et al.*, 2001) empowerment through fair engagement with scientists (Fraser *et al.*, 2006; Wiber *et al.*, 2009) and better local management of natural resources through interventions (Danielsen *et al.*, 2007). As such key requirements within this category were defined as: learning and awareness; technical capacity; and the contribution of local ecological knowledge (LEK) by local participants.

Learning and awareness

Specific learning and awareness should emerge from the use of the monitoring methods in the process. This is because of the notable benefits of learning in participatory approaches. These benefits include building knowledge about ecology (Toderi *et al.*, 2007), skills training (Abang *et al.*, 2007; Misiko *et al.*, 2008) and the potential for change in participants' actions through transformative learning (Sims & Sinclair, 2008; Pahl-Wostl *et al.*, 2008).

Technical capacity

Technical capacity to carry out the participatory monitoring methods is an important outcome for the monitoring process. This should include adequate capacity and skill among local monitors to collect data on the natural resource of focus and analyse the data so that conclusions can be drawn from this information (Stuart-Hill *et al.*, 2005).

Local ecological knowledge (LEK) contribution

Local ecological knowledge can be an important knowledge source for understanding local ecological components and processes (Chalmers & Fabricius, 2007). Its contribution can build legitimacy (Capistrano *et al.*, 2005) and help bridge the gap between Western and local knowledge systems. This in turn can contribute to social learning and a greater understanding of social-ecological systems in a community by building a relationship between different knowledge systems (Chalmers & Fabricius, 2007; Gadgil *et al.*, 2000; Cundill *et al.*, 2005).

Key questions which serve to assess the contribution of monitoring to adaptive capacity are:

1. To what extent is the technical capacity to monitor, for local participants, developed?
2. To what extent does the contribution of local ecological knowledge from local participants occur?
3. To what extent do learning and awareness occur?

Table 3.2. A summary of the identified key requirements for effective collaborative monitoring, within the category of building adaptive capacity. These were sourced from relevant monitoring and management literature

	Key requirements	Description	References
1	**Learning and awareness**	Social learning, and learning on ecology and management should occur	(Toderi *et al.*, 2007; Pahl-Wostl *et al.*, 2008; Sims & Sinclair, 2008; Abang *et al.*, 2007; Misiko *et al.*, 2008)
2	**Technical capacity**	Participants should develop technical skills to monitor	(Stuart-Hill *et al.*, 2005)
3	**Local ecological knowledge (LEK) contribution**	Monitoring should incorporate LEK to build legitimacy and empowerment	(Chalmers & Fabricius, 2007; Capistrano *et al.*, 2005)

The participatory process

A range of interventions stimulated community participation in the research process. The sequence of participatory interventions during the research process is shown in table 3.3.

Table 3.3. The interventions that stimulated community participation throughout the research process, in each study site with the time period for each phase

Phase	Duration of phase	Intervention	Frequency
II : Scoping	Feb – June 2007	Community meetings with local leadership and stakeholders	Done once for each study site
III : Rigorous	June – Dec 2007	Community meetings with local leadership and stakeholders	Done once for each study site
		Participant training Discussion groups Monitoring data collection Discussion groups	Done for each monitoring method
		Community feedback meetings	Done once for each study site

Stakeholder meetings were a very important part of the participatory process and would typically involve the local land management organization, local government officials and/or local traditional leaders. During the scoping phase one community meeting was held in each study site so that the research process for developing and testing relevant monitoring methods could be presented and permission could be obtained to proceed.

The scoping phase was then done with participants selected during the initial meetings to assist in assessing the monitoring methods. Following the scoping phase, final authorization was gained during a community meeting with local leaders and stakeholders in each study site. This was to introduce the testing of the monitoring methods rigorously using participants from the land management organization representing the villages of the study area. Local leaders included traditional leaders, local land management organization members and elected local government representatives. Local government representatives were not present in Nqabara although they were invited.

Following this, a second public meeting was arranged to identify the important natural resources in the community and the factors threatening them. The most knowledgeable participants were identified by the community members during the public meetings, and involved in the subsequent steps. A work plan was identified with the community. This was done through seeking consensus with the local community leaders (Mikkelsen, 2005).

In Machubeni and Nqabara one representative from each of the village land committees was selected to participate in the development of monitoring methods. These participants were identified because they had interests in the identified important natural resources considered to be under threat, and they would be able to relay information about the monitoring process back to their villages. The selected participants were then brought together for a third meeting prior to the participant training, to discuss the benefits of natural resource monitoring and its role in CBNRM.

As part of the participant training, proposed monitoring methods and procedures were described and discussed with the selected participants. A diagram of an adaptive monitoring cycle (fig 3.2) was presented and discussed. This was done using discussion groups because of the benefits discussion groups have in revealing social dynamics and participants perspectives in a social context (Mikkelsen, 2005). The discussion began by exploring the reason for monitoring the specific natural resource that would be monitored and the potential benefits or problems which might occur during monitoring in relation to the key requirements. This was to get early participant perceptions on whether they thought the monitoring methods may meet the key requirements successfully, and to identify any obvious problems. Specific threats to the natural resource to be monitored and the relevant scales and indicators were discussed in depth. Everything was explained in isiXhosa by the researcher or the research assistant who were both fluent in isiXhosa. The appropriate isiXhosa words were identified by the researcher and the research assistant to explain terms such as environment, natural resources, natural resource health, conservation, monitoring, management and the key requirements. If key words were not completely understood these terms were discussed to explain them further.

Due to the variation in literacy levels among participants, the key requirements were described and the monitoring methods were practiced through a training process. This involved the researcher explaining the monitoring methods and key requirements with the assistance of the isiXhosa speaking assistant. Once participants agreed that they understood the monitoring method and the monitoring process, a practice run was done. Participants experimented with the monitoring methods (cf.Chapter 4) until they were confident that they had no problems with the method. If there were parts which were still not understood these were explained again until each participant was confident that he/she had grasped it. Assistance was given where problems were experienced and these were noted. Actual monitoring exercises were then performed to collect data for each relevant natural resource of focus using the relevant monitoring method. The data collected were analysed and their significance discussed. After the data collection phase, the key requirements for good monitoring were discussed and reflected on to determine participants' views on whether the monitoring method had met the defined key requirements or not. The positive and negative aspects cited by participants for each key requirement were noted.

Finally, a public meeting was called by the land management organizations in the respective communities to report back the findings of the monitoring method testing to the community, including traditional leaders and local government officials who were involved.

Data collection

This study drew on four main sources of data. The first data source was that of personal observation and experiences which were documented in field notes. This was done daily and throughout the day's activities in the field to document information about conversations, meetings and discussion groups. Secondly, semi-structured interviews were conducted with participants as a second data source before and after monitoring occurred. Thirdly, data were collected by participants at benchmark sites, as well as by the researcher or 'expert'. Secondary data sources were also used, including agricultural records, climatic records, reports and analyses by other scholars.

Participant observation (Phase II and III)

Qualitative data were collected through participant observation and semi-structured interviews. Participants' actions and activities were documented as field notes throughout the research process. Participant observation occurred during community meetings, conversations with members in the study site area, discussion groups and during data collection at benchmark sites.

Semi-structured interviews (phase III)

Semi-structured interviews were held with the participants (Babbie, 1992; Yin, 2003). Interview times were pre-organized at community meetings, and a local community assistant accompanied the researcher to interviews. The local assistant who was a home language isiXhosa speaker was selected, by the local community land management organization, to assist the researcher in travelling around the village and finding the selected participants' homesteads. Semi-structured interviews were conducted in isiXhosa, and where the researcher did not fully understand the respondents' answers to questions, the local community assistant would help explain. A number of key questions and topics were used to guide the interview and additional information and issues raised by the participants were noted.

The first semi-structured interview was conducted with the selected participants before the testing of monitoring methods in the rigorous testing (phase III). A total of 30 participants were interviewed across the different monitoring methods tested. Some participants took part in the testing of more than one monitoring method. Twelve participants took part in the *Acacia karoo* density method, twelve in the forest health assessment, six participants in the fixed point photography method, six in the grass health assessment and five in the live ungulate health ranking. All participants were local members of the local land management organization. Some participants were local experts on the natural resources of focus as they had respected local ecological knowledge on these natural resources. There was at least one local expert participant, involved during the testing of each of the monitoring methods, who had local ecological knowledge on the natural resource of focus namely rangelands or indigenous forests.

Semi-structured interviews were done to get feedback on local participants' personal profiles, an understanding of their expectations of the process and their perspectives on the perceived incentives of being involved in the monitoring project. The semi structured interview was also used to asses the participants' awareness of important natural resources in the community, perceived natural resource threats and their perceptions on monitoring and management practices. After recording biographical details, the questions asked were:

1. What are your personal and general expectations for the monitoring testing process?

2. What are the important natural resources and threats in the community?
3. What monitoring occurs in the community and how?
4. What management practices occur in the community?

A second round of interviews was conducted after the practical monitoring method testing. This was done in order to get feedback about the local participants' understandings of the monitoring process, weaknesses and strengths of the monitoring methods, learning that occurred, local ecological knowledge contributed and views on the legitimacy of the monitoring methods. Questions asked were:

1. Can you describe the monitoring method process correctly?
2. Are there problems with the monitoring methods? How can they be solved?
3. Are more monitoring methods required?
4. What did you learn during the process?
5. Did your own ecological knowledge contribute to the process? If so, what knowledge?
6. Are the monitoring methods relevant and useful and do they have a potential future use in the community? How can they be used in future?
7. Did the monitoring process meet your initial expectations?

Sample constituency (phase III)

The local land management organizations at each study site selected participants for their skills and knowledge about the local natural resources. Local participants included 18 males and 12 females, with 15 respondents from each study site. The average age was 48.1 years (n = 30; SD = 13.2). The age distribution of the participants is shown in figure 3.4.

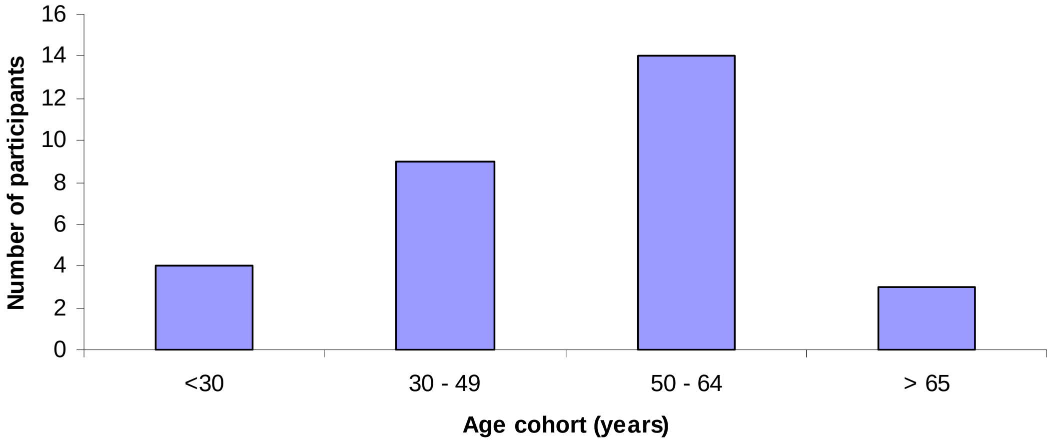

Fig 3.4. The age distribution of the participants interviewed.

The average age for female participants was 42.5 years (n = 12; SD = 12.6) while the male average was 51.8 years (n = 18; SD = 12.5). Of the 12 female respondents eight were from Machubeni and four from Nqabara. There were no female participants above the age of 64 (fig 3.5), while there were three males above 64 years of age.

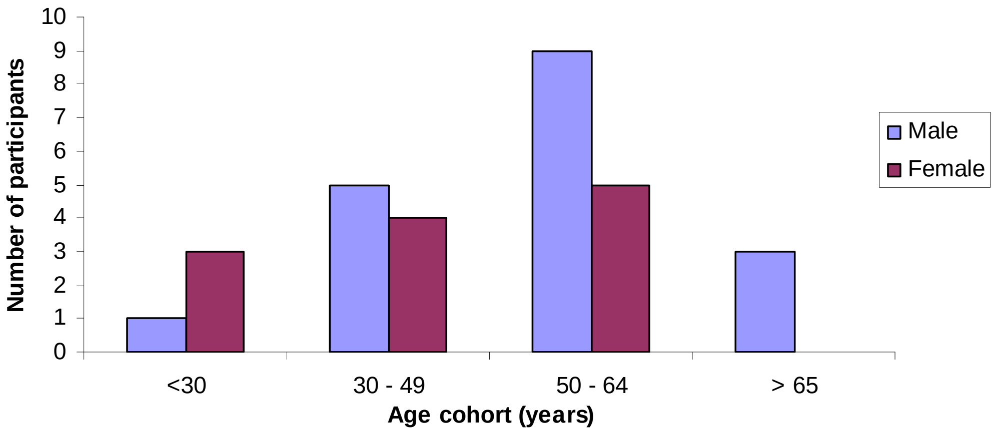

Fig 3.5. The gender distribution according to age of the participants interviewed.

Completing secondary school typically takes 12 years in South African government schools. Primary school is for the first seven years. The average number of years completed in formal education for participants was 8.4 years (n = 30; SD = 3) and only five participants had completed twelve years of schooling (fig 3.6). No participants had done tertiary education. However one participant had done short courses on HIV/AIDS education for schools. Four out of the five participants who had completed twelve years of schooling were female. All female participants had finished seven or more years of schooling, while four males had finished less than seven years of schooling.

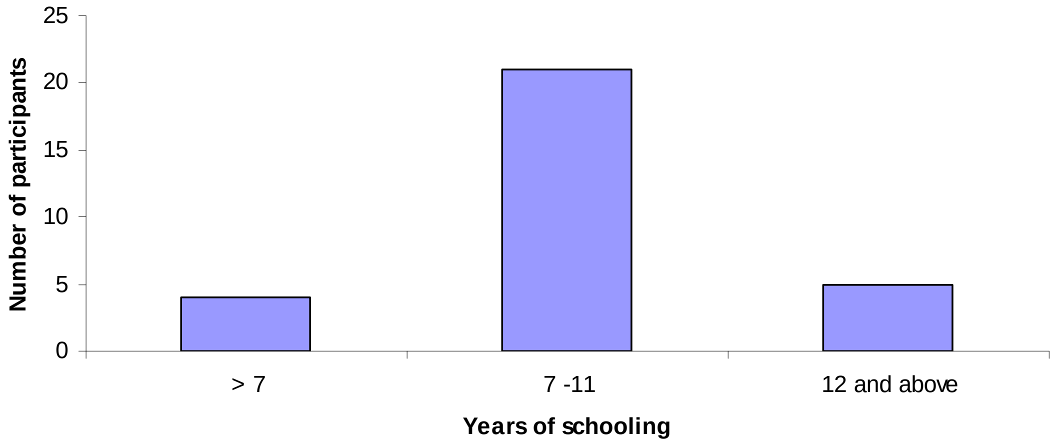

Fig 3.6. The number of participants which completed up to seven years, between seven and twelve years, and twelve years and higher, of formal schooling.

Participants had resided in the study area for an average of 44.5 years (n = 30; SD = 14.7). Twenty six of the 30 participants had been born in the study site area. The duration of residence in the study site area by participants is shown in figure 3.7.

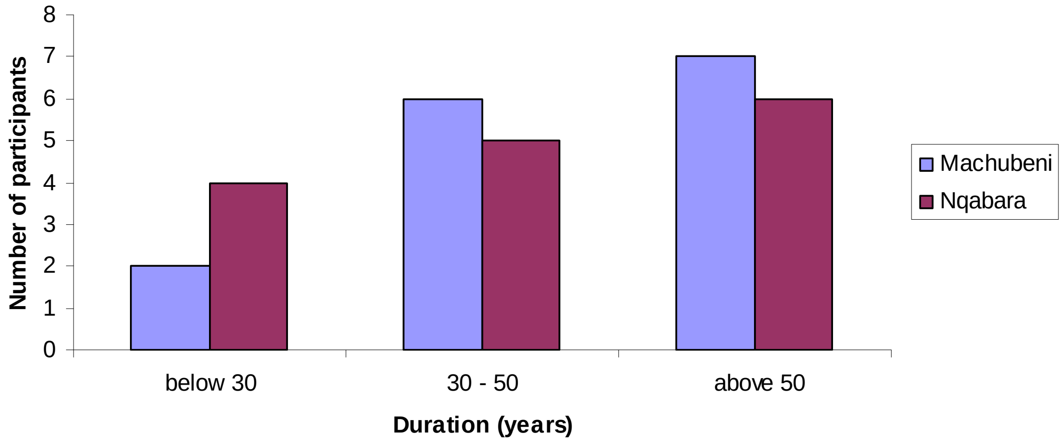

Fig 3.7. The duration of participants' residence in the study site area, of the participants interviewed.

Collecting baseline data (phase II and III)

Quantitative data collection included measuring natural resource variables at specific sites identified by participants. Sites were defined as benchmarks (Stringer, 2009) of health or benchmarks of degradation where possible, so that data collected could be tested for its sensitivity to differences among these sites (Fabricius *et al.*, 2006; Bailenson *et al.*, 2002; Chalmers & Fabricius, 2007). Differences between data collected by an 'expert' and locals were also assessed. The 'expert' was defined as a trained biologist who had been formally trained in scientific practices and had a tertiary education. Local participants had been trained specifically for the monitoring methods and had no tertiary education.

Collecting baseline data on benchmark sites was done to test the monitoring methods in the field on the identified threatened natural resources, after participants had learnt to use the monitoring methods. Participants were taught to use the monitoring methods during discussion groups where it was explained and discussed in depth. Participants then did a practice run for each monitoring method of data collection and data analysis until they were confident with the process. This was done so that participants could collect the most reliable data using the monitoring method. Data sheets (Appendix 1 - 6) were used to collect data on variables such as species abundance, health ranking, cover ranking, and tree diameter as modelled on the event book systems designed by Stuart-Hill *et al.* (2005). Participant data were compared to the formally trained biologist's data.

Participants identified the advantages and disadvantages of a monitoring method in relation to the defined key requirements of appropriateness, practical ease, costs and learning. These were discussed after data collection. The details of the monitoring methods identified advantages and disadvantages. The details of the monitoring methods' ability to effective measure change and contribute to adaptive capacity, are given in chapters four and five respectively.

The scoping phase (phase II)

During the Scoping phase, seven provisional participatory monitoring methods were identified for monitoring threats to rangelands and indigenous forests. The seven monitoring methods were assessed qualitatively by the researcher and the local land management organizations, to identify which had the greatest potential to fulfil the key requirements for effective measurement (table 3.1) and contribution to adaptive capacity (table 3.2). Those which had critical shortcomings were eliminated before the rigorous testing phase (phase III). Critical shortcomings were defined as weaknesses in key requirements which could not be resolved within the given research time. The monitoring methods which did not have critical weaknesses were further tested in the rigorous testing stage (phase III).

The local land management organizations assisted in giving feedback on the monitoring methods during the scoping phase, in order to identify critical shortcomings. One local participant from the land management organization in each study site was involved in data collection and gave feedback on the extent to which a monitoring method met the key requirements and whether there were any critical shortcomings within these (table 3.1).

The key requirements used to provisionally assess the participatory monitoring methods qualitatively were: appropriateness; practical ease; cost; speed; learning and local ecological knowledge (LEK) contributed. The key requirements of data reliability and technical capacity were only assessed in the rigorous testing (phase III). This was because of the low number of participants who collected data for the scoping stage (phase II) and therefore these could not yet be tested.

The scoping phase was a qualitative assessment of preliminary identified monitoring methods using the key requirements identified for successful participatory monitoring. The two main questions used for identifying the participatory monitoring methods with the greatest potential to meet the key requirements during the scoping stage were:

1. Did the monitoring method meet the key requirements sufficiently without critical shortcomings?
2. What actions could be taken to solve problems faced by the participatory monitoring methods, if they were not critical?

The scoping phase steps were as follows;

1. The main natural resource threats to rangelands and indigenous forests in the community were identified by the local land management organizations.
2. The researcher then selected provisional methods from the literature which had the potential to be participatory and could monitor the main local natural resource threats identified.
3. The selected monitoring methods were then tested qualitatively in the field to assess them against the key requirements for effective measurement and building adaptive capacity.
4. Weaknesses or critical shortcomings were noted for each monitoring method.
5. The monitoring methods which had critical shortcomings were removed from the list of potential participatory monitoring methods. Where possible these were replaced with new adapted participatory monitoring methods. Adaptation to the remaining monitoring methods was done to strengthen their weaknesses.
6. The remaining potential participatory monitoring methods were then further tested in the rigorous testing phase (phase III) to fully assess their strengths and weaknesses after they had been adapted from lessons learnt.

Provisional monitoring methods assessed

Acacia karroo GPS measurement

Three *Acacia karroo* woodland edges were identified by a local participant. At the fringe the nearest *Acacia karroo* individual with a diameter >10cm was marked with a Global Positioning Satellite (GPS) and documented. Three points on the grassland side of the *Acacia karroo* woodland fringe were then marked with the GPS and their relative distance to the measured *Acacia karroo* individual was documented. Any juvenile *Acacia karroo* individuals within the marked polygon were counted.

Fixed point photography

Fixed point photographs were taken of intervention sites (Rasmussen & Voth, 2001). These sites were areas where the following had been done by ATS Ikhwezi; gulley erosion rehabilitation, fencing off of areas from grazing, and the fencing off of river banks. ATS Ikhwezi was the local implementing agent for land restoration. Repeat photographs were then taken by the researcher at sites where original photographs had been taken of the site before the intervention had taken place by ATS Ikhwezi field workers. The GPS points for the photographs were documented. These were then ranked according to the state of the 1st and 2nd photograph and the change between the photographs, using the criteria in table 3.4.

Table 3.4. The ranking criteria for individual photographs and the change between photographs over the time frame between them, is shown below

Rank	Criteria
	Individual photographs
+2	Pristine area, ultimate grassland health
+1	Healthy grass cover, low bare patches, grassy
0	Fair, not good or bad
-1	Degraded with bare patches, eroded patches, grass cover thinning
-2	Highly degraded unusable area
	Change between 1st and 2nd photograph
+2	Highly improved in comparison to original picture
+1	Increase in grass cover, less bare patches, grass growing on previous eroded areas
0	None
-1	Increase in bare patches, eroded patches, grass cover thinning
-2	Highly degraded in comparison to original picture

There were different time frames between each pair of photographs, which were documented by participants who were ranking the photographs. Ten participants from the community's local land care groups did the ranking. Following this, baseline fixed point photographs were taken of the key resource areas in the Machubeni villages. This was done for 10 villages of 14 in the Machubeni area. For data analysis the ranked photograph results were converted into a bar chart so that the change in the state between the 1st and 2nd photograph could be assessed. The state of the 1st and 2nd photograph was also displayed in the column chart.

Forest health assessment

A 100m transect was placed in three different indigenous forests. The method described in the Nqabara Management Plan for monitoring indigenous forests was used (Mafa Environment & Development cc 2005). The transect start and end were marked with a GPS. Then indigenous tree indicator species were measured for diameter at breast height (DBH) and damage ranking along the 100m transect. This was done with a participant from the community. Damage ranking for trees was categorized according to the criteria in table 3.5.

Table 3.5. The criteria for damage ranking of indigenous trees is shown below

Rank	Criteria
0	No damage
1	A branch removed
2	More than one branch removed or bark removed
3	Trunk cut but re-sprouting
4	Dead

Commonly used tree species used by the community, as defined in the Nqabara Management Plan (Mafa Environment & Development cc 2005), were used as indicators. The species were *Millittia grandis* (Umsimbeet), *Ptaeroxylon obliquum* (Umthathi), *Premna mooiensis* (Umcacambane) and *Coddia rudis* (Insinde). For data analysis the information collected was converted into bar charts so that the number of tree species for each forest, the average diameter for each forest and the average damage ranking for each forest, could be compared.

Grassland health assessment

Three 100m transects were done on a healthy benchmark site, that had been enclosed by fencing and not grazed by livestock for approximately 2 years. Three additional 100m transects were done on an adjacent area which was highly degraded and unprotected from grazing. The co-ordinates of the start and end of each transect were documented. Grass cover was ranked using the Braun-blanquet cover abundance technique (Mueller-Dombois & Ellenberg, 1974), in 1 by 1m quadrants at 10 m intervals. This was done by a local participant from the land management organization. The ranking of cover abundance was done according to the criteria shown in table 3.6.

Table 3.6. The ranking criteria for the cover abundance of 1 x 1 m grassland quadrants, is shown below

Rank	Criteria
0	no cover
1	0 – 10% cover
2	10 – 25% cover
3	25 – 50% cover
4	50 – 75% cover
5	75 – 100% cover

A frequency analysis was done for each ranking and then a bar chart was made so that the frequency of ranks in the benchmark site could be compared with the degraded site.

Live ungulate health ranking

Ten percent (every 10th Livestock unit) of the cattle at a cattle dipping day were ranked according to the live ungulate health ranking (Rhiney, 1982). The cattle were ranked into three categories of good health, fair health and poor health according to the Rhiney 1982 indicators of live ungulate health ranking (fig. 3.8). If the angles at point (a) and (c) are not observed the animal is classed as in good condition. Poor condition is given to an animal if any two of the points indicated at (b), (d) or (e) can be seen. An animal is classed as in fair condition if it is not clearly classed as good or poor (Rhiney, 1982). For analysis the data collected was converted into percentages for each rank and put into a bar chart so that health ranks could be compared.

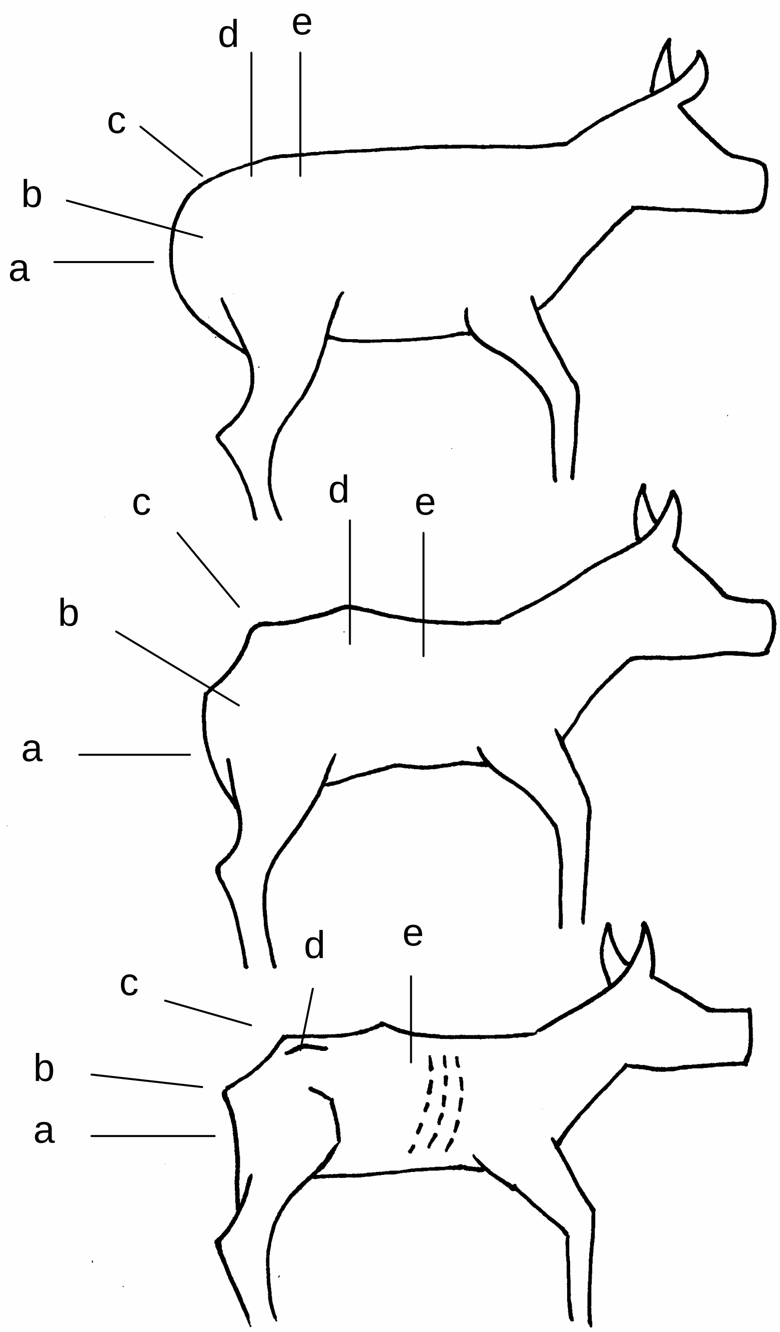

Fig 3.8. The physical indicators for live ungulate health ranking (Rhiney, 1982)

Livestock data collection

Records from a livestock unit (LSU) survey, done by the Agricultural Department in Lady Grey, were obtained from ATS Ikhwezi. ATS Ikhwezi was a local land restoration implementing agent in the area. This data was analysed per village area and per livestock type for the whole Machubeni area. For analysis data collected from ATS Ikhwezi records on the Machubeni LSU survey were put into a bar chart to compare total LSU for each village.

Livestock household survey

The potential for a household survey of livestock was explored in a discussion group. The monitoring tool was not tested in the field due to the critical negative aspects cited by participants for key requirements. The data sheet was structured as a bar chart.

Table 3.7. A summary of the provisional monitoring methods and the scoping phase findings with regards to critical shortcomings, and the action taken for each method before entering phase III

	Participatory monitoring method	**Critical shortcomings**	**Action taken**
1	*Acacia karroo* GPS measurement	no GPS literate participants	replaced
2	Fixed point photography	none	adapted
3	Forest health assessment	none	adapted
4	Grassland health assessment	none	adapted
5	Live ungulate health ranking	none	adapted
6	Livestock data collection	difficult to access data from local authorities	removed
7	Livestock household survey	social resistance to household census	removed

Monitoring methods with critical shortcomings

The *Acacia karroo* GPS measurement method was removed from further testing as a potential participatory monitoring method. The critical shortcoming for this monitoring method was the use of the GPS for distance measure, as this was practically difficult to use for the local participant who was not GPS literate (table 3.7). There were no other participants who were GPS literate in the community according to the land management organization. Therefore this monitoring method did not show adequate potential to be taken into the next phase for testing.

The monitoring methods of Livestock data collection and Livestock household survey were both removed for further testing as they both had critical shortcomings. This was for different reasons. For livestock data collection, this was because of the key requirement of practical ease. Difficulties in obtaining the livestock census records from external sources for the land management organization were experienced. The local land management organization cited difficulties due to lack of sufficient transport and communication with the local authorities of the department of agriculture who had the data. The livestock household survey method had a critical shortcoming for the key requirement of appropriateness, and this was due to perceived social resistance by locals of being asked about their livestock numbers from household to household. The local land management organization felt that household livestock censuses would create distrust between the local community and the local land management organization. The distrust was associated with agricultural extension officers who had used livestock census data to impose strict stocking rates and the culling of livestock, in the past.

Monitoring methods adapted and tested further

The monitoring methods namely grassland health assessment, fixed point photography, forest health assessment and live ungulate health ranking showed good potential for meeting key requirements with no critical shortcomings observed or given as feedback from the local land management organizations. These monitoring methods showed good potential of becoming strong participatory monitoring methods. However, all of them required further adaptation to strengthen their potential to meeting the key requirements of good collaborative monitoring. The adaptations made included making the monitoring methods more practically easy by using an event book system for data entry, data analysis (Stuart-Hill *et al.*, 2005) Monitoring methods which had GPS use were adapted so that the GPS could be substituted by written directions, clear numbering and markers for monitoring sites.

The *Acacia karroo* GPS measurement method was removed. An alternative collaborative monitoring method was required to monitor *Acacia karroo* woodland encroachment. The GPS method was substituted with an *Acacia karroo* density monitoring method, based on plant density monitoring methods (Cottam, 1956). This showed potential to be a good participatory monitoring method. A participatory monitoring method is still required to substitute the two livestock census monitoring methods which had critical shortcomings. However, no substitutes were found within the given research time for this study which could overcome the critical weaknesses.

The rigorous testing phase (phase III)

During the rigorous testing stage (phase III), the monitoring methods were assessed according to a five point rating system for the key requirements for effective measurement (cf.Chapter 4). The points were used to rate the monitoring methods against the key requirements of effective measurement, as strong or weak. This was done so that monitoring methods could be evaluated and compared. The monitoring methods were assessed qualitatively for the key requirements of building adaptive capacity namely; for the technical capacity gained; local ecological knowledge contributed and learning which occurred (cf.Chapter 5). The methods of assessing the monitoring methods and their specific details are given in chapter four and five.

CHAPTER 4: An Assessment of Methods Used in Community-based Ecosystem Monitoring in the Eastern Cape, South Africa

The need for appropriateness and effectiveness in measuring change

Rural impoverished communities who live on communal lands are faced with multiple threats which are evident at various scales (Fabricius *et al.*, 2006). The livelihoods of rural communities, in communal lands in South Africa, are also largely dependent on local natural resources (Shackleton *et al.*, 2007; Shackleton *et al.*, 2005). The threats which face important natural resources are specific to the resource itself. In rural communal lands over harvesting or over utilization are the common cause of natural resource degradation (Ostrom, 2008b; Shackleton *et al.*, 2009).

In this study, the main natural resources identified are grasslands and coastal indigenous forests. These are the key land elements found in the study sites. Grasslands face threats of overgrazing due to overstocking and a lack of proper rangeland management (DEAT, 2004; Hudak, 1999; Hoffman & Todd, 2000). There are also other related problems from overgrazing such as *Acacia karroo* invasion (De Klerk, 2007) and a the deterioration of livestock quality which are a valuable cultural and economic resource (Shackleton *et al.*, 2001).Indigenous forests face the threat of over-harvesting of prized species, which contribute to local livelihoods (Shackleton *et al.*, 2007). In order to curb the effects of over-harvesting of forests and overgrazing of rangelands, better local management and monitoring are required (Gibson *et al.*, 2005). Collaborative monitoring methods need to be evaluated with specific reference to their relevance to local threats, their connection to local livelihoods and their usefulness in contributing to natural resource management.

The effective measurement of change is an essential goal in monitoring as a function of management. This is because changes or threats to natural resources, inform managers about what is occurring, so that they may develop an appropriate managerial approach to deal with the nature of the change. In typical monitoring approaches, a target of the ideal state of natural resources and ecosystems is usually set (Spellerberg, 2005). In integrated monitoring projects a sustainable development goal is identified (Reed *et al.*, 2005). These benchmarks direct the monitoring approach. Once problems and threats have been identified, quantifiable measures of ideal natural resource states are used as benchmarks from which the monitoring data can be compared to when ascertaining the extent of change that has occurred (Kouplevatskaya-Yunusova & Buttoud, 2006).

Within this monitoring process, the identified key requirements that are set to assess the effectiveness of a monitoring method's ability to detect changes all contribute significantly to the attainment of social or ecologically responsive monitoring objectives. This needs to occur at an appropriate scale (Babu & Reidhead, 2000; Salafsky & Margoluis, 1999), and requires the use of indicators that are sensitive to change (Dale & Beyeler, 2001; Kremen *et al.*, 1998)

The usefulness of indicators depends on their sensitivity to threats and the appropriateness of the scale at which the threats occur. Indicators used to detect changes in natural resources mostly deal with the physical components of the ecological system. This includes factors such as silting water quality (United Nations Environment Programme (UNEP), 2009), species composition (Brandon *et al.*, 2003), abundance (Mayaux *et al.*, 2005; Gaidet *et al.*, 2003) and natural resource use (Van Rijsoort & Jinfeng, 2005). Sensitive indicators are needed for effective monitoring but can be difficult to identify and generally limited in scope (Dale & Beyeler, 2001).

Appropriateness of monitoring has many aspects (cf.Chapter 3). The critical aspects which need to be identified in relation to natural resource monitoring methods are : a) whether the monitoring methods are considered useful by participants (Smith *et al.*, 2003; Danielsen *et al.*, 2005a); b) whether participants regard them as relevant to their livelihoods (Capistrano *et al.*, 2005) and c) whether the participants see the methods as having potential future use (Lawrence *et al.*, 2006). Building the legitimacy of monitoring methods among local participants is critical to its sustainability. This ensures that the monitoring methodology is not seen as a passing and ineffectual trend, but is rather appreciated as having a recognisable function that has real long term benefits for land managers involved in the local management of natural resources (Topp-Jorgensen *et al.*, 2005).

Reliable data is a crucial aspect in the reproducibility of monitoring methods (cf.Chapter 3). Accurate data are required to reveal the actual trends which are occurring (Holck, 2008). Variability in local participant data collection can be an important factor to consider because if the reliability is low it becomes more difficult to confidently compare data over time and space (Brandon *et al.*, 2003; Holck, 2008). If follow up data collected is reliable then changes can be detected when compared to the baseline data. Follow up data collection needs to be replicated against the original baseline of data collected, so that they can be compared within the same parameters (Spellerberg, 2005). This requires the standardization of factors such as sample size, site and seasonal time in order to make the follow up data a replicable sample which is comparable with the baseline data collection.

Practical ease (cf.Chapter 3) is crucial in running monitoring processes (Babu & Reidhead, 2000; Danielsen *et al.*, 2005a; Salafsky & Margoluis, 1999). In professionally executed monitoring, monitoring is commonly done by professional monitors who are trained and skilled in the area of concern. With collaborative monitoring this is not the case and therefore it is imperative that the monitoring methods are user friendly for local monitors. Financial and labour costs are also very important factors in contributing to the sustainability and practicality of monitoring methods. These therefore need to be considered carefully during the monitoring process (Caughlan & Oakley, 2001; Danielsen *et al.*, 2005a). In summary this section has summarised important issues that need to be taken into account when addressing effective measurement in collaborative monitoring. Therefore key questions that need to be considered for effective measurement of change include:

1. Are the monitoring methods appropriate to local threats and livelihoods to be useful for future community monitoring?
2. Are the data collected reproducible and reliable?
3. Are the monitoring methods straightforward enough for participants?
4. Are the monitoring methods cost effective?

Methods

Local participation and the methods selection process

During a scoping phase the local land management organisations in the two study sites assisted in giving feedback on a variety of potential participatory monitoring methods for rangeland and indigenous forest health, (cf.Chapter 3: pg 53). One local participant from each study site was selected by the land management organization members through consensus (cf.Chapter 3: pg 43, refer to the section on the participatory process). These participants were involved in data collection so as to give feedback on the key requirements of the monitoring methods. Criteria used for feedback included assessing the monitoring methods for their appropriateness, practical ease, costs; speed; learning that occurred and local ecological knowledge (LEK) contributed by participants. This was to provisionally review the suitability of the monitoring methods so that the methods with the greatest potential to meet the key requirements could be further tested (cf.Chapter 3). Monitoring methods which had critical shortcomings were removed. The remaining methods that were tested were and are assessed in detail in this chapter were: *Acacia karroo* density; fixed point photography; forest health assessment; grassland health assessment and live ungulate health ranking.

Methods to monitor natural resource health

Acacia karroo density

The monitoring of *Acacia karroo* was seen as a relevant method because its encroaching density was considered a threat to the agricultural and grazing lands in Nqabara (O'Connor, 1995; De Klerk, 2007; Walters *et al.*, 2005). Dense stands of *Acacia karroo* are commonly found along forest edges. A mark was set up on a random *Acacia karroo* individual in the vicinity of the footpath entering two forests, namely; Lubelu and Mbencane (plate 1). One sample was done at each site. Randomness was ensured by throwing a rock away from the forest entry point and using the closest *Acacia karroo* individual as the centre point. These sites were considered to be in the encroachment zone of the forest. *Acacia karroo* density was attained by counting all *Acacia karroo* individuals within ~400m² (a circle with radius 11.2m) around the mark. Counting was done by participants and a formally trained biologist and entered into the method data sheet (appendix 1). The radius was defined using a rope fixed to a pivot point. *Acacia karroo* density counts were compared in the sites sampled.

Plate 1. Monitoring participants are seen setting up the 11.2 m rope from a central *Acacia karroo* individual, so that sampling can take place within this radial area

Fixed point photography

Fixed point photography and ranking (Rasmussen & Voth, 2001) were done at four rangeland localities (Schmidt & Hewitt, 2004). Photographs which had been taken in March 2007 were used for comparison against pictures taken in December 2007. This was done so that seasonal and overgrazing impacts through the duration of the winter could be assessed. In addition to this, participant ranking of these seasonal changes were tested. A pair of photographs, from March and December 2009 (plate 2 & 3), was ranked by six participants from the Machubeni land management organisation and a formally trained biologist. This was done by subjectively ranking the rangeland condition in the 1st and 2nd photograph, and the change between them according to the criteria in table 4.1. Ranks and photographic information were entered into the method data sheet (appendix 5)

Table 4.1. The ranking criteria for individual photographs and the change between photographs over the time frame between them, is shown below

Rank	Criteria
	Individual photographs
+2	Pristine area, ultimate grassland health
+1	Healthy grass cover, low bare patches, grassy
0	Fair, not good or bad
-1	Degraded with bare patches, eroded patches, grass cover thinning
-2	Highly degraded unusable area
	Change between 1st and 2nd photograph
+2	Highly improved in comparison to original picture
+1	Increase in grass cover, less bare patches, grass growing on previous eroded areas
0	None
-1	Increase in bare patches, eroded patches, grass cover thinning
-2	Highly degraded in comparison to original picture

Plate 2. A fixed point photograph taken by the researcher in March 2007 at the Helushe village

Plate 3. A repeat fixed point photograph taken by a participant in December 2007, at Helushe village. This is a repeat photograph for plate 2. Evidence of increased grazing and bare patches can be seen when the two photographs are compared visually. The local participant is displaying the photograph identity, date and village name

Forest health assessment

A forest health assessment, along fixed transects, was done in two forest patches, in Nqabara, with different harvesting levels. The communal forests of Mbencane and Lubelu were identified by the local land management organization as differing in species composition and use. Lubelu forest was identified as highly used with a low abundance of useful species. This was considered to be due to the forest location which is easier to access as it is closer to the centre of the village. The Mbencane forest was identified as infrequently used with a high abundance of useful species due to it being further away from the centre of the village. Harvesting patterns vary within the forests of Nqabara and this is likely due to their accessibility or inaccessibility to local forest harvesters (De Klerk, 2007).

A 100m fixed transect was set up alongside foot paths in each of the forests, immediately off the main footpath into the forest. The most important species used by the community were identified as good indicators. These were identified as *Millettia grandis* (Umsimbeet), *Ptaeroxylon obliquum* (Umthathi), *Premna mooiensis* (Umcacambane), *Duveronia adhatodoiodes* (Ihlwehlwe), *Strychnos henningsii* (UmNonono) (Van Wyk & Gericke, 2000). All the indicator tree species were identified, counted, and measured for diameter at breast height (DBH), on 1m of either side of the 100m fixed transects (plate 4). Damage to indicator trees was ranked. This was done by 14 participants from Nqabara and a formally trained biologist. Damage ranking for trees was categorized according to the criteria in table 4.2. Data collected was entered and analyzed using the method data sheet (appendix 6).

Table 4.2. The criteria for damage ranking of indigenous trees is shown below

Rank	Criteria
0	No damage
1	A branch removed
2	More than one branch removed or bark removed
3	Trunk cut but re-sprouting
4	Dead

Plate 4. A monitoring participant practices measuring the DBH (diameter at breast height) of important forest species, on a 100m fixed transect

Grassland health assessment

Quadrants positioned along fixed transects in grasslands were surveyed using cover abundance estimates. A healthy grazing field and degraded one were identified as benchmarks by participants at Machubeni. The healthy benchmark site had been completely surrounded by fencing for three years and closed off to livestock grazing. Six transects of 110meters in length were surveyed in total with ten quadrants which were respectively, 1m by 1m in size. Quadrants were surveyed every ten meters along the transect length (plate 5). Three transects were surveyed on the un-grazed field and three on the grazed field.

Grass cover was ranked using the Braun-blanquet cover abundance technique (Mueller-Dombois & Ellenberg, 1974) shown in table 4.3.

Table 4.3. The ranking criteria for the cover abundance of 1 x 1 m grassland quadrants, is shown below

Rank	Criteria
0	no cover
1	0 – 10% cover
2	10 – 25% cover
3	25 – 50% cover
4	50 – 75% cover
5	75 – 100% cover

This was done for total cover of all grass species, total cover of wanted/desirable grass species and total cover of unwanted/undesirable grass species. Weeds and *Euryops floribundus* (Lapezi) were counted in each quadrant. Results were documented and then put into data entry sheets for each site (appendix 2). Data analysis was done by comparing the frequency of ranks from each site (appendix 3). The data were collected by five participants from the Machubeni community and a formally trained biologist.

Plate 5. Monitoring participants, are seen ranking a 1 x 1m quadrant along a 100m transect, for grass cover on an overgrazed camp

Live ungulate health ranking

Ten percent of the 330 herd size at a cattle dipping day were assessed according to their live ungulate health ranking (Rhiney 1982). This was compared with baseline data collected during the scoping phase at the same dip (cf.Chapter 3) to detect changes in cattle health and herd estimates. Every 10th animal walking past a fixed point along the cattle race (alley running to the dip tank) was ranked (plate 6). The ranking was done according to the criteria described in Rhiney 1982. The cattle were categorized by meeting the criteria shown in fig 3.8 (cf.Chapter 3: pg 59). If the angles at point (a) and (c) were not observed the animal was classed as in good condition. Poor condition was given to an animal if any two of the points indicated at (b), (d) or (e) could be seen. An animal was classed as in fair condition if the animal was not clearly classed as good or poor (Rhiney, 1982). Data was entered and analyzed using the method data sheet (appendix 4).

Plate 6. Participants and the formally trained biologist rank cattle health at the exit to the cattle race of the dipping site

This was done at the dipping point which services three villages in the study site area. Data collected were placed in a bar chart for analysis so that the relative abundance of collected data on health ranking done by participants could be compared and tested against previous baseline data collected in March 2007, during the scoping phase (cf.Chapter 3). The total number of cattle at the dip was estimated by multiplying the number of cattle ranked by ten. Five participants and a formally trained biologist took part in the data collection.

Assessing the monitoring methods

<u>Appropriateness & ease of use to local participants</u>

The appropriateness and practical ease of the monitoring methods were qualitatively assessed during discussion groups and interviews. Appropriateness of the monitoring methods was assessed according to their acceptance by participants in relation to these four criteria: their usefulness; potential future use; relevance to local livelihoods; and relevance to local threats. Practical ease was assessed from participant feedback, on the advantages and disadvantages of each monitoring method.

Reproducibility and reliability of methods

The reproducibility and reliability of the monitoring methods was assessed in two ways. Firstly by assessing the variance in the results of data collected by participants, and secondly by assessing the accuracy of the data collected by participants. The variance among participant data was assessed by comparing the means for variables measured, among participants. The accuracy of participant data collected was assessed by comparing participant means for variables measured, against data collected by the formally trained biologist.

Costs

The costs of the monitoring methods were assessed by comparing the cost of equipment used plus the costs of monitoring done by participants against the costs involved in monitoring by a formally trained biologist. Costs of labour per day were estimated at approximately ZAR50 - 100 or $6 - 12 for one local participant, according to the Working for Water Programmes (WfW) basic labour rates in the Eastern Cape. The Working for Water Programme is an environmental and social development initiative (WfW, 2009). Working for Water Programme remuneration rates are typically kept below the local minimum wage of an area so that it does not compete with local labour of the private sector. For a trained biologist the cost was approximately ZAR40 or $6 per hour which adds up to ZAR 320 or $45 per day according to independent contractor rates for biologists who have a Bachelor of Science degree. This is according to the wage scale for 2009 of a Grahamstown based environmental consultancy, Coastal Environmental Services (CES), which is based in the Eastern Cape (www.cesnet.co.za). The frequency of monitoring required was assessed from feedback from participants about the number of times monitoring should take place annually. The time taken to train participants in a particular monitoring method was also included in the estimates.

Analysis

Statistics for testing the reliability of the data

Participant variance

To assess the variation among collected local participant data the co-efficient of variation (CV) among participants' means for variables measured, in a particular monitoring method, was determined using the formula:

CV = standard deviation / mean (Zar, 1998)

These were then rated as having high or low variance according to the criteria in table 4.4.

Participant accuracy

Significance of difference tests were done for the forest health assessments and grassland health assessments because participant numbers and samples were large enough for statistical analysis. A Mann Whitney U test for paired samples (Zar, 1998) was done for the forest health assessment where n = 10. The mean of the data collected by participants for each variable for each important tree species, were statistically compared with data collected by the formally trained biologist, from both benchmark forest patches. A Wilcoxon matched pairs test (Zar, 1998) was done for the grassland health assessment where n = 30 (30 quadrants per benchmark site). The mean of the rank data collected by participants for each quadrant, for the healthy benchmark site and the degraded benchmark site were statistically compared with data collected by the formally trained biologist. These were then rated as having high or low accuracy according to the criteria in table 4.4.

For the remaining monitoring methods accuracy was assessed by comparing the ratio of means for a variable, for the data collected by the participants against the data collected by the formally trained biologist. The ratio of the means was calculated by dividing the mean of a variable, across the participants' data collected, by the mean of the data collected by the formally trained biologist, for the same variable. These were then rated as having high or low accuracy according to the criteria in table 4.4.

Table 4.4. The criteria defining the key requirements of variance among participant data and accuracy of participant data compared with a formally trained biologist as high or low

Variance among participant means	Level
Co-efficient of variation	
Co-efficient of variation level ≥ 10% among participants data	High variance
Co-efficient of variation level < 10% among participants data	Low variance
Accuracy of participant data	
Significance of difference tests (Mann-Whitney U test or Wilcoxon matched pairs test)	
Expert and participant mean data NOT significantly (N.S) different ($p > 0.05$)	High accuracy
Expert and participant mean data significantly (Sig.) different ($p \leq 0.05$)	Low accuracy
Ratio of means	
Expert and participant means differ by less than 10%	High accuracy
Expert and participant means differ by more than 10%	Low accuracy

Comparison of the monitoring methods: radar charts

To compare the monitoring methods the key criteria of appropriateness, practical ease, participant data variance and accuracy were described using radar charts (Chambers, 1983). The results of the assessments of the key requirements were ranked according to the criteria in tables 4.5 and 4.6 and then presented on the radar charts for each monitoring method.

Table 4.5. The criteria defining the ranking categories for each monitoring method, for the radar charts. This is for the key requirements of appropriateness and practical ease

Criteria	Rank	Category
More advantages than disadvantages	+1	Strong
Equal disadvantages and advantages	0	Medium
More disadvantages than advantages	-1	Weak

The ranking was used to illustrate strengths and weaknesses of each monitoring methods in radar charts. This is in relation to appropriateness, practical ease (table 4.6), variability among participant data collected and the accuracy of data collected by participants (table 4.6). Where the ranking was higher, the monitoring method was assumed to be stronger in that particular aspect than other methods.

Table 4.6. The criteria defining the ranking categories for each monitoring method, for the kite diagrams, as weak, medium or strong. This is for the key requirements of variability and accuracy. High and low ratings are based on the criteria defined in table 4.4

Variability among participants' data	Rank score	Category
Low variance rating for all variables measured	+1	Strong
Combination of high and low variance ratings for variables measured	0	Medium
High variance rating for all variables measured	-1	Weak
Accuracy of participants data when compared with the expert		
High accuracy rating for all variables measured	+1	Strong
Combination of high and low accuracy ratings for variables measured	0	Medium
Low accuracy rating for all variables measured	-1	Weak

***Acacia karroo* density**

Participants considered this monitoring method to be adequate to measure changes in the threat of expansion and invasion of *Acacia karroo* in key resource areas. However, it must be said that three out of the 13 participants did not think that *Acacia karroo* expansion was an actual threat and thought that this should be debated further. Some participants viewed it as a resource for fuel wood and not a threat, while others thought it was a major threat to grazing lands and did not perceive forest expansion as good. The extent of *Acacia karroo* invasion in the whole village area and on specific land types such as rangelands and agricultural lands could not be conceptualized adequately by participants. Some participants suggested not monitoring it but just destroying it. The majority of participants considered its expansion a threat to agricultural lands while acknowledging its importance as fuel wood. Mrs. Mkhosi commented on its usefulness rather than its threat status saying that:

> We want to know how much *Umnga* (*Acacia karroo*) has grown. This should be so that the small ones can kept and not killed. The big ones should then be used for firewood.

Mr. Moho on the other hand had a different opinion when asked whether he thought it was necessary to monitor the *Acacia karroo* in the future. His response was as follows:

> We are monitoring Umnga (*Acacia karroo*) because we want to see how it is increasing and at what speed it is increasing but we don’t need to monitor Umnga, we should just destroy it. It is taking our land. We will have less need for it in future.

Both the above comments illustrate how participants had different perceptions on the reason for monitoring *Acacia karroo* and did not always consider it a threat. Different monitoring objectives were also given due to differing opinions. Mrs Mkhosi suggests monitoring it so that dense *Acacia karroo* stands can be thinned, while Mr Moho suggests destroying all of it.

The practical strengths of the methodology highlighted by participants were the ease of identifying *Acacia karroo* individuals and comparing density values across different sites (table 4.7). Participants highlighted that *Acacia karroo* density could be better assessed if adults were only counted as some juvenile individuals were difficult to see in long grass, for participants with eye sight problems, and therefore additional indicators were suggested. In addition to this, measuring the length of the 11.2m radius in an area of 400m² was confusing for some participants.

Table 4.7. The advantages and disadvantages for the appropriateness and practical ease of the monitoring method, identified from participant feedback. The numbers represent the number of advantages versus the number of disadvantages identified

Appropriateness	**Advantages (2)**	**Disadvantages (2)**
Local participant responses	Useful to assess *Acacia karroo* woodland encroachment threat	*Acacia karroo* woodland encroachment was not perceived as a threat by all participants
	Acacia karroo is useful for local fuel wood use	Participants could not conceptualize the extent of *Acacia karroo woodland* encroachment
Ease of use	**Advantages (2)**	**Disadvantages (2)**
Practical issues	Easy to identifying *Acacia karroo* individuals	Radius distance confusing (11.2m)
	Easy to compare density values across sites	Eye sight problems for counting small individuals

Participant variance was high across both sites but lower for the Mbencane site which had a coefficient of variation of six percent (table 4.8). This illustrates that variability can occur due to different types of sites. The accuracy of the participant means was also more precise for the Mbencane site, with the ratio of the mean of the participants' data and the formally trained biologist at 0.91.

Table 4.8. The variance and accuracy values for *Acacia karroo* density at the two sample sites are shown below. The variance was calculated using co-efficient of variation and the accuracy was calculated by comparing the formally trained biologist and participant means

Forest site	Mbencane	Lubelu
Variance	*Coefficient of Variation*	
Co-efficient of Variation	0.06	0.15
Accuracy	*Ratio (biologist mean / participants mean)*	
Ratio (biologists mean / participants mean)	0.91	0.75

Fixed point photography

This monitoring method was considered useful for visually showing changes in the state of rangelands. The main practical strength highlighted by participants was for the value of using a camera to observe changes such as bare patches, grass height and invasion by Lapezi (*Euryops floribundus*). Participants considered this monitoring method to be useful to monitor grassland degradation, eroded areas and natural springs (table 4.9). The livestock farmers in the group considered the method to be relevant and beneficial to their livelihoods. Mr Madunyelwa, a local livestock farmer, commented on the methods usefulness by saying;

> It is important because we need to check how things were and then we must go back to the same place, with its specific number, and check if it is the same or has changed. Also, we can tell if the grass has been eaten, and ask who put the cattle in the grazing camp, because nobody will argue with you if you show them a photo.

This shows how participants appreciated the repeatability of the method. Also the method was considered useful for managing grazing camps because photographs could be used for showing other community members the state or change of the grazing land since cattle had been introduced.

The practical weaknesses of this methodology identified were: difficulties in conceptualizing distance and size in the photograph; eye sight problems especially with regard to the difficulty the elderly participants in the group had in seeing the digital camera screen; confusion in numbering the fixed point and the photograph together as they required different numbers; and over or under exposure of the photograph confused the ranking in photographs where shadows or light were difficult to interpret. There were also major concerns about transferring the digital photographs to a computer as there was no computer literate person in the group. Participants highlighted that there were computer literate youths in the community who could be approached to assist in the transfer of photographs from the camera to the computer. In addition to this, training was considered as a possibility for participants who are computer illiterate.

Table 4.9. The advantages and disadvantages for the appropriateness and practical ease of the monitoring method, identified from participant feedback. The numbers represent the number of advantages versus the number of disadvantages identified

Appropriateness	**Advantages (5)**	**Disadvantages (1)**
Local participant responses	Useful to show the community changes visually	There are no computer literate participants
	Can assist in management of grassland camps	
	Can assist in the management of eroded areas	
	Can assist in the management of springs	
	Relevant to local livestock farmers	
Ease of use	**Advantages (2)**	**Disadvantages (6)**
Practical issues	Visual change easy to see	There are no computer literate participants
	Using a camera was easy	Difficulties in conceptualizing distance and size in the photograph
		Eye sight problems
		Numbering
		Over and under exposure of photographs confusing
		Transferring digital photographs to a computer

The variance among the means of participant ranking was high for photo one, photo two and the difference between photos. The average of the coefficient of variation was found to be 36 percent, 38 percent and 29 percent respectively (table 4.10). This suggests different interpretation or accuracy in ranking by participants. However, sites one and two had no variance among the participants for the change in the photographs, suggesting that change was easier to rank between the photographs of these sites, for participants.

The accuracy of participant data was low as the ratio of the mean ranks between participants' data and the formally trained biologist's data, for photo one, photo two and difference between photos was between 0.79 percent and 0.68. This was most likely due to inconsistencies in understanding the ranking categories or exaggerated ranking, by participants. Regardless of this, some of the participants' ranking means did not differ when compared with the formally trained biologists data namely: photo one at site one and the change for site one; photo one at site two; and the change ranking for site three, suggesting that some photographs were easier to rank more accurately than others, for participants.

Table 4.10. The variance and accuracy values for the four sample sites are shown below. The variance was calculated using co-efficient of variation and the accuracy was calculated by comparing a formally trained biologist and participant means

Site	Site 1	Site 2	Site 3	Site 4	Average
Variance	*Coefficient of Variation*				
Photo 1	0.27	0.42	0.45	0.31	0.36
Photo 2	0.31	0.39	0.39	0.42	0.38
Difference between Photo 1 and 2	0	0.54	0	0.62	0.29
Accuracy	*Ratio (biologist mean / participants mean)*				
Photo 1	1	0.95	0.6	0.6	0.79
Photo 2	0.6	0.75	0.75	0.63	0.68
Difference between Photo 1 and 2	1	0.55	1	0.6	0.79

Forest health assessment

Participants considered this monitoring method as useful in adequately assessing the threats of over harvesting of important trees and damage to important trees (table 4.11). Participants considered the monitoring method to be useful for Participatory Forest Management (PFM) objectives such as: identifying forest health, and assessing important tree species distribution. This was seen to have the potential benefits of improving stakeholder relations and securing livelihoods in the community. Participatory Forest Management (PFM) is a collaborative approach to forestry management between local communities and outside stakeholders (Topp-Jorgensen *et al.*, 2005) and was developed for joint forestry management with the local communities in Nqabara and the Department of Water Affairs and Forestry (DWAF). Participants thought it was pivotal to have monitoring methods which showed where the community should be able to harvest and which forests should be closed for harvesting. The traditional healers in the group highlighted the fact that the method did not monitor medicinal plants and that this should be included. On the usefulness and potential future use of the monitoring method Mr Dlangalavu commented:

> The monitoring helps for protection of the forests. Now with monitoring we can tell people that a certain number of forests are being destroyed, so that we can close off different forest camps. The people, who own the forests, can monitor them, through PFM. For example, people who live here, like me. The Department of Water Affairs and Forestry must give us permission at some point. We must do this because we live off the forests and we need to know what's happening to protect certain areas.

This shows how participants found the monitoring to be useful for managing the forests and for building collaborations with external stakeholders. Mr Dlangalavu's comment also illustrates how considered the monitoring method to be potentially beneficial for sustaining local livelihoods.

Three practical strengths highlighted were that species identification, the method of data entry and the use of bar charts for analysis were easily understood. The Weaknesses cited were eye sight problems among the elderly when measuring with a ruler for tree diameter at breast height (DBH), a lack of tree species knowledge among three of the thirteen participants, a lack of clarity about assigning ranks to damage levels. Two of the thirteen participants had extremely low literacy levels and therefore had difficulties with data entry. During data analysis the participants who had completed their secondary education were comfortable using a calculator.

Table 4.11. The advantages and disadvantages for the appropriateness and practical ease of the monitoring method, identified from participant feedback. The numbers represent the number of advantages versus the number of disadvantages identified

Appropriateness	**Advantages (5)**	**Disadvantages (1)**
Local participant responses	Useful for identifying priority tree species distribution and abundance	Medicinal shrubs are not included
	Useful for identifying forest health	
	Can contribute to PFM	
	Can improve confidence among stakeholders	
	Indigenous tree species monitored are important for livelihoods	
Ease of use	**Advantages (3)**	**Disadvantages (4)**
Practical issues	Species identification	Poor eye sight
	Bar chart data entry	Species identification
	Bar chart analysis	Ranking of damage levels
		Calculating averages

This monitoring method showed high variances among participant data for all the variables measured namely priority tree species count, DBH (diameter at breast height). The coefficient of variation ranged from 19 percent to 56 percent (table 4.12). This suggests different levels of accuracy in collecting data by participants.

The accuracy of the monitoring method was rated medium as not all variables had high accuracy according to the criteria defined in the methods. However, both the important species count and the DBH were found to not be significantly different from the biologist's data (table 4.12). Tree damage ranking was found to be significantly different. This was likely due to inconsistencies in understanding the ranking categories by participants.

Table 4.12. The variance and accuracy values for the two sample sites are shown below. The variance was calculated using co-efficient of variation and the accuracy was calculated by comparing a formally trained biologist and participant means using a Mann Whitney U test to test for significance of difference

Forest site	Mbencane	Lubelu
Variance	*Co-efficient of Variation*	
Important species count	0.19	0.36
DBH	0.32	0.48
Tree damage ranking	0.51	0.56
Accuracy	*Significance of difference (Mann-Whitney U test)*	
Important species count	N.S (p level 0.35)	
DBH	N.S (p level 1)	
Tree damage ranking	Sig. (p level 0.03)	

Grassland health assessment

Participants were satisfied with this monitoring method for its ability to detect changes in the identified threats of erosion of grasslands, expansion of unwanted species and over grazing impacts (table 4.13). This monitoring method was considered to be useful for the management of local grazing camps. The bar charts used in the data analysis were considered useful for presenting results to the community. However not all participants considered the monitoring method to be relevant to their livelihood as they were not cattle owners. Mr Majandana, a livestock owner, reflected on the usefulness and future use of the method by saying;

> It is important and will help because if we can monitor the grass it will help with our livestock. We need to have selected monitors

> who will monitor the grass camps at the village level. This must be done in spring and summer, not winter as it is just dry then. The grass sprouts in August, it also depends on when it rains. If it hasn't by then you need to do it in December.

This shows how participants considered the monitoring method to be useful for grassland and cattle health. Participants also considered the method to be useful for managing the grasslands during different seasons.

The practical strengths highlighted, during data collection and analysis, were related to grass species identification of the main grass species, data entry and data analysis using bar charts. Concerns were raised about the ranking which required good estimates of the percentage grass cover in a quadrant. The Laying out of quadrants evenly every 10m along the 100m transect was also difficult for a number of participants. There was incomplete knowledge in the identification of less common grass species, by four out of the five participants. A number of participants also had difficulty with understanding the concept of frequency during data analysis.

Table 4.13. The advantages and disadvantages for the appropriateness and practical ease of the monitoring method, identified from participant feedback. The numbers represent the number of advantages versus the number of disadvantages identified

Appropriateness	**Advantages (3)**	**Disadvantages (1)**
Local participant responses	Useful for identifying grassland health	Not relevant to all participant livelihoods especially women
	Useful for assisting grazing camp management	
	Can present bar charts results to the community easily	
Ease of use	**Advantages (3)**	**Disadvantages (4)**
Practical issues	Percentage cover ranking	Ranking percentage cover
	Grass species identification	Transect layout
	Bar chart display	Grass species identification
		Analyzing frequency data

The monitoring method had low variance among participant data for the variables of total cover and wanted species cover. The co-efficient of variation was less than ten percent (table 4.14). The unwanted species cover, weed count and Lapezi (*Euryops floribundus*) count had higher than 10% variance among participants. This suggests a high variation in the accuracy of monitoring these variables among participants. This was likely due to large variations in the knowledge of species identification of unwanted grass species and weeds among participants, as there was only one grass species 'expert' in the group .

The accuracy of the monitoring method was rated medium as not all variables had high accuracy levels according to the criteria defined in the methods (table 4.4). Wanted species ranks did not differ significantly ($p>0.05$, Wilcoxon matched pairs) between the participants and the formally trained biologist, for both the overgrazed (degraded) and protected (healthy) site (table 4.14), suggesting that this was the easiest for participants to identify and the most accurate.

The ranks for total cover were not significantly ($p<0.05$, Wilcoxon matched pairs) different between the participants and the formally trained biologist, for the overgrazed site (table 4.14). This suggests that the overgrazed site was easier, for participants, to rank total cover. The ranks for unwanted species were not significantly different ($p<0.05$, Wilcoxon matched pairs), between the participants and the formally trained biologist, for the protected site. This suggests that the protected site was easier, for participants, to rank unwanted species cover. The means for both the Lapezi (*Euryops floribundus*) and weed counts had a difference of more than 10 % from the formally trained biologist's data suggesting low accuracy among participants.

Table 4.14. The variance and accuracy values for the two sample sites are shown below. The variance was calculated using co-efficient of variation and the accuracy was calculated by comparing biologist and participant means using a Wilcoxon matched pairs test to test for significance of difference

Site	Protected site	Over grazed site
Variance	*Co-efficient of Variation*	
Total cover rank	0.03	0.08
Wanted grass species cover rank	0.03	0.09
Unwanted grass species cover rank	0.13	1.99
Weed count	1.23	0.81
Lapezi (*Euryops floribundus*) count	0.22	0.29
Accuracy	*Significance of difference (Wilcoxon matched pairs)*	
Total cover rank	Sig. (p level 0.03)	N.S (p level 0.55)
Wanted grass species cover rank	N.S (p level 0.55)	N.S (p level 0.69)
Unwanted grass species cover rank	N.S (p level 0.9)	Sig. (p level 0.007)
	Ratio (biologist mean / participants mean)	
Weed count	0.78	0.17
Lapezi (*Euryops floribundus*) count	0.79	0.71

Live ungulate health ranking method

Threats to cattle health were considered by participants to only be partly met by the monitoring method as it only measured fat content of cattle and did not assess cattle disease (table 4.15). Participants highlighted the need for additional indicators to monitor latent cattle disease as a part of cattle health and to also monitor other livestock. All participants acknowledged the method's relevance to local livelihoods due to the cultural and economic importance of cattle in the community. The future uses described for this monitoring method included its use for grazing camp management, cattle management, disease control and assessing selling potential. Mr Xhanywa commented on the usefulness and future potential use of the monitoring method by saying that:

> It is very important that we know how many cattle are eating in our fields and that there is only a specific amount for the carrying capacity, to get good cattle health. This is also important for the sheep so that we can get wool and sell it. We need to keep checking the dip for thin ones and fat ones, so we can tell which way the cattle health is going, and then we can decide what to do with them. For example put them in a camp or give them medicine.

Mr Xhanywa's comment shows that participants found the method to be useful as a tool for improving cattle health and thereby increasing the value of cattle. Mr Xhanywa also illustrated the need to monitor sheep and to come up with management strategies to deal with unhealthy livestock.

The practical strengths highlighted were that the ranking categories of fat content (Rhiney, 1982) were easily understood as well as data entry and analyzing the result in the bar charts. The only weakness cited was due to the difficulty of conceptualizing the one in ten samples of all the cattle at the dip. Two out of five of the participants did not trust that ten percent of the cattle ranked at every tenth interval would be a good representation of the whole cattle populations' health. Participants considered that ranking every livestock individual would be more reliable rather than every 10th individual, and did not consider cost to labour to be a problem.

Table 4.15. The advantages and disadvantages for the appropriateness and practical ease of the monitoring method, identified from participant feedback. The numbers represent the number of advantages versus the number of disadvantages identified

Appropriateness	**Advantages (6)**	**Disadvantages (2)**
Local participant responses	Cattle are highly valued for local livelihoods and cultural practices	Required for other livestock
	Can assist in grassland management	Required for cattle disease symptoms
	Can assist in cattle management	
	Can assist in controlling cattle disease	
	Can assist in increasing cattle selling potential	
	Useful to display on bar charts to the community	
Ease of use	**Advantages (2)**	**Disadvantages (1)**
Practical issues	Health ranking	Sampling every 10th individual is confusing
	Bar chart display	

The participant variance was low for the ranking sample of the Gxojeni dipping tank as the coefficient of variation was less than ten percent. This was also found for the estimated cattle numbers from the number of individuals ranked. This suggests participants sampled in a similar method.

The accuracy of participant data was high for ranking means when compared with the biologists data as the ratio between means was 0.94 for the Gxojeni dipping site (table 4.16). This suggests that participants ranked the cattle health accurately according to the health ranking categories in the method. The accuracy was low, for the number of cattle estimated and the seasonal change in ranks, when participant means were compared with the formally trained biologist. The ratio between the formally trained biologists mean and the participants was 0.86 for the estimated cattle numbers. This suggests that the participants ranked more than 10 percent of the cattle. The ratio between the formally trained biologists mean and the participants was 1.18 for the change in cattle ranking means over the seasonal period. This suggests that participant ranking was less accurate when comparing ranks over time.

Table 4.16. The variance and accuracy values for the two cattle ranking samples are shown below. The variance was calculated using co-efficient of variation and the accuracy was calculated by comparing biologist and participant means

Site	**Gxojeni Dipping tank**
Variance	*Coefficient of Variation*
Cattle mean ranks	0.063
Number of cattle estimated	0.045
Accuracy	*Ratio (biologist mean / participants mean)*
Difference in ranking means	0.94
Number of cattle estimated	0.86
Seasonal change difference	1.18

Comparison of costs

The direct cost of monitoring equipment varied from zero to $280. Equipment costs were all below $10 for the monitoring methods except for the fixed point photography ranking method which required a digital camera and computer (table 4.17). This method was also the only one which required equipment to be bought from outside of the study site whereas for the others methods the equipment could be sourced locally. Monitoring methods either required monitoring once or twice a year with a minimum of one local participant.

Table 4.17. A comparison of the cost requirements for each monitoring method is shown below

	***Acacia karroo* density**	**Fixed point photography**	**Forest health assessment**	**Grassland health assessment**	**Live ungulate health ranking**
Equipment required	Colourful permanent marks, rope, pen and paper	Colourful permanent marks, digital camera, computer, pen and paper	Colourful permanent marks, ruler, pen and paper	Colourful permanent marks, 4 x 1m poles, pen and paper	Pen and paper
Equipment costs (US$)	4	280	5	2	0
Equipment sourcing	Equipment is locally available	Equipment must be bought elsewhere	Equipment is locally available	Equipment is locally available	Equipment is locally available
Frequency of monitoring	Annually	Every 6 months	Annually	Every 6 months	Every 6 months
Human resources	Minimum 1 person	Minimum 1 person	Minimum 1 person	Minimum 1 person	Minimum 1 person
Required training	1/2 day	1/2 day	1/2 day	1/2 day	1/2 day
Cost effectiveness	Cost effective	Relatively expensive	Cost effective	Cost effective	Cost effective

Comparison of key requirements using kite diagrams

The kite diagrams (fig 4.1) indicate the strengths and weaknesses of methods for the key requirements of appropriateness, practical ease, participant accuracy and participant variance. The *Acacia karroo* density method showed the most evenly spread ranking with a ranking of zero (medium) for each of the key requirements of participant data variance, participant accuracy, appropriateness of the monitoring method, and practical ease (fig 4.1). The live ungulate health ranking method was strong in all key requirements, ranked positive one (strong), except for the accuracy of the monitoring method which was ranked zero (medium).

The rest of the monitoring methods were ranked positive one (strong), in specific key requirements but ranked zero (medium) or negative one (weak), in others. The fixed point photography method showed strong appropriateness but was rated weak for all the other key requirements. In addition to this it was expensive (table 4.17). The forest health assessment method was ranked positive one (strong) for appropriateness and zero (medium) for accuracy. The grassland health assessment method was ranked positive one (strong) for the appropriateness and zero (medium) for accuracy and variance among participant data collected. It ranked negative one (low) for practical ease.

No monitoring method was rated weak for appropriateness suggesting that the monitoring methods were generally well accepted as being appropriate to local threats and livelihoods by participants. Accuracy was only rated weak for fixed point photography suggesting that participants collected accurate data for a significant number of variables in among the methods. Variance was rated weak in two monitoring methods suggesting that not all participants collected data accurately. While three monitoring methods were rated weak for practical ease suggesting that this is still an important challenge in the utilisation of the monitoring methods.

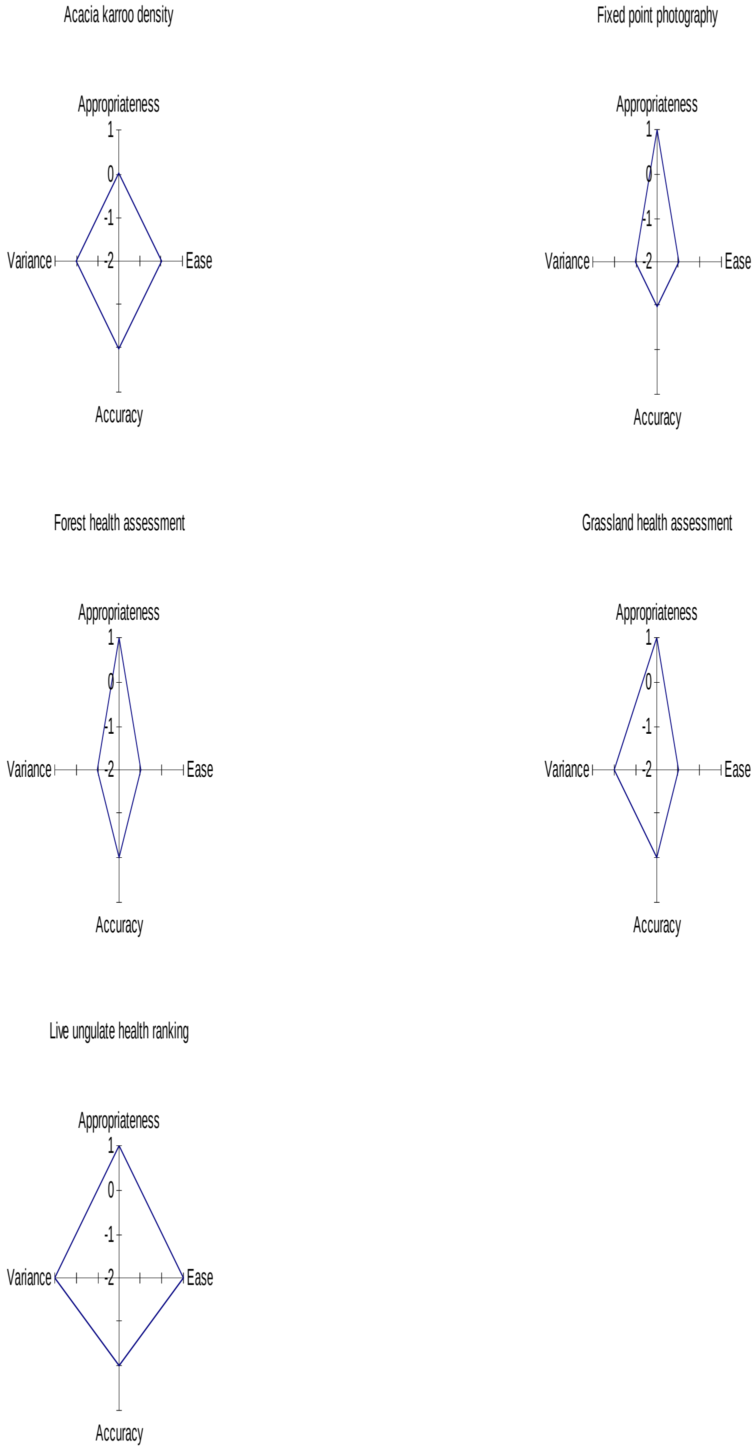

Fig 4.1. The kite diagrams for the monitoring methods showing their ranking for variance of participant data, accuracy of participant data, appropriateness to participants, practical ease to participants and costs

Towards the reinforcement of the effective measurement of change in participatory monitoring

The following discussion is structured so that firstly, the adaptive process of identifying the monitoring methods is reviewed. Secondly, each key requirement for the effective measurement of change in participatory monitoring is discussed in relation to the findings of the tested monitoring methods. The key requirements and their respective findings are explored in this order namely: appropriateness, ease of use, reproducibility and reliability of the data collected, and the cost effectiveness of the monitoring methods. Recommendations to strengthen weaknesses are also given.

The adaptive process

The scoping stage (phase II) was very useful in identifying those monitoring methods that had the potential to be good collaborative monitoring methods (Jones, 1986). This was evident from the adaptive and iterative process (Kouplevatskaya-Yunusova & Buttoud, 2006) where monitoring methods which had critical shortcomings were removed while monitoring methods with potential were adapted to be used in the rigorous testing stage (cf.Chapter 3). In addition to this, discussion groups (Danielsen *et al.*, 2000), meetings with the local community and other stakeholders were important for receiving feedback (Nare *et al.*, 2006) on the advantages and disadvantages of the monitoring methods. The monitoring methods which were removed could not all be replaced with effective monitoring methods that could be adapted to meet the key requirements for good collaborative monitoring. This shows the difficulty of finding relevant monitoring methods which can meet all the key requirements for good collaborative monitoring.

Appropriateness and relevance of the monitoring methods

A large number of favourable aspects were raised by participants about the monitoring methods' usefulness, future potential use and relevance to local livelihoods. However, differences of opinion existed about the usefulness of some monitoring methods, for example *Acacia karroo* density as a threat to rangelands. This stimulated debate about ecological processes and trade-offs in managing ecosystem services. According to participant feedback most of the monitoring methods were able to assess the relevant threats related to local natural resources and livelihood. Threats and key questions relevant to the monitoring tools need to be clearly identified early on in the process to make monitoring effective in the long-run (Jones, 1986). In addition to this, threats and key questions should ideally be reconsidered in an adaptive approach to constantly assess the relevance of monitoring methods (Lindenmayer & Likens, 2009). Concurrently, local participants need to engage with other knowledgeable experts, such as ecologists, about local threats. This is an important part of the collaborative process where knowledge can be shared between scientists and local participants (Fabricius *et al.*, 2006) and relevant threats identified.

Village meetings, group discussions and interviews were very useful in assessing participants' and community members' feedback on the legitimacy of the monitoring methods. Legitimacy implies that the process of monitoring was relevant and useful for the local participants and the local land management organizations. Legitimacy is enhanced through consensus and compromise during a participatory process where multiple actors are involved (van den Hove, 2006). Legitimacy is important for sustainability because it increases the likelihood that the local community will be actively involved in future. Multi-stakeholder processes need to be incorporated into decision-making to make the decisions made relevant to stakeholders interests (Fraser *et al.*, 2006) therefore enhancing legitimacy. However, there is a possibility that opinions on local legitimacy can change. Therefore the sustainability of the monitoring methods should be further tested over the long-term.

It would be useful to know which factors influence the long term legitimacy of a monitoring method. From this study, the relevance of the monitoring method to local livelihoods was found to be a good indicator of appropriateness to local problems and priorities, as well as whether participants considered it to be useful at the time and in the future. Legitimacy is also influenced by participants' understandings of other knowledge systems such as the scientific approach. For example, the sampling methods which are essential for collecting reliable data were new to many participants and not all participants were convinced by their validity. This shows the difficulties of merging or bridging knowledge systems (Fabricius *et al.*, 2006). Research into the changes of participant's views, during the merging of different knowledge systems is required to assess the possibility of sustainable long term monitoring. If there is a co-opting of one knowledge system into another an important question to investigate is: what are the responses of participants to the co-option of their knowledge systems into new developed monitoring methods. Collaborative monitoring is founded on the premise of equality and empowerment, and therefore all knowledge systems come to be respected, and their values considered. As such collaborative monitoring needs to build legitimacy through equal engagement, and needs to acknowledge the challenges towards reaching this.

Ease of use

Practical difficulties were consistently flagged by participants during the monitoring methods. Regardless of this, participants were able to carry out the monitoring confidently after training and practice. This may infer that some of monitoring methods were simple enough for replication by local participants. There is an urgent need for monitoring methods to be made simpler and more user friendly to increase their relevance to participatory monitoring (Danielsen *et al.*, 2005a). Other studies have been successful in finding simple monitoring methods for monitoring with the involvement of local participants, e.g. the event book system developed in Namibia for conservation rangers (Stuart-Hill *et al.*, 2005; Gray & Kalpers, 2005), the ranger based monitoring system used in the International Gorilla Conservation Programme (Gray &

Kalpers, 2005), and fish censuses done by monitors who snorkel on Tanzanian reefs (Uychiaoco *et al.*, 2005). Therefore more research is required into the further development of simple methods using lessons learnt from this and other case studies.

One approach to adapting the monitoring methods to make them practically easier is to further re-design the method and its respective datasheets to facilitate data entry and analysis (cf.Stuart-Hill *et al.*, 2005). Whilst this did occur for most of the monitoring methods, the practical ease of monitoring methods was confounded by low literacy levels of participants. Some participants struggled to read and write properly even though they said they had had formal education, while elderly participants also struggled with their eyesight. This is a widespread problem in developing countries and requires the focus of adult education approaches, such as those suggested by Rao & Robinson-Pant (2006), or preferably the participation by younger, more literate community members. However, the traditional patriarchal systems found in many African societies may present an obstacle to this.

A focus on effective training for participants is also important in monitoring, as commonly suggested for sustainable land management (Hurni, 2000). Danielsen (2005a) suggests that participatory monitoring can be done by people with little or no formal education. This is possible in case studies where there is external support for participant monitors such as training and environmental education. Some examples where this support was given to local participant monitors is within the turtle monitoring done in Costa Rica (Townsend *et al.*, 2005) and hunter self-monitoring in Bolivia (Noss *et al.*, 2005). This research showed that basic education is required for data entry and data analysis if no support is available. Solutions such as adapting monitoring methods further, identifying the best literate and visually strong participants, and rigorous training would meet the requirements to strengthen practical ease. These solutions were also put forward by participants during discussion groups.

The reproducibility and reliability of the data collected

Certain variables were more accurately measured than others. Across the monitoring methods no method was considered both accurate and with low variability. This illustrates the difficulty of obtaining consistent and accurate data in participatory monitoring (Holck, 2008). However, differences in natural resources across space and time were shown to be comparable to the formally trained biologist's data, even though there was a margin of error. Ways of improving consistency would be to select specific participants who have the best data collection skills and improving their training. However, a high turnover rate amongst trained community members is a common problem in community-based natural resource management and therefore several participants of different ages require training. Practice over time also contributes to more accurate and reliable data collection by participants. The amount of practice required to reach an acceptable level of accuracy, by participants, requires further investigation.

Cost effectiveness

The monitoring methods tested here were effective in maintaining low costs with respect to equipment and labour. Local participant monitors tend to be involved in other activities to sustain their livelihoods. Therefore a successful monitoring method should be time efficient for participants (Danielsen *et al.*, 2005a) so they are able to continue with other livelihood activities. In addition to this the financial costs of labour need to be within the available budget of a monitoring programme. Labour costs require further assessment in specific contexts, in relation to the distance of key resource areas from local villages. Time allocated for travel was not included in the study because of its variability depending on the village locality in relation to a key resource area to be monitored. The area being monitored can also affect the number of samples required which in turn would affect the time taken to monitor a key resource area. All the methods except fixed point photography were rated as affordable for equipment costs.

Conclusion

Practical ease and the reproducibility of data remains a key challenge in developing good collaborative monitoring methods. Effective training, discussion groups and selecting the appropriate participants emerged as critical factors for strengthening the key requirements for future use, across the monitoring methods. Assessing monitoring methods adequately still requires further research into how to strengthen these key requirements and consequently strengthen collaborative monitoring efforts further in the future.

CHAPTER 5: Local Learning and Capacity Development in Participatory Ecosystem Monitoring

The value of building adaptive capacity

Building adaptive capacity through social learning, is an important aspect to cultivate when dealing with the challenges of managing social-ecological systems in co - management (Armitage *et al.*, 2009). Co- management is the term used widely to describe efforts in collaborative management. The adaptive cycle which occurs in social-ecological systems (SES) requires that local land managers adapt to the changing states of the system (Allison & Hobbs, 2004). An important aspect of the resilience theory in social-ecological systems is understanding change (Berkes & Seixas, 2005). The key concepts of adaptive capacity, resilience and vulnerability are used differently and can have diverse meanings depending on the context they are used in (Gallopin, 2006). It is therefore important to clarify their meaning in the context of SES. In the context of social-ecological systems, adaptive capacity is described by Gallopin (2006) as firstly referring to the capacity of the SES to cope with environmental disturbance, and secondly, as the capacity of the SES to improve the condition of the environment. Resilience is described by Holling (1973) as the maximum amount of disturbance a system can withstand without loosing its ability to return to its previous state of equilibrium (Holling, 1973; Walker *et al.*, 2004). Vulnerability is described as the aspects or components of the SES that relate to its sensitivity and its ability to adapt to disturbance (Adger, 2006).

In the context of social-ecological systems, adaptive management has the potential to improve management through learning, consultation, collaboration and monitoring (Schreiber *et al.*, 2004). In the study sites of Machubeni and Nqabara, interventions by external stakeholders occurred to promote adaptive co-management strategies and to strengthen governance in the local communal lands (Fabricius & Collins, 2007). In Machubeni and Nqabara land committees were developed to drive CBNRM. This was done so that the technical capacity of local managers, for management and monitoring, could be developed with the intention of building adaptive capacity through learning and awareness about environmental threats (Fabricius & Collins, 2007). This was seen as relevant because of the environmental challenges that exist within these communities. These challenges include; natural resource degradation, poverty and social-ecological vulnerability to rapid change. Building social-ecological system resilience and adaptive capacity is therefore a desired goal in these communities.

One approach of building resilience and adaptive capacity is to promote social learning (Fazey *et al.*, 2007). This is because learning allows a system to adapt in relation to lessons learnt about changes in the environment (Allison & Hobbs, 2004). Social learning is a broad term which refers to the learning and the changes which occur to individuals and social systems (Pahl-Wostl *et al.*, 2008). In addition to this, learning can occur from the social interactions in a group when individuals observe others (Bandura, 1977). An iterative feedback process occurs between learners and their environment where learners change their environment and the changes in the environment affects the learners (Pahl-Wostl *et al.*, 2008). This can be an important benefit of collaborative monitoring process because learning can contribute to the resilience of management systems. This learning should ideally occur through participatory and adaptive engagement which has the potential to build adaptive capacity in the local community with positive consequences for local land management actions.

Learning and awareness of critical ecological threats and their potential impact on ecosystems and human well-being, is essential for the recognition of immediate and long term threats (Ticheler *et al.*, 1998; Andrianandrasana *et al.*, 2005). It is important for local people and scientists to have reliable and informed ideas about the critical social-ecological threats found in local communities, through reliable local knowledge systems (Chalmers & Fabricius, 2007). This information can assist in the setting of relevant goals and benchmarks for effective management. However, if the reliability of local ecological knowledge (LEK) is limited, then the goals and benchmarks identified by local participants to reach real change can be flawed (Chalmers & Fabricius, 2007).

The contribution of LEK by community members is an important part of contributing to the legitimacy of the local knowledge systems used (Capistrano *et al.*, 2005). This can be a beneficial aspect of collaborative land management processes. Bridging LEK and Western knowledge allows participants to contribute their knowledge on an equal basis therefore adding to the legitimacy of the process (Chalmers & Fabricius, 2007). LEK can contribute to the robustness of monitoring and management systems by co-opting ecological knowledge which would take additional time and resources for scientists to access (Fleming & Henkel, 2001; Maurel *et al.*, 2007). The challenge for scientists is to understand how this knowledge works (Cundill *et al.*, 2005) and where this knowledge is held in the community, as it is not always evenly spread and can be held by local 'experts' (Chalmers & Fabricius, 2007).

Learning can lead to a transformation of participants' world views and actions. This is referred to as transformative learning (Pahl-Wostl *et al.*, 2008; Sims & Sinclair, 2008; Toderi *et al.*, 2007; Sinclair *et al.*, 2007). Transformative learning occurs in a social learning context. If this occurs participants will have learnt instrumental and communicative aspects with the potential to change their world view and future actions. Instrumental learning, is a pivotal part of transformative learning. It refers to the interaction of participants with their environment through manipulation or control (Sims & Sinclair, 2008). The three main aspects of instrumental learning highlighted by Mezirow (1996) are a) skills and information obtained b) determining cause and effect relationships and c) task oriented problem solving. Communicative learning, on the other hand involves understanding and negotiating concepts and values. The main aspects within this are a) understanding values and concepts and b) understanding others' points of view (Mezirow, 1996). In this perspective new information and perspectives can be accumulated through learning and can help contribute to better decision making by land management practitioners which could positively influence their management actions (Bennett *et al.*, 2005; Olsson *et al.*, 2004; Schreiber *et al.*, 2004).

Adaptive co-management, through learning, has the potential to deal with and overcome some of the challenges faced by previous community participatory approaches. These challenges include; the rigidity of management systems, vulnerability to change and a lack of legitimacy (Armitage *et al.*, 2009; Cundill & Fabricius, 2009). It is able to overcome these challenges because it has the potential to combine different knowledge systems which can help better understand complex social-ecological systems (Cundill *et al.*, 2005; Berkes *et al.*, 2000). Collaboration in this case helps build legitimacy (Olsson *et al.*, 2004), and further stimulates social learning for adaptive capacity in SES (Armitage *et al.*, 2009). Monitoring is an important part of adaptive co-management processes. It is used to inform the management system of the state of the environment. Monitoring has the potential to stimulate learning through its processes of enquiry and reflection.

The purpose of this chapter is to assess the role of monitoring in social learning, capacity development, knowledge sharing and, in due course, the role of monitoring in promoting adaptive co-management on communally managed lands. Key questions explored in this chapter are:

What was the role of monitoring in developing the technical capacity of participants to monitor?
What LEK did participants use or contribute during the monitoring process?
What learning and awareness occurred during the monitoring process?

Methods

Potential to build adaptive capacity during monitoring was assessed according to three main aspects namely; technical capacity built, LEK contributed and learning and awareness, in each monitoring method. These aspects were assessed qualitatively, as described below through participatory processes (cf.Chapter 3: pg 45, refer to the section on the participatory process), The monitoring methods through which these aspects were assessed were *Acacia karroo* density, fixed point photography, forest health assessment, grassland health assessment and live ungulate health ranking (cf.Chapter 4).

The participatory process: feedback and reflection

Observations of participants' comments and actions, relating to the key aspects, were noted during the monitoring process and discussion groups. Discussion groups and semi-structured interviews (cf.Chapter 3: pg 45, refer to the section on the participatory process) with participants were held after monitoring to discuss the monitoring process and the key aspects of building adaptive capacity. Key questions were asked during discussion groups to get feedback from participants on the key requirements for building adaptive capacity namely; technical capacity built; LEK contributed; and learning and awareness. Key questions that were posed to the participants are as follows:

1. Did the participants master the monitoring process aspects, and could they do the monitoring again without assistance?
2. What LEK did participants contribute during the monitoring?
3. What did participants learn from the monitoring process?

The researcher was fluent in Xhosa and had a first language Xhosa assistant during the discussion groups and interviews. This was to over come language barriers as all participants were first language Xhosa speakers. Cultural differences between the researcher and the participants were navigated sensitively by adhering to local cultural practices where possible.

Power dynamics that were present in the group when some participants dominated the debating and discussion process were managed. This was done by giving other participants an equal opportunity to give their feedback and views on a particular subject. Otherwise the participants were left to explore the key questions amongst themselves during discussion groups. When the topic of conversation among the participants veered away from the subject of the three questions then the researcher interjected to return the conversation to the key questions. The researcher also directed questions at participants who had not yet had a chance to give their opinion and feedback, so that they could get an opportunity to do this. When all the participants had an opportunity to talk on the three main questions, the discussion group was concluded.

The three questions were then asked directly to each participant individually during the semi-structured interviews (cf.Chapter 3: pg 48, refer to the section on data collection). These were conducted individually in the participant's home, or a place of their preference. This allowed the researcher to gain more detailed feedback on the personal opinions and experiences of the participants with respect to the three questions.

Assessment of technical capacity, LEK contribution and learning

Technical capacity built was assessed from observation and feedback from participants, during discussion groups. This was done after participants had conducted the monitoring. Monitoring methods were assessed on whether feedback from the majority of the participants, on a monitoring aspect, was positive or negative. The technical aspects of the monitoring process were identified as follows:

1. Identifying benchmark sites for monitoring
2. Species identification
3. Transect or site setup for monitoring
4. Sampling techniques

5. Data entry
6. Data analysis and interpretation

When a technical aspect of monitoring was considered easy and to have been mastered by the majority of participants this was defined as positive feedback for the aspect. When a monitoring process aspect was considered to be difficult and to have not been mastered by the majority of participants this was defined as negative feedback for the aspect.

The contribution of LEK during the monitoring was assessed from participant feedback during discussion groups and interviews. The number of participants, who felt they had contributed their own LEK and the type of LEK they contributed, was documented. Participants who learnt LEK from a local ‘expert’ in a group, and the local ‘experts’ in the group, were also documented.

Learning and awareness was assessed through observation and feedback from participants during discussion groups and interviews. Three categories were used to discern this namely:

1. Ecology and threats;
2. The value of monitoring and the outcome of good management practices.
3. Transformative learning aspects

Learning by participants on aspects of ecological cause and effect relationships, and threats to local natural resources were documented. Learning aspects on the value of monitoring in informing good management was also documented. Additionally, learning in aspects of the importance of good local management practices for sustainable natural resource management, were documented.

A transformative learning framework, as referred to in the introduction, was kept in mind during the monitoring process, as used by Sims & Sinclair (2008) in a land management study in Costa Rica. Transformative learning aspects were identified from observation, meetings and discussion groups.

An assessment of technical capacity, LEK contributed and learning through participatory monitoring

In this section the monitoring methods are assessed within the categories of technical capacity built, local ecological knowledge contributed and learning and awareness. A general summary of the trends observed in these areas is given. Following this, a description of the results is given for each of the specific methodologies of *Acacia karroo* density, fixed point photography, forest health assessment, grassland health assessment and live ungulate health ranking.

A summary of the technical capacity, LEK and learning trends observed

Technical capacity built

Useful technical monitoring skills gained by the participants related to the aspects of identifying benchmark sites; species identification; transect setup, sampling procedures, data entry into event sheets; and data analysis and interpretation using bar charts. Data analysis and interpretation skills for the fixed point photography, grass health assessment; and the live ungulate health ranking, were not gained sufficiently by participants judging from the overall negative feedback given by participants.

Local ecological knowledge (LEK) contributed

Across all methods 79 percent of participants on average said that they had contributed their own LEK during a monitoring method. Participants contributed LEK in all the monitoring methods (table 5.1). LEK assisted with species identification as well as understanding cause and effect relationships which were related to possible causes of degradation for the natural resource in focus. Twenty three percent of the participants on average were considered to be ‘experts’ for the natural resource of focus during a monitoring method.

Local ‘experts’ contributed their knowledge on species identification for monitoring methods while other participants with less LEK learnt from the ‘experts’ while also contributing knowledge which they had. The *Acacia karroo* density method and the fixed point photography method both had no obvious ‘experts in the group.

Table 5.1. The number of participants who said they had contributed their local ecological knowledge, and the number of ‘experts’ in the group, for each monitoring method, is shown below. n = the number of participants interviewed

	***Acacia karroo* density (n=12)**	**Live ungulate health ranking (n=4)**	**Forest health assessment (n=12)**	**Grassland health assessment (n=5)**	**Fixed point photography (n=6)**
Number of participants who contributed LEK	11/12	3 / 4	10 / 12	3 / 5	4 / 6
Number of ‘experts’	none	3 / 4	5 / 12	1 / 5	none

Learning and awareness

Across the monitoring methods the main learning that occurred included information on the ecological and threat aspects, and the monitoring and management aspects of the local natural resources. Transformative learning through instrumental learning was observed during all the monitoring methods. Communicative learning was only observed during the forest health assessment and the fixed point photography. Learning about ecological and threat aspects was about new species identification and ecological cause and effect relationships of the main natural resources in focus namely; rangelands and indigenous forests. Learning on monitoring and management occurred largely with regard to the value of monitoring the natural resource in focus, for better management. This contributed to informing local management towards the creation of better sustainable harvesting and utilization practices.

Acacia karroo density

Technical capacity built

Useful monitoring skills gained from the *Acacia karroo* density method were the counting of *Acacia karroo* individuals in a standard area for density, data entry into data sheets, and the comparison of density counts across sites. Data analysis and interpretation was found to be easy for participants with all participants giving positive feedback on these aspects. Miss Dinwa, a local crafter and teaching assistant at the local secondary school, commented on the main difficulties and straightforward aspects of this method.

> *Acacia karroo* is very thorny. We had to struggle in the dense stands. However, it is an easy method as *Acacia karroo* stands are not as thick as the forest and it is easy to count them.

Miss Dinwa illustrated how she considered the data collection aspect of the method to be straightforward, but how other factors such as the vegetation density can hinder participants' ability to carry it out easily.

Local ecological knowledge (LEK) contributed

During the *Acacia karroo* density method, participants tended to be able to identify *Acacia karroo* but were not always aware of the threats that it posed as an invader. There were no obvious 'experts' on *Acacia karroo* invasion in the group. Mr Sidlova, a local traditional healer, commented on his knowledge of *Acacia karroo* invasion stating that:

> I could identify an *Acacia karroo* individual in the past, however, I had just looked at it for its medicinal properties, rather than for its ability to invade areas.

Mr Sidlova highlighted the significant role that *Acacia karroo* has in the community, for its uses. He also illustrated how local ecological knowledge may be focused on these aspects rather than on the ability of *Acacia karroo* to invade grasslands.

Learning and awareness

Learning on monitoring and management occurred about the need for effective grassland camp management to increase grassland productivity and health. Participants learnt about ecological cause and effect relationships such as the link between *Acacia karroo* density, invasion and rangeland health. Some participants believed that *Acacia karroo* was invading the grassland while others were not aware of this. Learning and awareness occurred on the ecological process of *Acacia karroo* expansion along forest edges and onto rangelands. Mrs Twani, reflected on her learning saying that:

> I learnt that Umnga (*Acacia karroo*) grows so quickly. I didn't know that it could grow so quick. We wouldn't be able to remember the monitored area if we didn't mark it. By then it would probably be a forest.

Mrs Twani's comment illustrates how participants changed their perspectives on the threat that *Acacia karroo* poses to grasslands due to its ability to invade. The benefit of monitoring in assessing this threat was also acknowledged.

Fixed point photography

Technical capacity built

Useful monitoring skills gained from the fixed point photography by participants were those needed for digital camera use, systematic numbering of repeat photography sites and event chart data entry. Participants gave negative feedback for the interpreting of the results of the fixed photography method when they were analysing changes in the photographs over time. They found it easier and more useful to identify the present ranks of a photograph as indicators for required management action for the grassland site. However, participants gave positive feedback for all the other aspects of the monitoring method process. Mr Madunyela, a local livestock owner, commented on the ease of ranking and its usefulness:

> There were no major problems with the method and it became easier once we had learnt the process properly. The ranking values are good, and it is important to have these so that we know which areas need to be fixed a little, or areas which need to be completely closed off.

Mr Madunyela shows how participants learnt how to rank fixed point photographs and the importance of using these as indicators for rangeland health and improving management strategies.

A concern for the method was that none of the participants were computer literate to transfer and display the digital photographs on a computer. However, participants noted that there were computer literate members of the community who could be enrolled to assist with the technical aspects involving a computer. Mrs Mbaliso commented on the participants' potential technical capacity to use the computer:

> We need to check who can use a computer in the land management organization. If there is nobody then we must find somebody in the village that can. There are definitely people in the village who I know can use a computer.

Mrs Mbaliso suggested that there were members of the community who were computer literate, and which meant that they could be potentially co-opted to assist the land management organization, for this method.

Local ecological knowledge (LEK) contributed

During the fixed point photography participants contributed knowledge on cause and effect relationships related to grassland degradation. There were no obvious 'experts' on land degradation in the group. Mrs Mbaliso commented on the LEK, that she contributed during the method, and what she learnt about monitoring:

> At first I used to check the grass by looking at its greenness as an indicator for health rather than checking for dongas [erosion gulley's] and open bare patches on the grassland. I learnt that it is important to do this. However, I knew that overgrazing leads to open bare patches and dongas from erosion.

Mrs Mbaliso's comment showed that she had local ecological knowledge on indicators for grassland health however she also learnt new indicators for identifying degraded rangelands.

Learning and awareness

Ecological cause and effect relationships were learnt when the link between indicators of rangeland health namely; grass cover, bare patches and erosion were debated by the group. The link between overgrazing, erosion, rangeland health and rangeland camp management were also discussed in the group with learning occurring among participants. Task oriented problem solving was learned when possibilities for erosion control and rehabilitation were discussed. Solutions were proposed by participants. Mrs Mateyisi, reflected on her learning by saying:

> I learnt that when you take a photograph at a single place, you need to mark it so that you can come back to the exact same spot. I have told the headman to dig in the marking stones so that we can go back and so that nobody moves them. I didn't know we could tell if an area has changed or isn't from a

> photograph. Also holding a camera was new to me but it was great to learn how to use a camera properly.

Mrs Mateyisi's comment illustrates how her learning encouraged her to take initiative in marking the fixed point sites permanently. Also participants learnt the importance of repeating the photograph, and the valuable information that can be seen in a photograph about rangeland health.

For monitoring and management awareness, learning occurred on the need for grassland camp management to increase grassland productivity and health. Understanding other's point of views also occurred when the women in the discussion group commented on the men's principles with regard to their cattle management, as they are the main cattle owners. The men then acknowledged that something had to be done about uncontrolled cattle and overgrazing in the community by involving cattle owners.

Forest health assessment

Technical capacity built

For the forest health assessment the skills gained by participants were those needed in transect setup in the forest, tree species identification, counting tree density along the transect length, measuring diameter at breast height (DBH), ranking tree damage, data entry into event charts and the analysis of the results across different forests. The interpretation of the results was well understood by the participants. However, participants had different strengths in the groups as some were tree species identification 'experts' while others were better at data collection. Mr Somdaka, a local traditional healer, commented on the training:

> The training was difficult at first. The method became easier with practice. We need more practice. It would also be good to identify people with the best abilities for monitoring.

This suggests that the main monitoring skills were gained during the process. However, participants still felt that additional training would increase their abilities, and that some participants had gained the technical skills better than others.

Local ecological knowledge (LEK) contributed

During the forest health assessment 11of the 12 participants said they had contributed their knowledge on the identification of indigenous tree species. There were five local tree species ‘experts’ identified in the group. Mr Mbinda, an indigenous forest tree species ‘expert’ commented on his ability to identify tree species during the monitoring method:

> I definitely knew all the tree species during the method and I knew it the best out of all participants.

Mr Mbinda’s comment illustrates the confidence that he had in his ability to identify tree species as an ‘expert’ in the group.

Some participants learnt how to identify tree species from the ‘experts’. Mr Mazwai, a young forest harvester, commented on the knowledge that he contributed and what he learnt from others:

> I knew all the tree species names, but I also learnt new tree species which are found in different forests from the other ‘experts’ in the group.

This suggests participants learnt new species by going to different forests which they may not have visited before, and from the experts such as Mr Mbinda.

Although almost all the participants contributed local ecological knowledge, some felt that their knowledge was lower than that of the ‘experts’ and that they had other skills to contribute. Miss Dinwa, commented on her numerical skills that she learnt at school how they assisted in her ability to carry out the method confidently:

> I felt I was quicker at data entry than other participants but my knowledge of tree identification is low. I think my environmental knowledge is below others in the group.

This shows how some participants had lower ecological knowledge than others but how they also felt they had other knowledge which was an advantage, such as numerical skills.

Learning and awareness

Useful indicator tree species were identified by expert participants in the group while other participants learnt how to identify species from these 'experts'. Ecological cause and effect relationships were learned as participants went into different forests and saw the differences in damage to trees and the waste of timber due to irresponsible harvesting. One participant identified a cause and effect problem of the irresponsible harvesting of important species and then suggested a possible management solution to solve it. Miss Dinwa, remarked that:

> We knew damage was happening to trees but we didn't know that there were different levels of damage. We just thought damage is damage. We also see that waste is happening when we go into the different forests, with logs just lying around from being cut. So if there is a permit system people wouldn't leave logs lying around in the forest.

Miss Dinwa's comment illustrates awareness on the value of monitoring and management that occurred. Learning occurred on the need for indigenous forest management, through the possible implementation of a permit system, to protect depleting indigenous species, and to promote sustainable harvesting.

Understanding the different values and concepts occurred as indicators for forest monitoring were discussed. At the forefront of the debate was the definition of important species and how to identify the different levels of damage. Defining the quality of different forests was also considered to be a major priority in determining which forests should be monitored and managed for sustainable harvesting. Participants learned about the concept and value of monitoring in its formal sense. Mr Somdaka, a local traditional healer, noted:

> We are monitoring to check that the trees are not being damaged so that our children can appreciate and live off of them. I have learned the method to monitor. I have also learnt which ranking to give to a type of tree damage and also methods to count trees.

Mr Somdaka highlighted the technical monitoring skills he gained and his awareness on their value for sustainable management, and the implications of this for future generations.

Grassland health assessment

Technical capacity built

The main useful monitoring skills gained from the grassland health assessment were transect and quadrant setup, grass species identification, grass cover ranking, and event chart data analysis. Participants gave positive feedback for the sampling method. Participants found the ranking difficult at first but useful for describing what they saw visually. Mrs Tshisa, commented on the difficulty she experienced in the ranking process and the value she sees in it:

> At first the ranking was difficult. We are used to just looking at the grass, we are not used to writing down numbers to represent what we see. The ranking is good because of this, and doesn't need changing.

This shows how participants struggled with understanding the ranking at first but eventually mastered it. It also illustrates how participants considered the ranking as an important tool for representing what they had seen.

Participants had difficulties in interpreting the results of the data collected, by comparing the frequency of ranks across benchmark sites, during the data analysis and interpretation process. This suggests that data analysis and interpretation requires further attention in order to transfer these monitoring method skills to the participants.

Local ecological knowledge (LEK) contributed

Local ecological knowledge (LEK) about species identification contributed to learning during the grassland health assessment. There was one grass species 'expert' in the group. This contributed to learning among participants who could not identify the grass species. Mr Majandana, the local grass species identification 'expert' in the group and a local livestock owner, commented on the LEK that he contributed:

> I know all the different grass species names. I know which are liked by the cattle and which are not. I also know Lapezi [*Euryops floribundus*] and the other weeds which the cattle don't like.

This shows that the grass species 'expert' was knowledgeable on all the variables used for ranking in the method. Participants who did not know all the grass species learnt from the local 'expert'. Miss Goniwe, a young village representative for the local land management organization, commented on her low knowledge of grass species and her learning in this area:

> I knew Lapezi [*Euryops floribundus*] and I knew some of the grass names but I didn't know what they all looked like. I learnt this through the method.

Miss Goniwe's comment illustrates that *Euryops floribundus* and a number of common grass species were known by less ecologically knowledgeable participants. In addition learning on other grass species occurred.

Learning and awareness

For monitoring and management awareness, learning occurred on the need for rangeland management to increase grassland productivity and health. Participants could identify some grass species but most participants could not identify all the wanted and unwanted grass species which were highlighted by Mr Majandana, the local grass species identification ‘expert’. The majority of the participants eventually learnt how to identify new grass species.

Ecological cause and effect relationships were learned through the clarification of links between different natural resources. The link between grassland health, rainfall and soil was discussed as well as the link between grass cover and erosion. Participants learnt the strong link between grassland health and grazing intensity when evaluating the benchmark and degraded sites. This led to discussions about the need for grassland management. Mrs Msini reflected on her learning and commented:

> I learnt lots, we didn’t know that if there is open bare ground that we shouldn’t put cattle in. I learnt new types of grasses. The ones liked by cattle and the ones not liked by cattle. This gave me new knowledge.

This shows how participants learnt about cause and effect relationships related to overgrazing and erosion. In addition the ecological uses of grass species were learnt, such as which species are grazed by cattle and which are not.

Live ungulate health ranking

Technical capacity built

Useful monitoring skills gained from the live ungulate health ranking by participants were those needed for defining the dipping site and the respective villages it services, ranking cattle health, data entry into event data sheets, sampling ten percent of the cattle, estimating the cattle numbers at the dip and data analysis using event charts. Sampling and data analysis were found to be well understood by the participants. Mr Madwabe, a member of the Machubeni land management committee, commented on the easy technical aspects of the monitoring method and the importance of practice:

> The more you do the method the easier it becomes. It is easy to see the ranking [of] health on the pictures. It is easy to see it in real life too at the rear of the cattle.

This suggests that practice improves the ease of the monitoring for participants. In addition the ranking was easy to comprehend by participants as they could relate the ranking images to live cattle.

Although participants could do the monitoring they were not all convinced by the sampling method of ranking ten percent of the cattle population. Participants preferred to rank all the cattle which passed through the dipping tank and did not consider this a cost to labour. Mr Gongo, a local livestock owner, commented on the difficult aspect of the sampling:

> Ranking every tenth cow was confusing and I didn’t understand this. I thought it would be best to rank all the cattle as then you would really know what is happening. I don’t trust only ranking every tenth cow.

This illustrates that even though participants could do scientific sampling they were not always accepted by participants. This may have negative consequences for the legitimacy of this monitoring method.

Local ecological knowledge (LEK) contributed

Local ecological knowledge (LEK) of cause and effect relationships related to cattle health and grassland health contributed to learning during the live ungulate health ranking. There were three local 'experts' on livestock health and grassland potential for grazing in the group. These 'experts' were also livestock owners. Mrs Madikane, who did not own livestock but had experience herding livestock, commented on her LEK. She then suggested how monitoring can help improve grassland management:

> I knew a thin cow walks slowly and struggles to get up, I also knew what a fat and healthy cow looked like before we started the monitoring method. I learnt how to show that using numbers in the ranking. We need to monitor in winter, to see how the cattle health is being affected by the grassland health. In summer the grass is usually good quality for cattle, while in winter it is not. Grasslands should be monitored as well as cattle so that proper grassland camps can be made.

This demonstrates that participants had knowledge on cattle health and that they learnt how to represent this with ranking. Mrs Madikane also highlighted the importance of knowledge on seasonal factors and creating grassland camps for effective rangeland management. Ecological knowledge on the link between cattle health and grassland health were also shown.

Learning and awareness

Learning and awareness about ecological cause and effect relationships occurred when the link between cattle production, cattle health, grassland health and potential monetary income from healthy livestock were discussed. Participants learnt that increasing grassland productivity can influence the cattle health and therefore also the economic value of the cattle for livestock owners.

For monitoring and management awareness, learning occurred on the need for grassland camp management to increase grassland productivity and health. During the discussion group the idea of pre-emptive management action and camp management were discussed. The concept of carrying capacity and overgrazing were also explored in detail in relation to their link to ungulate health. Participants understood that carrying capacity is a static concept and is dependent on the rainfall and production potential of a rangeland. Participants learnt that if carrying capacity is exceeded then rangeland health decreases due to overgrazing. This highlighted the need for effective rangeland management. One participant already had knowledge on these issues while others were not aware of them. A further discussion on how livestock should be managed if there is an overstocking problem was debated along side the possibility of developing a livestock census monitoring method. Mr Gongo, a local livestock owner and 'expert', reflected on his learning from the cattle health monitoring and the potential usefulness of the method:

> I learnt lots, because many people haven't heard of this type of monitoring before. When I stood up in the meeting today and reported back to them, I could tell them something new, which they will be able to do. It's important because we can use this method to find out how many cattle we must put in camps so that we meet the carrying capacity. If the carrying capacity is not met then there will be soil erosion because the cattle will finish the grass.

Mr Gongo highlighted the usefulness of the monitoring method in raising awareness and reporting information to the land management organization. He also learnt the concept of carrying capacity and its influence on soil erosion when exceeded.

Towards building adaptive capacity through learning in participatory monitoring

The following discussion will firstly investigate what factors may have stimulated learning that occurred during the monitoring methods. Following this the extent to which adaptive capacity has been built through the contribution of LEK by participants, and the learning and awareness that occurred, will be discussed. Finally, the transformative learning that occurred will be discussed and its potential consequences for sustainable land management.

The monitoring methods compared

The monitoring methods had different aspects which stimulated learning during the monitoring process. The fixed point photography method had a strong visual approach where photographs were compared. This assisted in stimulating learning during the process through seeing differences and changes in the rangelands over time. In participatory monitoring initiatives in the Philippines similar advantages were found for using a photographic documentation method where comparisons of photographs were useful for education. Natural resource changes were explored more adequately during discussion groups using photographs (Danielsen *et al.*, 2000). Additionally, the fixed point photography method dealt with all the main threats faced by grasslands through visual observation on the grazing areas. The threats of erosion, donga formation, Lapezi (*Euryops floribundus*) expansion and bad rangeland management were observed by participants and considered in relation to their ecological and management consequences.

The *Acacia karroo* density method and the forest health assessment made good contributions to the technical capacity of participants across the method aspects. This showed that these monitoring methods were easy for participants to understand with the potential for easily training other participants in the respective techniques.

The forest health assessment contributed to people's learning about indigenous forest management. This was largely due to the stimulating discussion groups where the issues of over harvesting threats and the need to protect valuable patches of forests were discussed. This shows the importance of stimulating social learning during discussion groups where ideas and concepts are shared and debated (Lawrence *et al.*, 2006). Feedback by participants to the community was useful for transferring knowledge about the monitoring process to community members and also important for building the legitimacy for using the monitoring methods in future. This was because questions could be asked about aspects where community members were uncertain and participants who were involved could show how monitoring methods could be useful for community based natural resource management (CBNRM).

The grassland health assessment contributed to ecological and threat learning among participants. This was due to learning during discussion groups and observation about the threat of overgrazing to grassland health. Grass species identification was also learnt by most of the participants due to the 'expert' knowledge of a local livestock owner.

Similarly, learning occurred for the live ungulate ranking method on cause and effect relationships between cattle health and rangeland health during discussion groups after monitoring. In sum, the results of the learning therefore show that different forms of participation such as discussion groups or data collection can stimulate different types of learning depending on the natural resource in focus and the monitoring method (Sims & Sinclair, 2008; Van Rijsoort & Jinfeng, 2005). These factors need consideration when attempting to stimulate social learning for adaptive capacity.

Learning, local knowledge and building adaptive capacity

Ecological learning was related to the threats, cause and effect relationships, and species found on the indigenous coastal forests and grasslands of Nqabara and the interior rangelands of Machubeni. Ecological learning was a commonly cited learning aspect, showing that increased ecological awareness is a major benefit from participatory monitoring. This has positive implications for the adaptive capacity of local managers in adaptive co-management. This is because a good understanding of ecological threats and cause and effect relationships allows local managers to make informed decisions when adapting management action in relation to environmental change (Fabricius *et al.*, 2007). Learning how to identify important indicator species was also a main outcome of ecological learning for some of the monitoring methods. Ecological knowledge is also important for collaborative management and monitoring (Lawrence *et al.*, 2006). These aspects are interrelated because management practices influence ecosystem services to local communities (Capistrano *et al.*, 2005). Therefore, effective monitoring is informed by good ecological knowledge and has positive consequences for adaptive co-management practices, for natural resources, with potential benefits to ecosystem services.

Participatory methods such as discussion groups need to involve discussion and debate on the concepts and value of monitoring and adaptive management systems for a particular natural resource. This occurred successfully, in relation to learning on the need for management and monitoring, for many of the monitoring methods. This is central to building the adaptive capacity of local managers and the legitimacy of monitoring methods (Armitage *et al.*, 2009).

Literacy levels appeared to have an affect on the potential to build technical capacity in monitoring among participants as found in other monitoring programmes (Obura *et al.*, 2002). This was due to the limitations of very low literacy levels among certain participants. Participants who had higher literacy levels found it easier to learn the technical process. General ecological learning and awareness or eco-literacy (Pilgrim *et al.*, 2007) was not obviously affected by literacy levels as this was rather influenced by the amount of participants' previous ecological knowledge, such as being a local 'expert' or not. Therefore participants who were not local 'experts' were more likely to learn more ecological knowledge, from local 'experts' involved (Berkes *et al.*, 2000). Consequently, local 'experts' also contributed more LEK to the monitoring methods as they were more knowledgeable on the natural resources in focus (Chalmers & Fabricius, 2007). Age directly correlated with education showing that the older participants had lower literacy levels than younger participants.

Local ecological knowledge (LEK) was found to be variable among participants. This shows the need to have a more rigorous selection process of participants to identify participants who have 'experts' on local ecological knowledge (LEK). This is difficult at times due the dynamics of participant selection, where participants may be selected due to their association with land management organizations or through political affiliations as was suggested by sources in Machubeni. This undermines the process of identifying the most competent and knowledgeable 'experts' from the community. Therefore the goals of a monitoring programme should be clearly defined in terms of the type of participants that are required. If learning is to be maximized then local 'experts' and generalists should be mixed. If monitoring effectiveness is to be maximized then only local 'experts' may be required.

Transformative learning and sustainability

Transformative learning can lead to a change in the behaviour and actions of community members (Sims & Sinclair, 2008), and is part of social learning in environmental management. Participatory monitoring has the potential to contribute to the transformative learning of the local communities with regard to community land management, as has been found in other land management projects (Sims & Sinclair, 2008; Van Rijsoort & Jinfeng, 2005; Pahl-Wostl *et al.*, 2008). Some of the transformative learning aspects of instrumental learning and communicative learning occurred across the monitoring methods.

Instrumental learning occurred for all the monitoring methods as technical skills and ecological information were learnt. While communicative learning was observed for the three monitoring methods namely fixed point photography ranking, forest health assessment and live ungulate health ranking. Communicative learning occurred mainly in the discussion groups where participants were able to debate values and concepts in natural resource monitoring while instrumental learning occurred during both the discussion groups and practical monitoring. Therefore communicative learning needs to be stimulated further in discussion groups to make transformative learning more complete in the collaborative monitoring process.

It was very promising to see parts of transformative learning occurring with its potential for changes in local participant perceptions and behaviour. This is in the context of ecological cause and effect relationships and natural resource management values and concepts. Transformative learning has the potential to build adaptive capacity by increasing participant ecological awareness and technical skills and transforming perceptions and behaviour in relation to learning that occurs (Marschke & Sinclair, 2009; Armitage *et al.*, 2009). Learning has been found to contribute to legitimacy and empowerment in other land management projects (Sims & Sinclair, 2008) and these are important aspects to consider for sustainable locally based monitoring and management. Participants gained skills to enable them to monitor independently as well as ecological awareness of threats during the monitoring process. This contributed to empowering participants as they generally felt that they had learnt an important skill which could be useful in a monitoring program and could be acknowledged by external stakeholders and partners. Building legitimacy through learning is another important factor in conjunction with adaptive capacity for supporting sustainable management of natural resources.

Conclusion

The assessment of the participatory monitoring methods illustrated that learning is a key outcome of participatory monitoring and can potentially build adaptive capacity in local land management organizations, thereby promoting adaptive co-management. Ecological learning was a main component of the monitoring process. Additionally, learning among participants from 'experts' with local ecological knowledge (LEK), was important for building greater ecological knowledge. Learning and awareness, on the need for monitoring and management as well as the technical capacity of participants are also important for building adaptive capacity. Training and participatory methods are required for stimulating social learning with the aim of transforming local participants' perceptions on environmental threats and effective management actions, for greater sustainability.

CHAPTER 6: Building an Adaptive and Collaborative Framework for the Use of Participatory Methods: Lessons Learnt and Recommendations

Introduction

After assessing the identified collaborative monitoring methods for their ability to effectively measure change, and promote social learning and legitimacy, it is useful in this final chapter to reconsider the original aim of the study and the progress made toward that aim. The original aims of the study were to:

1. Identify the key requirements for participatory natural resource monitoring methods to a) effectively measure change and to b) build adaptive capacity through learning.

2. Use a participatory scoping phase to Identify and adapt appropriate participatory monitoring methods, to be relevant to two CBNRM study site contexts, Machubeni and Nqabara.

3. Determine to what extent the selected natural resource monitoring methods meet the key requirements for a) effectively measuring change and b) building adaptive capacity through learning,

4. To document lessons learnt and recommend practical improvements with the aim of developing a framework, for collaborative monitoring in adaptive co-management in the Eastern Cape, South Africa.

In chapter one, the need for collaborative monitoring, in the context of the social-ecological systems of common pool resources through CBNRM was shown. The potential challenges that have to be overcome to develop good collaborative monitoring were also highlighted. An important factor in the development of monitoring methods was identifying key requirements for successful collaborative monitoring in the socio-ecological contexts of communal lands. These were identified and described in chapter three. In chapter three the adaptive and participatory processes required to refine and practice collaborative monitoring methods was shown. The methods required to collect both qualitative and quantitative data during the process were outlined. The relevant collaborative monitoring methods were identified in phase I, and tested through an adaptive, iterative and participatory process and two phases namely; the scoping stage (cf.Chapter3) and rigorous testing stage (cf.Chapter 4&5). This was done using the identified key requirements (cf.Chapter3) as points of assessment for each collaborative monitoring method in the two study sites of Machubeni and Nqabara.

In this chapter, the lessons learnt and recommended practical improvements are documented from the research process. Additionally, the results of the tested monitoring methods, with regard to their effectiveness and their contribution to building adaptive capacity, are applied to the CBNRM contexts of Machubeni and Nqabara. This is so that a framework can be developed for collaborative monitoring for CBNRM in the Eastern Cape, South Africa.

Revisiting the goal of building sustainable socio-ecological systems in communal lands with collaborative monitoring

Collaborative monitoring methods have the potential to be used in South Africa's communal lands, as a contribution to building sustainable socio-ecological systems. This is because of the benefits that can be realized. Such benefits come from strong collaboration between stakeholders (Danielsen *et al.*, 2005a), adaptive and participatory processes (Kouplevatskaya-Yunusova & Buttoud, 2006; Fazey *et al.*, 2007). Effective measurement of local natural resources (Spellerberg, 2005) can be attained through this methodology. Consequently, important and potential outcomes of collaborative monitoring are social learning (Pahl-Wostl *et al.*, 2008) and adaptive capacity (Fazey *et al.*, 2007; Fabricius *et al.*, 2007) in local communities, being relevant to local community needs and improved local land management action (Danielsen *et al.*, 2007).

Social-ecological resilience is a key concept in understanding the potential for managing social-ecological systems, sustainably (Allison & Hobbs, 2004). Resilience is an objective in social ecological systems (Olsson *et al.*, 2004). This is because of the interrelatedness of the social and ecological spheres and the need to diminish their vulnerability to negative change (Adger, 2006). This is important when considering how ecosystem changes are driven by social factors, or conversely, how ecosystem changes influence local communities. For example, people living in poor rural communities are reliant on ecosystem health for human well-being, through resource extraction and ecosystem services. However, ecosystem degradation is also a result of over extraction and use (Capistrano *et al.*, 2005). Ecosystem degradation can affect people's livelihoods through the scarcity of important species and therefore negatively influence their ability to cope, by having diminished safety nets (Shackleton & Shackleton, 2004; Shackleton & Campbell, 2007). This can increase social-ecological vulnerability.

Adaptive capacity is highlighted as important in these systems to maintain resilience within change (Olsson *et al.*, 2004). Adaptive co-management, in contrast to command and control management approaches, deals directly with change, and is especially relevant to common pool resources (Ostrom, 2008c). In common pool resource contexts change can be high and social-ecological resilience is a desired outcome (Olsson *et al.*, 2004). Social learning is a pivotal part of adaptive management systems (Olsson *et al.*, 2004) because of the need for local people to have the ability to change their actions in relation to new information acquired about changes in their local environment.

In order to deal with social-ecological related problems, management requires the integration of different disciplines so that both social and ecological issues can be addressed within a common management system (Pahl-Wostl, 2007). In some instances water catchments management systems (Pollard & du Toit, 2009) and coastal management systems (Christie *et al.*, 2005) have adopted this type of approach because of the multi-faceted nature of the social-ecological system. This has brought about the need to incorporate the significant roles of both social and ecological spheres in maintaining sustainable management practices and outcomes (Pahl-Wostl, 2007).

In South Africa's communal lands integrated and adaptive management approaches can be useful because of the complexity of the social-ecological systems. CBNRM attempts to engage in the social spheres of livelihoods and governance, and the ecological sphere of natural resources. These are significant areas which need to be considered in relation to each other because of their linkages and relationships (Fabricius, 2004). Within the social system of local communities, where natural resource reliance is high, such as in the communal lands of South Africa, livelihood demands (Turner, 2004) and local governance (Fabricius & Collins, 2007) play an important role in the managed state of the local natural resource base. Concurrently, ecosystem damage can severely affect local human well-being where local dependence is high (Capistrano *et al.*, 2005).

Local communities require external support from stakeholders due to the lack of local resources namely: human capital; physical capital; and financial capital (Fabricius & Collins, 2007). Collaboration between stakeholders can facilitate knowledge exchange (Fabricius *et al.*, 2006), co- learning, empowerment (Wiber *et al.*, 2009) and the transfer of skills to local community members (Danielsen *et al.*, 2005a). However, power dynamics play a significant role during participatory processes and stakeholder engagements. If these power dynamics are not acknowledged at an early stage in the process and addressed continually as a part of the process they can have a negative affect on participatory management efforts (Wiber *et al.*, 2009). Therefore good stakeholder relations are required in collaborative arrangements (Nare *et al.*, 2006).

In order to build resilience in social-ecological systems such as South Africa's communal lands, strong adaptive co-management approaches are required. These need to have an integrated and interdisciplinary approach to deal with social and ecological factors, as a means for dealing with high change and vulnerability to change.

Building a framework for monitoring in the context of adaptive co-management on South Africa's communal lands

Community based environmental management plans (EMP's) are typically developed collaboratively for implementing CBNRM. Community based EMP's typically have defined rules, management objectives, identified threats and key resource areas, which are identified through participatory processes (Fabricius, 2004). In South Africa's communal lands and especially the former Transkei, important natural resources foci are livestock (McAllister, 2001; Shackleton *et al.*, 2005), rangelands (Friedel *et al.*, 2004), indigenous forests (Moll, 1974) and water sources (Pollard & du Toit, 2009). These resources contribute significantly to local livelihoods and human-well being.

It is important to understand the major dynamics of interaction in CBNRM of communal lands (fig 6.1). CBNRM literature highlights three important areas of focus to consider, namely; local livelihoods (Turner, 2004), governance (Koch, 2004) and natural resources (Fabricius, 2004). The interaction of these spheres is important to consider in the context of social-ecological system resilience in the rural communal lands of South Africa (Burns *et al.*, 2006).

Figure 6.1 illustrates how the community based EMP, as described for the study sites of Nqabara and Machubeni (cf.Chapter 2), attempted to influence the natural resource base which was in turn directly influenced by governance structures and local livelihood priorities in the community. Community based EMP's can directly influence's how livelihood practices are carried out once rules of natural resource management are applied (Fabricius & Collins, 2007). The monitoring system does not directly influence the natural resource base (fig 6.1), but rather informs the community EMP decision makers about the state of the natural resource base so that responsive action can be taken

(Spellerberg, 2005). The EMP acts as a bridge between the social and ecological system.

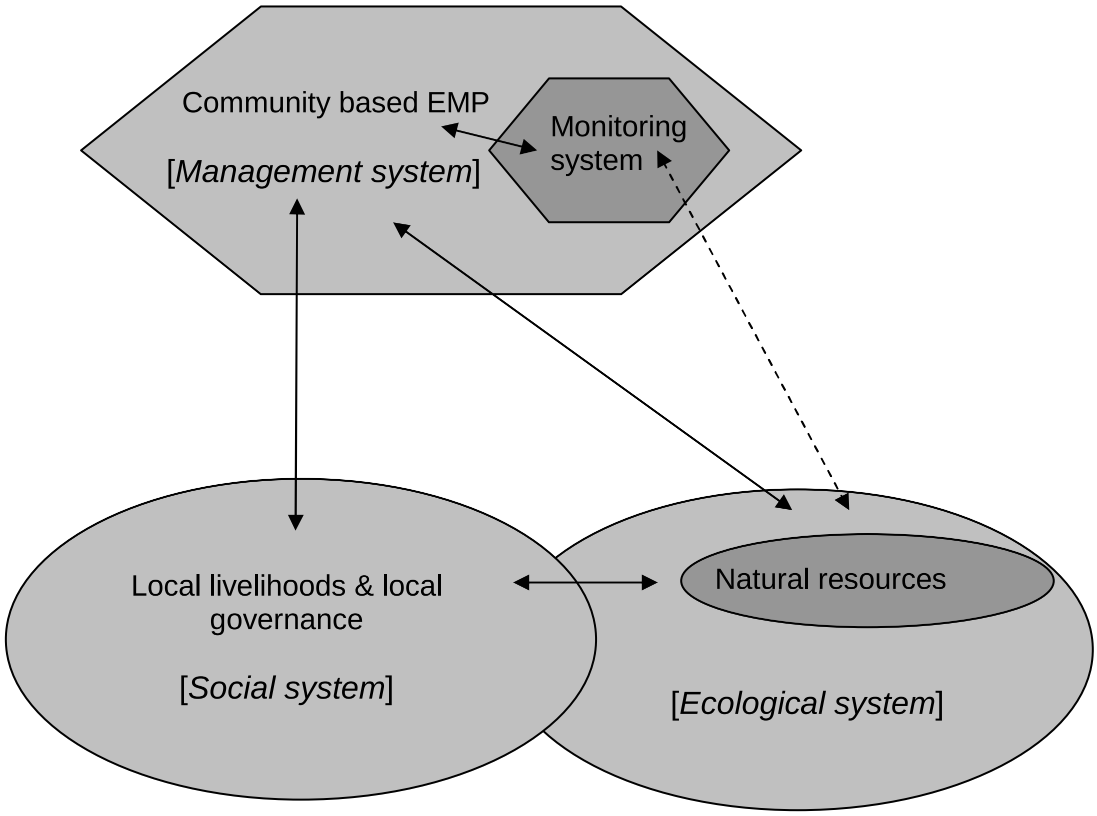

Fig 6.1. The multi-directional interactions and feedbacks in the CBNRM contexts of Nqabara and Machubeni. This diagram is meant as a guide to discuss the interactions of the natural resources base, local livelihoods and local governance. The size and shape of objects do not represent their level of influence but is used for ease of interpretation

An adaptive framework for monitoring in CBNRM

The continual and rigorous development of management systems in relation to the changing state of the environment can be successfully done through adaptive (Schreiber *et al.*, 2004; Fazey *et al.*, 2007) and iterative processes (Kouplevatskaya-Yunusova & Buttoud, 2006; Muro & Jeffrey, 2006). Part of the adaptive process of a monitoring system is its iterative nature (Kouplevatskaya-Yunusova & Buttoud, 2006). Through an adaptive and iterative process threats, priority natural resources and objectives are continuously assessed where necessary. This can therefore support management needs in relation to constantly changing environments.

In this research study, the community based EMP was interlinked with the monitoring system through an adaptive iterative and participatory approach. These links are shown in the adaptive framework illustrated in figure 6.2. This allowed the monitoring system to be informed by management needs which may be continuously changing (Schreiber *et al.*, 2004). The monitoring system could respond by developing the necessary monitoring methods to meet those needs. This was done in an adaptive and iterative process dependent on the needs of the monitoring system in relation to the community based EMP. The research study focused on the areas of 1) and 2) shown in figure 6.2, namely the development of monitoring methods and the monitoring cycle, respectively.

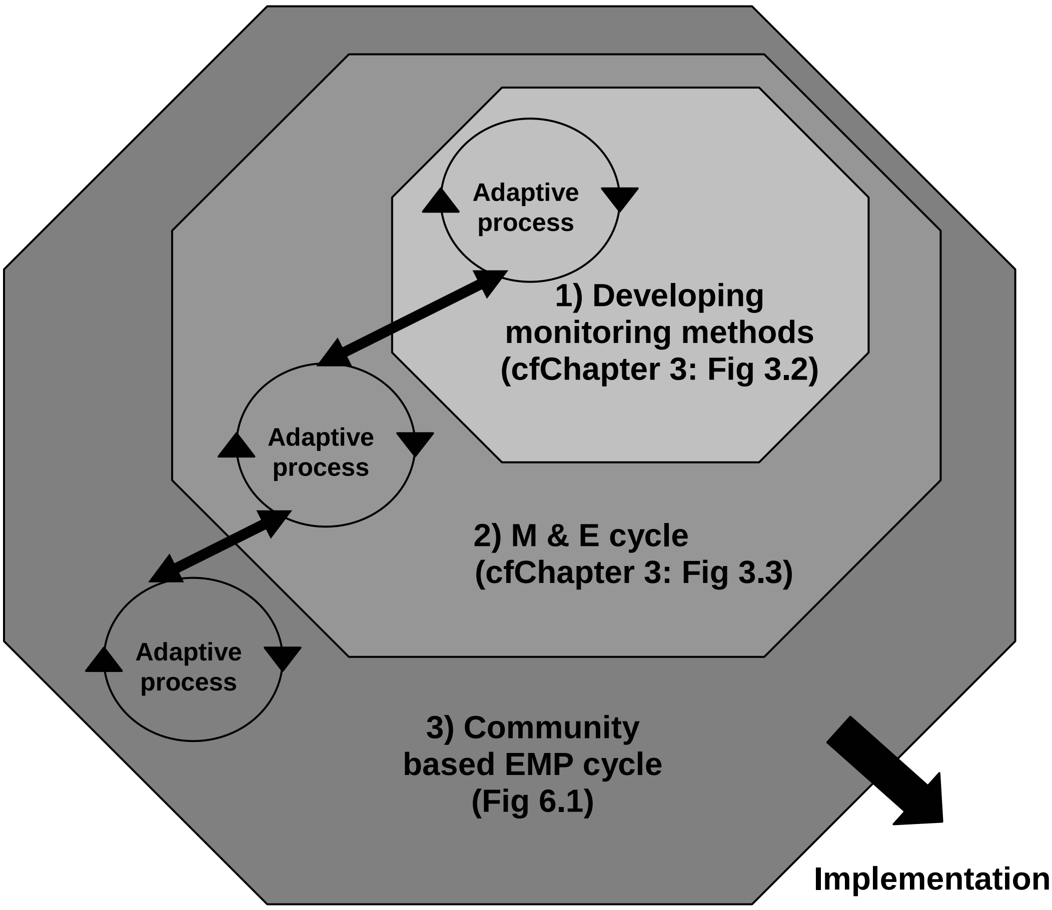

Fig 6.2. A diagram showing the multi-directional triple adaptive iterative system linking the development of relevant monitoring methods, the monitoring system and the community based EMP. Directed and informed implementation was the desired outcome from the cycles. This diagram seeks to conceptually explain the adaptive and iterative interaction of the community EMP, the monitoring system and the development of relevant monitoring methods

The process was adaptive so that adjustments could be made in response to changes in the natural resource base and threats, of the community based EMP. It was iterative because of the continual cyclical nature required to meet the needs of the changing natural resource base, threats and community objectives. The EMP, monitoring cycle and development of monitoring methods, were linked through duel feedback links which allowed each component to inform the other, with the ultimate goal of directed and informed land management (fig 6.2). This made the interactions between these components, a multi-directional triple adaptive and iterative system (fig 6.2).

Participation was especially important for developing collaborative monitoring methods. These monitoring methods are locally based with the objective of them being used by local people in the long term. In participatory management or monitoring programmes, the adaptive capacity of individuals in local communities (Fazey *et al.*, 2007; Fabricius *et al.*, 2007) is important as this allows learning to occur (Fazey *et al.*, 2007) and changes in the land management system to be made in relation to changes observed in the environment. Social learning can typically be a positive outcome of participation if carried out correctly (Tippett *et al.*, 2005).

Monitoring methods were a pivotal component of the monitoring system as they were instruments for data collection (Jones, 1986) of specific natural resources and threats. Well defined key requirements were useful for assessing monitoring methods in their ability to be successful collaborative methods (Danielsen *et al.*, 2005a). Key requirements, which are important in collaborative monitoring, assessed the ability of methods to effectively measure change and to promote social learning processes and legitimacy. Effective measurement was required so that reliable data could be collected by local participants (Spellerberg, 2005; Stuart-Hill *et al.*, 2005). This was also required so that monitoring could be carried out easily and cost-effectively. Social learning is required to promote environmental awareness, adaptive capacity and transformation of local actions in local communities (Bandura, 1977; Pahl-Wostl *et al.*, 2008; Sims & Sinclair, 2008; Fabricius *et al.*, 2007).

Legitimacy is required amongst the local participants and community involved in monitoring to strengthen the sustainability of monitoring. This can encourage local ownership of the process through continual negotiation between stakeholders (van den Hove, 2006), and consequently lead to greater long term sustainability for local land management.

A defined monitoring cycle was important to guide the monitoring process and had defined specific steps along the way (Jones, 1986). However, the ability of the management and monitoring system to be adapted according to lessons learnt was important, especially for contexts where the rate of environmental change was fast (Olsson *et al.*, 2004; Lindenmayer & Likens, 2009). Natural resources that are considered a priority by community members, and the threats facing them, can change according to local knowledge and understanding (Berkes *et al.*, 2000). Therefore the ability of a monitoring system to adapt to these changes reinforces its usefulness in potentially responding to changes in the environment through channelling community objectives in local land management

Monitoring effectively and building local adaptive capacity through learning: tradeoffs and stimuli

Considering tradeoffs in selecting monitoring tools

The developed participatory monitoring methods performed differently against the key requirements for effective measurement of change, and building adaptive capacity (cf.Chapter4 & 5). Monitoring methods were found to be strong in different key requirement areas, and weak in others. Therefore, it is important to be aware of these characteristics when choosing the monitoring methods for specific contexts. It is also important to select the monitoring method based on its strengths in specific aspects.

For example, the fixed point photography ranking method showed strength in the key requirements of building adaptive capacity but had weaknesses in its effectiveness to measure change. Therefore, this monitoring method would be useful where building adaptive capacity and learning and awareness of ecological factors are required, and less useful where effective monitoring were required. Similarly, the live ungulate health monitoring method has strengths in its ability for participants to monitor change reliably, easily and quickly and is therefore useful for monitoring change effectively. Participatory monitoring methods still need to be developed through additional testing processes. Particular stimuli are required to strengthen key requirements in the context of collaborative monitoring and these are discussed more specifically below.

Strengthening the effective measurement of change

The strongest key requirement for the effective measurement of change, across the majority of the monitoring methods, was appropriateness (cf.Chapter 4). Appropriateness, when assessed across the monitoring methods was related to the relevance of the monitoring methods to local livelihoods, usefulness in local land management and practical ease. This shows the importance of considering local livelihoods in monitoring and management objectives. The usefulness of the monitoring methods was also related to their potential effectiveness in managing local natural resources. The management of local natural resources links strongly to the governance of local communal lands. Therefore, the usefulness of the monitoring methods was also dependent on the monitoring methods' ability to inform local managers so that local natural resources could be governed better on the communal lands. This shows that the monitoring methods were appropriate to the problem and were therefore likely to be sustainable if implemented correctly.

Discussion groups and community meetings proved very useful in deliberating the appropriateness of monitoring methods in responding to threats, protecting important natural resources, sustaining local livelihoods and their usefulness in responding to land management goals. Therefore discussion groups and community meetings are a pivotal point in continually assessing appropriateness and need to be initiated at frequent stages of the adaptive monitoring cycle.

However, despite these strengths there were weaknesses found among the monitoring methods in the measurement of change. In order to strengthen the practical ease of data collection, data analysis, and the accuracy of the data collected by participants, further development of the monitoring methods, adequate training and constant practice is required. This training is also necessary to lower the variability of participant data. Selecting participants with the best monitoring skills, such as numerical and literacy skills is likely to improve participant responses to the practical ease of the monitoring methods; improve the accuracy of data collection; and lower variance among participants collecting data. Some monitoring methods had high accuracy levels while others had low variability in participant data collection. These are both positive aspects for data reliability. In spite of this, no monitoring method had both these qualities (cf.Chapter 4). This shows that accuracy and variability of participant data is a concern and still needs to be addressed.

Costs, are an essential consideration for sustainable long term monitoring (Caughlan & Oakley, 2001) as has been mentioned in previous chapters They need to be kept at the minimum in collaborative monitoring where funding may be low (Danielsen *et al.*, 2005a). This includes equipment and labour costs because local participants may require financial compensation for their time in certain programmes (Danielsen *et al.*, 2009). Only the fixed point photography method had high equipment costs. The monitoring costs of monitoring by local participants rather than formally trained biologists are significantly lower per hour which translates to greater cost effectiveness when local participants are used. This is a major positive finding and illustrates that participatory monitoring can be affordable and potentially sustainable in the long run through these practices.

Stimulating learning and building adaptive capacity

Building adaptive capacity among participants during the monitoring process occurred in three main areas. These areas include building technical capacity in data collection and data analysis procedures; local ecological knowledge (LEK) contribution, ecological monitoring and management learning; and aspects of transformative learning (cf.Chapter 5).

These aspects of learning among participants contributed to social learning in its broad sense (Bandura, 1977) and occurred during community meetings, discussion groups and during the monitoring cycle. Learning is a critical part of collaborative land management and monitoring process. This is because of the benefits of building sound environmental awareness (Andrianandrasana *et al.*, 2005; Sims & Sinclair, 2008) and social learning (Wolfenberg *et al.*, 2001) among local participants. This is a positive outcome of the process and suggests the possibility that local land management organizations in communities can implement effective management action based on sound ecological knowledge and lessons learnt. Through this adaptive capacity can be built to deal with environmental change during participatory monitoring. Even in saying this it must be acknowledged that the process of building adaptive capacity is an ongoing one. The process of data collection and analysis still requires practice and more frequent training on the part of the participants in order to strengthen their technical capacity. Additionally, environmental awareness is still variable among participants, therefore necessitating the need to further stimulate learning in these communities.

The contribution of LEK to monitoring methods also contributed to the legitimacy of monitoring methods by incorporating knowledge which is locally relevant and legitimate. Most LEK contributed by participants was related to species identification and ecological knowledge on cause and effect relationships on rangelands and indigenous coastal forests. Methods to strengthen adaptive capacity require the inclusion of local 'experts' and formally trained biologists, in the monitoring, through collaborative processes. This is so that knowledge sharing can occur through social learning from more knowledgeable participants to less knowledgeable participants. The power dynamics that may be present within this relationship need to be recognized (Blaikie, 2006) and constantly considered as a part of this process, so that both scientific knowledge and local knowledge are accepted and interact on an equal basis (Moller *et al.*, 2004) without diminishing legitimacy. This remains a significant challenge for participatory monitoring.

Additional considerations for sustainable and legitimate collaborative monitoring systems: The impact of social factors

Additional factors, apart from the key requirements, which may affect the sustainability and legitimacy of monitoring methods, presented themselves during this research. Social factors need to be considered in local community participatory contexts. Power dynamics between participants have the potential to negatively influence the sustainability of processes (Stenseke, 2009). Individual interests can negatively affect the direction of a monitoring programme, the defined objectives and the identification of relevant threats. An example of the way in which power struggles can negatively influence the process is the exclusion or expulsion of knowledgeable and experienced participants from land management organizations. Questions of equity and inclusion are also important aspects to consider. For instance, it is important to be aware of the nature of social dynamics in an area, especially the significance of age and gender roles in local communities. Democratic principles are strongly suggested in local participation (Stenseke, 2009), these principles have to be continually promoted as part of the process.

Local communities have their own values, priorities (Topp-Jorgensen *et al.*, 2005; Shriver & Randhir, 2006) and varied local ecological knowledge (LEK) (Chalmers & Fabricius, 2007). Integrating different monitoring systems which include social and ecological factors (Pahl-Wostl, 2007) has the potential to meet multiple priorities in local rural communities. Other factors which can influence the sustainability of long-term local communal management are incentives for local participants through benefits (Uphoff & Langholtz, 1998). For example, increasing the security of the local communities' rights to use natural resources can have a positive influence on creating incentives for local management and monitoring (Danielsen *et al.*, 2007). These issues need to be considered when developing a participatory monitoring system. A number of these factors emerged during the research process and are discussed in detail below.

Resolving participant incentives

Participant's expectations emerged as an important aspect to consider during the research process. In order to avoid the reduction of levels of participant involvement and motivation these expectations need to be met or negotiated (Fabricius, 2004; Uphoff & Langholtz, 1998). If expectations are not met it can potentially jeopardize the monitoring process.

Participant expectations, determined during interviews, were used to assess participant incentives for being involved in the process of monitoring. All participants said that learning would be a welcomed outcome. A significant number of participants said that they were content with what they would learn from the monitoring process and they could use these skills in future. Incentives cited among participants for being involved in the monitoring process were to build their ability to share knowledge in village meetings; getting involved in local land management projects with a better understanding; building skills related to working with people; and improving their communication skills.

However, a significant number of participants in Machubeni said that they expected to get employment after doing the collaborative monitoring training and testing, by doing monitoring for the local land management organization, or for external land management projects. Future employment was not clear for the participants. Mrs Tshisa summed up her expectations of the monitoring and that of others by saying:

> I would like to get a certificate, to confirm that I have done the monitoring training. This will help so that I can work in the future land management organization and to get a better income.

This shows how participants had the objective of obtaining work through the experience they had gained from the monitoring process. The majority of participants at Machubeni raised the issue of financial compensation and employment for monitoring in future. They felt that they should be employed as monitors by the land management organization alongside their duties in village land committees. Individual incentives were not clearly defined by the land management organizations with respect to what individuals would gain from being involved in monitoring. Monitoring was considered a value for the land management organization so that it could manage natural resources effectively for the benefit of the community, however individual incentives still need to be clarified. In this way, the objectives of the land management organization failed to meet all the expectations. This could compromise the long-term success of collaborative monitoring in this region.

Being aware of community priorities, values and cultural beliefs

The link between priority natural resources, threats or resource problems and the objectives of the community (Babu & Reidhead, 2000) are significant. This is because of the potential changes that may occur in these factors as a result of stakeholder perceptions, and objectives. In this research, it emerged that the priorities of participants and the community would be important when defining a monitoring system for land management and for the development of the community. Community priorities were not necessarily only about natural resource issues. There were other issues in the community that were also considered important. These included issues such as inadequate service delivery from local government, social-economic problems and lack of good governance. The presence of additional factors, such as these, needs to be considered when developing a monitoring system. Monitoring methods may also need to meet these social priorities in conjunction to natural resource monitoring seeing as these issues are interrelated

Alternative values that people hold showed themselves to be an important aspect to consider in monitoring. For example, Mr Mbinda, a local participant, when asked by a passer-by what the group were doing in the forest replied that: 'we are counting God's trees'. This illustrates how monitoring was not perceived as being highly practical. Mr Mbinda's comment about 'counting God's trees' insinuated that it may actually be a futile exercise to engage with, because nature is hugely complex and may only be understood by God. In this perspective scientific monitoring was attempting the impossible. This may be a common perception by local participants and therefore needs to be considered in relation to building legitimate and sustainable monitoring.

Another participant Miss Dinwa, noted that she was scared to go into the forests on her own, unlike males of her age, because she believed there were ghosts in the forests who could capture young girls and make them slaves. This was a local belief in the community. The spiritual and cultural beliefs related to natural resources are therefore also an important consideration. Cultural beliefs which may influence monitoring processes should be identified and weighed. If these are found to be significant then the monitoring system should be adapted to incorporate these factors.

Power dynamics in the community and the sharing of knowledge

In Machubeni power struggles emerged between the ex-members and the newly elected members of the local land management organization. Sufficient knowledge transfer mechanisms were considered as important ways to reduce these power struggles. A number of participants among the newly elected members resisted the inclusion of ex-members with previous knowledge of land management issues. This was considered to be unconstructive for the transfer of knowledge on local land management issues. Both ex and new members of the local management organization noted that knowledge transfer should occur during community feedback meetings to ensure that knowledge on land management is protected and continued by the active members of the community land management organizations.

Equity and inclusion in monitoring discussion groups

Equity within participation is important for promoting democratic principles in working relationships (Rosenstrom & Kyllonen, 2007) and adult education programmes (Rao & Robinson-Pant, 2006). Some of the younger participants felt that they were disempowered during discussion groups, which were designed to stimulate learning. Perceived age and gender discrimination made these participants feel that they could not participate equally, or contribute their knowledge freely with other participants in discussion groups on monitoring.

Strong collaboration between land management stakeholders

Good collaborative stakeholder relations are important in environmental management and development programmes (Thabrew *et al.*, 2009; Fabricius, 2004). Good stakeholder relations were identified as important by participants for successful monitoring and sustainability of the monitoring programme. Participants, from both study sites, saw difficult and sometimes weak relations with external stakeholders as an impediment. These stakeholders included local government, national government structures and development organizations. In Nqabara, the community land management organization expressed that their relationship with Department of Water Affairs and Forestry (DWAF) could be strengthened. This was because there were too few meetings with them and it was taking very long to reach an agreement on the issuing of permits for indigenous forest protection. In Machubeni, the community land organization complained of a lack of involvement of the government agricultural extension officer at community meetings. Complaints were also received from the local community, about the lack of an open consultative process with the local community by the external environment and development organization working in the area. Therefore in both these communities stakeholder relations require strengthening to ensure that monitoring and management initiatives are robust.

Recommendations for the application of collaborative natural resource monitoring methods, in Machubeni and Nqabara

Managing indigenous coastal forests

The local land management organization, in Nqabara, seeks a partnership with the Department of Water Affairs and Forestry (DWAF) to set up Participatory Forest Management (PFM). This requires additional participatory monitoring methods, similar to those developed in other programmes around the world, to monitor threats to forest health. Monitoring methods required are for example patrol records by rangers (Gray & Kalpers, 2005), identifying the number of forest users, the quantity of timber harvested by resource users, quantity and species of non-timber forest products (NTFPs) harvested (Topp-Jorgensen *et al.*, 2005) and the quantity and species of wild game hunted (Noss *et al.*, 2005a; Marks, 1994) .

The ecological services to the local community from the indigenous forests (De Klerk, 2007) are diverse and therefore diverse monitoring methods are required to assess the harvesting impacts. The forest health assessment only used five of the main popular indigenous tree species, namely *Millettia grandis* (Umsimbeet), *Ptaeroxylon obliquum* (Umthathi), *Premna mooiensis* (Umcacambane), *Duveronia adhatodoiodes* (Ihlwehlwe), and *Strychnos henningsii* (UmNonono) as indicators of the health of the forests. Additional indicators are required to monitor other commonly used species. The ecological function of these species should be further investigated. This is required to ascertain ecological impacts of over harvesting on forest health. These assessments could be done by external researchers in collaboration with the local land management organization. The forest health assessment requires the inclusion of medicinal plants as indicators for the threat of poaching and over harvesting of this natural resource. This will give a better indication of diverse over harvesting patterns and better identify damaged forests. The *Acacia karroo* density method can assist in the monitoring of the expansion of indigenous forests through woodland encroachment. This can be beneficial in controlling woodland encroachment from forest edges into rangelands (De Klerk, 2007).

Biodiversity value and ecosystem services need to be addressed when monitoring the indigenous forests. Biodiversity value and the delivery of ecosystem services are intrinsically linked (Green *et al.*, 2005; Capistrano *et al.*, 2005). Biodiversity can be a foreign concept to rural forest dependent communities. This has been observed in studies in Nepal where the value of forests are evaluated by communities on the basis of the usefulness of species found or the greenness of forest patches (Lawrence *et al.*, 2006), rather than on their diversity value. The monitoring of indigenous forests therefore needs to look critically at how to incorporate a biodiversity approach so that monitoring supplies both socially and ecologically relevant data. This can be done by stimulating learning and awareness about the ecological value of different species, and the value of biodiversity in forests (Dahal *et al.*, 2000). In the forest health assessment method, indicators should incorporate both the livelihood and ecological value of species (Kotwal *et al.*, 2007), in order to heighten the potential of detecting threats to the forest ecosystem and the degradation of ecosystem services. This can be informed by external researchers through collaboration with the local land management organizations and/or local ecological knowledge ‘experts’. Having a diversity of information on the ecological state of indigenous forests is important so that ecosystem services can be maintained through informed sustainable harvesting practices. Local communities can thus continue to benefit from these forests without degrading their ecosystem and biodiversity value, thereby building socio-ecological resilience.

Managing rangelands and agricultural fields

Management of rangelands for social and ecological benefit requires diverse monitoring approaches (Lynam & Stafford Smith, 2004; Western, 2004). The grassland health assessment only ranks grassland health and pioneer invasion. This method falls short of monitoring stocking rates and fire frequencies. Collaborative monitoring methods are required to assess stocking rates as has been done in other parts of the world (Cramb *et al.*, 2004). This is also required for fire frequency as these were highlighted as important aspects to monitor. These should be used in conjunction with information on the ideal stocking levels, using Livestock Units (LSU) as a measurement, to manage the local grasslands sustainably. The *Acacia karroo* density method assesses *Acacia karroo* pioneer invasion in Nqabara and can be used on local grasslands to monitor *Acacia karroo* encroachment. Soil erosion on local grasslands can be monitored using the fixed point photography ranking method. The live ungulate health ranking method can be used as an indicator for grassland degradation or overstocking while also potentially warning of cattle disease.

The state of agricultural lands with regard to pioneer invasion can also be assessed by the *Acacia karroo* density method used in Nqabara. Cultivation practices can influence pioneer invasion (De Klerk, 2007) and food productivity. For that reason, management should ideally include education on sustainable farming practices (Tengberg *et al.*, 1998) as part of its training in monitoring. Bad farming practices have negative consequences on the ecological processes of soil and water (Tengberg *et al.*, 1998) and can promote unwanted pioneer invasions which degrade the potential of agricultural lands (De Klerk, 2007).

Agro-ecological management approaches which improve diversity of productivity and limit negative ecological damage (Abang *et al.*, 2007) are required in these study sites. Monitoring methods developed in this regard will need to be relevant to the agricultural methods employed. Monitoring the state and production of agricultural lands should be made a priority so that information is available about the state of agricultural fields and their potential use as a safety net for local communities. This will require a motivated attempt to build and maintain knowledge about cultivation practices. These efforts will ensure the continued maintenance of lands for agriculture, by clearing pioneer species such as *Acacia karroo* and conserving soil integrity. This could contribute to more sustainable agro-ecosystem processes through building knowledge and learning about the local ecology and changing agricultural practices, for social ecosystem resilience (Berkes & Turner, 2006).

Conclusion

Adaptive and iterative processes in monitoring and management are shown to have valuable benefits when dealing with changing social and environmental contexts. CBNRM has attempted to reconcile community needs, communal land tenure and sustainable natural resource practices through participatory processes and collaboration. The adaptive and iterative process used in this study shows that valuable learning occurred during participatory monitoring with the potential to build local adaptive capacity. Also, the development and testing of monitoring methods was shown to be an important part of legitimizing the monitoring process in communities and finding the most potentially effective methods. Collaborative monitoring methods are more likely to be sustainable and successful if carried out, through strong stakeholder collaborations and community cohesion. Challenges such as incentives, cultural values, participant expectations and power dynamics need to be negotiated as a continual part of collaborative monitoring, for success.

Monitoring methods were found to be cost effective and appropriate to local threats. However, practical ease and the reproducibility of data remains a key challenge in developing good collaborative monitoring methods. Effective training, discussion groups and selecting the appropriate participants can strengthen these aspects for future use.

Learning was a key outcome of monitoring and can potentially build adaptive capacity in local land management organizations, thereby promoting adaptive co-management. Ecological learning was a key component of the monitoring process as well as learning about the value for monitoring and management, and technical monitoring skills. Ecological learning also occurred among participants from local ‘experts’, illustrating the dissemination of knowledge during the process. There was also evidence of aspects of transformative learning which occurred, with potential to improve local land management actions.

If developed adequately, collaborative monitoring has much to contribute to promoting resilience in vulnerable social-ecological systems (SES) such as Nqabara and Machubeni. Furthermore, this process has the potential to be used in other communal land management contexts to monitor similar natural resources effectively, and build local adaptive capacity to deal with environmental change.

Appendices

Appendix 1: *Acacia karroo* density data sheet

Date	Site	Density value

Appendix 2: Grassland health assessment data entry sheet

Date:					
Site:					
Quadrant	Transect interval		Rank	Number of Lapezi	Number of Weeds
1	10m	Total cover			
		Wanted species			
		Unwanted species			
2	20m	Total cover			
		Wanted species			
		Unwanted species			
3	30m	Total cover			
		Wanted species			
		Unwanted species			
4	40m	Total cover			
		Wanted species			
		Unwanted species			
5	50m	Total cover			
		Wanted species			
		Unwanted species			
		Total cover			
6	60m	Total cover			
		Wanted species			
		Unwanted species			
7	70m	Total cover			
		Wanted species			
		Unwanted species			
8	80m	Total cover			
		Wanted species			
		Unwanted species			
9	90m	Total cover			
		Wanted species			
		Unwanted species			
10	100m	Total cover			
		Wanted species			
		Unwanted species			
		Total cover			

Appendix 3: Grassland health data analysis bar chart

30					
29					
28					
27					
26					
25					
24					
23					
22					
21					
20					
19					
18					
17					
16					
15					
14					
13					
12					
11					
10					
9					
8					
7					
6					
5					
4					
3					
2					
1					
Frequency for three transects	Rank 1	2	3	4	5
Variable: Site: Date:					

Appendix 4: Live ungulate health ranking data entry sheet

50			
49			
48			
47			
46			
45			
44			
43			
42			
41			
40			
39			
38			
37			
36			
35			
34			
33			
32			
31			
30			
29			
28			
27			
26			
25			
24			
23			
22			
21			
20			
19			
18			
17			
16			
15			
14			
13			
12			
11			
10			
9			
8			
7			
6			
5			
4			
3			
2			
1			
Cattle number	1	Rank 2	3
Date:			
Site:			

Appendix 5: Fixed point photography data entry sheet

Site	1st Photo number	1st Photo date	1st photo rank	Reason	2nd Photo number	2nd Photo date	2nd Photo rank	Reason	Rank change between photos	Reason

Appendix 6: Forest health assessment data entry sheet

20																			
19																			
18																			
17																			
16																			
15																			
14																			
13																			
12																			
11																			
10																			
9																			
8																			
7																			
6																			
5																			
4																			
3																			
2																			
1																			
	Number	Damage	Diameter		Number	Damage	Diameter		Number	Damage	Diameter		Number	Damage	Diameter		Number	Damage	Diameter
	Species 1				Species 2				Species 3				Species 4				Species 5		
	Date:																		
	Site:																		

References

Abang,M.M., Bayaa,B., bu-Irmaileh,B. & Yahyaoui,A. (2007) A participatory farming system approach for sustainable broomrape (*Orobanche* spp.) management in the Near East and North Africa. *Crop Protection*, **26**, 1723-1732.

Acocks,J. (1988) *Veld types of South Africa: Memoirs of the botanical survey of South Africa*. Government printer, Pretoria.

Adger,W.N. (2006) Vulnerability. *Global Environmental Change*, **16**, 268-281.

Agrawal,A. & Gibson,C.C. (1999) Enchantment and disenchantment: The role of community in natural resource conservation. *World Development*, **27**, 629-649.

Ainslie,A. Managing natural resources in a rural settlement in Peddie district. 1998. Grahamstown, Rhodes University.
Ref Type: Thesis/Dissertation

Allen,W., Bosch,O., Kilvington,M., Brown,I. & Harley,D. (2001) Monitoring and adaptive management: Resolving social and organizational issues to improve information sharing in natural resource management. *Natural resources Forum*, **25**, 225-233.

Allison,H.E. & Hobbs,R.J. (2004) Resilience, adaptive capacity, and the "lock-in trap" of the Western Australian agricultural region. *Ecology and Society*, **9.** R1-online

Andrianandrasana,H.T., Randriamahefasoa,J., Durbin,J., Lewis,R.E. & Ratsimbazafy,J.H. (2005) Participatory ecological monitoring of the Alaotra Wetlands in Madagascar. *Biodiversity and Conservation*, **14**, 2757-2774.

Armitage,D.R., Plummer,R., Berkes,F., Arthur,R.I., Charles,A.T., Davidson-Hunt,I.J., Diduck,A.P., Doubleday,N.C., Johnson,D.S., Marschke,M., McConney,P., Pinkerton,E.W. & Wollenberg,E.K. (2009) Adaptive co-management for social-ecological complexity. *Frontiers in Ecology and the Environment*, **7**, 95-102.

Babbie,E. (1992) *The practice of social research*. Wadsworth Publishing Company.

Babu,S.C. & Reidhead,W. (2000) Monitoring natural resources for policy interventions: A conceptual framework, issues, and challenges. *Land Use Policy*, **17**, 1-11.

Bailenson,J.N., Shum,M.S., Atran,S., Medin,D.L. & Coley,J.D. (2002) A bird's eye view: Biological categorization and reasoning within and across cultures. *Cognition*, **84**, 1-53.

Balmford,A., Green,R.E. & Jenkins,M. (2003) Measuring the changing state of nature. *Trends in Ecology & Evolution*, **18**, 326-330.

Bandura,A. (1977) *Social learning theory*. Prentice Hall, Engelwood cliffs, New Jersey, U.S.A.

Barrett,C.B., Reardon,T. & Webb,P. (2001) Non-farm income diversification and household livelihood strategies in rural Africa: Concepts, dynamics, and policy implications. *Food policy*, **26**, 315-331.

Barrios,E., Delve,R.J., Bekunda,M., Mowo,J., Agunda,J., Ramisch,J., Trejo,M.T. & Thomas,R.J. (2006) Indicators of soil quality: A South-South development of a methodological guide for linking local and technical knowledge. *Geoderma*, **135**, 248-259.

Bennett,J., Lawrence,P., Johnstone,R. & Shaw,R. (2005) Adaptive management and its role in managing Great Barrier Reef water quality. *Marine Pollution Bulletin*, **51**, 70-75.

Bennun,L., Matiku,P., Mulwa,R., Mwangi,S. & Buckley,P. (2005) Monitoring important bird areas in Africa: Towards a sustainable and scaleable system. *Biodiversity and Conservation*, **14**, 2575-2590.

Berkes,F. & Turner,N.J. (2006) Knowledge, learning and the evolution of conservation practice for social-ecological system resilience. *Human Ecology*, **34**, 479-494.

Berkes,F. & Seixas,C.S. (2005) Building resilience in lagoon social-ecological systems: A local-level perspective. *Ecosystems*, **8**, 967-974.

Berkes,F. (2004) Rethinking community-based conservation. *Conservation Biology*, **18**, 621-630.

Berkes,F., Colding,J. & Folke,C. (2000) Rediscovery of Traditional Ecological Knowledge as adaptive management. *Ecological applications*, **10**, 1251-1262.

Berkes,F. (1999) *Sacred ecology, traditional ecological knowledge and resource management*. Taylor and Francis, Philadelphia, Pennsylvania.

Blaikie,P. (2006) Is small really beautiful? Community-based natural resource management in Malawi and Botswana. *World Development*, **34**, 1942-1957.

Boateng,E.A. (1978) *A political geography of Africa*. Cambridge University Press, Cambridge.

Brandon,A., Spyreas,G., Molano-Flores,B., Carroll,C. & Ellis,J. (2003) Can volunteers provide reliable data for forest vegetation surveys? *Natural Areas Journal*, **23**, 254-261.

Brashares,J.S. & Sam,M.K. (2005) How much is enough? Estimating the minimum sampling required for effective monitoring of African reserves. *Biodiversity and Conservation*, **14**, 2709-2722.

Brown,J., Mitchell,N. & Beresford,M. (2005) *Protected landscapes: A conservation approach that links nature, culture and community*. IUCN, Gland, Switzerland and Cambridge, U.K.

Bundy,C. (1988) *The rise and fall of the South African peasantry*. Blackshaws (Pty) Ltd, Cape Town, South Africa.

Burns,M., Audouin,M. & Weaver,A. (2006) Advancing sustainability science in South Africa. *South African Journal of Science*, **102**, 379-384.

Capistrano,D., Samper K.C., Lee,M.J. & Raudsepp-Hearne,C. (2005) *Millennium Ecosystem Assessment (MEA)*. Island Press, Washington D.C.

Carter,M.R. & May,J. (1999) Poverty, livelihood and class in rural South Africa. *World Development*, **27**, 1-20.

Caughlan,L. & Oakley,K.L. (2001) Cost considerations for long-term ecological monitoring. *Ecological Indicators*, **1**, 123-134.

CES . Coastal Environmental Services (CES). www.cesnet.co.za . 2009.
Ref Type: Electronic Citation

Chalmers,N. & Fabricius,C. (2007) Expert and generalist local knowledge about land-cover change on South Africa's Wild Coast: Can local ecological knowledge add value to science? *Ecology and Society*, **12**, R10 - online.

Chambers,J. (1983) *Graphical methods for data analysis*. Wadsworth, Belmont, California.

Chambers,R. (1994) Participatory rural appraisal (PRA): Challenges, potentials and paradigm. *World Development*, **22**, 1437-1454.

Christie,P., Lowry,K., White,A.T., Oracion,E.G., Sievanen,L., Pomeroy,R.S., Pollnac,R.B., Patlis,J.M. & Eisma,R.L. (2005) Key findings from a multidisciplinary examination of integrated coastal management process sustainability. *Ocean & Coastal Management*, **48**, 468-483.

Convention on Biological Diversity . The 2010 biodiversity target indicators. http://www.biodiv.org/2010-target/indicators.aspx . 2005.
Ref Type: Electronic Citation

Cottam,G. (1956) The use of distance measures in phytosociological sampling. *Ecology*, **37**, 451-460.

Cramb,R.A., Purcell,T. & Ho,T.C.S. (2004) Participatory assessment of rural livelihoods in the Central Highlands of Vietnam. *Agricultural Systems*, **81**, 255-272.

Cronin,M. (1982) Radiocarbon dates for the Early Iron Age in Transkei. *South African Journal of Science*, **77**, 38-39.

Cundill,G. & Fabricius,C. (2009) Monitoring in adaptive co-management: Toward a learning based approach. *Journal of Environmental Management*, **90**, 3205-3211.

Cundill,G. & Fabricius,C. (2008) Adaptive co-management under resource-poor conditions: Lessons from South Africa. *Exploring Sustainability Science* (ed. by M.Burns and A.Weaver), pp. 537-568. African Sun Media, Stellenbosch.

Cundill,G., Fabricius,C. & Marti,N. (2005) Foghorns to the future: Using knowledge and transdisciplinarity to navigate complex systems. *Ecology and Society*, **10**, R2 - online.

Dahal,S.P., Gibbon,H., Kafle,G. & Subedi,R. (2000) Learning to learn: working with local people to develop timber and non timber forest products in Nepal. *Forestry, forest users and research: New ways of learning* (ed. by A.Lawrence), pp. 109-122. ETFRN, Wageningen, Netherlands.

Dale,V.H. & Beyeler,S.C. (2001) Challenges in the development and use of ecological indicators. *Ecological indicators*, **1**, 3-10.

Dane,A. Developing a systems model for the provision of water in the Machubeni dam. 2006. Environmental Science department, Rhodes University.
Ref Type: Thesis/Dissertation

Danida (2000) *Towards 'best' practice in biodiversity conservation in Southern Africa*. Royal Danish Ministry of Foreign Affairs, Copenhagen, Denmark.

Danielsen,F., Burgess,N.D., Balmford,A., Donald,P.F., Funder,M., Jones,J.P.G., Alviola,P., Balete,D.S., Blomley,T., Brashares,J., Child,B., Enghoff,M., Fjeldson,J., Holt,S., Hobertz,H., Jensen,A.E., Jensen,P.M., Massao,J., Mendoza,M.M., Ngaga,Y., Poulsen,M.K., Rueda,R., Sam,M., Skielboe,T., Stuart-Hill,G., Topp-Jorgensen,E. & Yonten,D. (2009) Local participation in natural resource monitoring: A characterization of approaches. *Conservation Biology*, **23**, 31-42.

Danielsen,F., Burgess,N. & Balmford,A. (2005a) Monitoring matters: Examining the potential of locally-based approaches. *Biodiversity and Conservation*, **14**, 2507-2542.

Danielsen,F., Jensen,A.E., Alviola,P.A., Balete,D.S., Mendoza,M., Tagtag,A., Custodio,C. & Enghoff,M. (2005b) Does monitoring matter? A quantitative assessment of management decisions from locally-based monitoring of protected areas. *Biodiversity and Conservation*, **14**, 2633-2652.

Danielsen,F., Balete,D.S., Poulsen,M.K., Enghoff,M., Nozawa,C.M. & Jensen,A.E. (2000) A simple system for monitoring biodiversity in protected areas of a developing country. *Biodiversity and Conservation*, **9**, 1671-1705.

De Klerk,H. The mutual embodiment of landscape and livelihoods: An environmental history of Nqabara. 2007. Environmental Science department, Rhodes University.
Ref Type: Thesis/Dissertation

De Wet,C.J. (1995) *Moving together, drifting apart: Betterment planning and villagisation in a South African homeland*. Witwatersrand University Press, Johannesburg.

DEAT . Machubeni catchment management plan. 17. 2004. Pretoria, Department of Environmental Affairs and Tourism.
Ref Type: Report

Derricourt,R.M. (1977) *Prehistoric man in the Ciskei and Transkei*. Struik, Cape Town.

du Toit,J.T., Walker,B.H. & Campbell,B.M. (2004) Conserving tropical nature: Current challenges for ecologists. *Trends in Ecology & Evolution*, **19**, 12-17.

Duncan,J.S. & Ley,D. (1993) *Place/ culture/ representation*. Routledge, London.

Dupre,J. (2007) *Value-free science? Ideals and illusions*. Oxford University Press, Oxford, U.K.

Ericksen,P. & Woodley,E. (2005) Using multiple knowledge systems: Benefits and challenges. *Ecosystems and human well-being: Multi-scale assessments* (ed. by D.Capistrano, C.K.Samper, J.L.Marcus and C.Raudsepp-Hearne), pp. 85-118, Island Press, Washington D.C.

Fabricius,C. & Collins,S. (2007) Community-based natural resource management: Governing the commons. *Water Policy*, **9**, 83-97.

Fabricius,C., Folke,C., Cundill,G. & Schultz,L. (2007) Powerless spectators, coping actors and adaptive co-managers: A synthesis of the role of communities in ecosystem management. *Ecology and Society*, **12**, R29 - online.

Fabricius,C., Scholes,R. & Cundill,G. (2006) Concepts and applications in ecosystem assessment. *Bridging scales and knowledge systems* (ed. by W.V.Reid, F.Berkes and D.Capistrano), pp. 166-182. Island Press, Washington.

Fabricius,C. (2004) The fundamentals of community-based natural resource management. *Rights, resources & rural development* (ed. by C.Fabricius, E.Koch, H.Magome and S.Turner), pp. 3-43. Earthscan, London.

Fazey,I., Fazey,J.A., Fischer,J., Sherren,K., Warren,J., Noss,R.F. & Dovers,S.R. (2007) Adaptive capacity and learning to learn as leverage for social-ecological resilience. *Frontiers in Ecology and the Environment*, **5**, 375-380.

Fleming,B. & Henkel,D. (2001) Community-based ecological monitoring: A rapid appraisal approach. *Journal of the American Planning Association*, **67**, 456 - 465.

Ford,E.D. (2000) *Scientific method for ecological research*. Cambridge University Press, Cambridge, U.K.

Fraser,E.D.G., Dougill,A.J., Mabee,W.E., Reed,M. & McAlpine,P. (2006) Bottom up and top down: Analysis of participatory processes for sustainability indicator identification as a pathway to community empowerment and sustainable environmental management. *Journal of Environmental Management*, **78**, 114-127.

French,S. (2007) *Science: Key concepts in philosophy*. Continuum, London.

Friedel,M., Stuart-Hill,G. & Walsh,D. (2004) What engages the interest of land managers in rangeland monitoring? *African Journal of Range and Forage Science*, **21**, 89-100.

Gadgil,M., Seshagiri Rao,P., Utkarsh,G., Pramod,P. & Chhatre,A. (2000) New Meanings for Old Knowledge: The People's Biodiversity Registers program. *Ecological applications*, **10**, 1307-1317.

Gaidet,N., Fritz,H. & Nyahuma,C. (2003) A participatory counting method to monitor populations of large mammals in non-protected areas: A case study of bicycle counts in the Zambezi Valley, Zimbabwe. *Biodiversity and Conservation*, **12**, 1571-1585.

Gallopin,G. (2006) Linkages between vulnerability, resilience and adaptive capacity. *Global Environmental Change*, **16**, 293-303.

Gibson,C.C., Williams,J.T. & Ostrom,E. (2005) Local enforcement and better forests. *World Development*, **33**, 273-284.

Gray,M. & Kalpers,J. (2005) Ranger based monitoring in the Virunga Bwindi region of East-Central Africa: A Simple Data Collection Tool for Park Management. *Biodiversity and Conservation*, **14**, 2723-2741.

Green,R.E., Balmford,A., Crane,P.R., Mace,G.M., Reynolds,J.D. & Turner,R.K. (2005) A framework for improved monitoring of biodiversity: Responses to the world summit on sustainable development. *Conservation Biology*, **19**, 56-65.

GTZ Transform . GTZ Transform. www.gtz.de/en/689.htm . 2009.
Ref Type: Electronic Citation

Haberl,H., Wackernagel,M. & Wrbka,T. (2004) Land use and sustainability indicators. An introduction. *Land Use Policy*, **21**, 193-198.

Hartanto,H., Lorenzo,M.C.B. & Frio,A.L. (2002) Collective action and learning in developing a local monitoring system. *International Forestry Review*, **4**, 184-195.

Hellawell,J.M. (1992) Development of rationale for monitoring. *Monitoring for conservation and ecology* (ed. by J.M.Hellawell), Chapman & Hall, London.

Heller,N.E. & Zavaleta,E.S. (2009) Biodiversity management in the face of climate change: A review of 22 years of recommendations. *Biological Conservation*, **142**, 14-32.

Hockley,N.J., Jones,J.P.G., Andriahajaina,F.B., Manica,A., Ranambitsoa,E.H. & Randriamboahary,J.A. (2005) When should communities and conservationists monitor exploited resources? *Biodiversity and Conservation*, **14**, 2795-2806.

Hoffman,M.T. & Todd,S. (2000) A national review of land degradation in South Africa: the influence of biophysical and socio-economic factors. *Journal of Southern African Studies*, **26**, 743-758.

Holck,M.H. (2008) Participatory forest monitoring: An assessment of the accuracy of simple cost-effective methods. *Biodiversity and Conservation*, **17**, 2023-2036.

Holling,C.S. (1973) Resilience and stability of ecological systems. *Annual Review of Ecological Systems*, 1-23.

Holte-McKenzie,M., Forde,S. & Theobald,S. (2006) Development of a participatory monitoring and evaluation strategy. *Evaluation and Program Planning*, **29**, 365-376.

Hornborg,A. (1996) Ecology as semiotics. Outlines of a contextualist paradigm for human ecology. *Nature and Society: Anthropological Perspectives* (ed. by P.Descola and G.Palsson), Routledge, London.

Hudak,A.T. (1999) Rangeland mismanagement in South Africa: Failure to apply ecological knowledge. *Human Ecology*, **27**, 55-78.

Hurni,H. (2000) Assessing sustainable land management (SLM). *Agriculture, Ecosystems & Environment*, **81**, 83-92.

Ikhwezi Development . Machubeni land plan: Land use plan report. 1-38. 2004a. Chris Hani District Municipality, GTZ/RULIV.
Ref Type: Report

Ikhwezi Development . Machubeni land plan: Situation assessment report. 1-48. 2004b. Chris Hani District Municipality, GTZ/RULIV.
Ref Type: Report

Ikhwezi Development . Land use plan for the Machubeni catchment, Emalahleni District, Eastern Cape. 188. 2003. Pretoria, GTZ Transform.
Ref Type: Report

Janssen,M.A. & Ostrom,E. (2006) Resilience, vulnerability, and adaptation: A cross-cutting theme of the International Human Dimensions Programme on Global Environmental Change. *Global Environmental Change*, **16**, 237-239.

Jensen,A.E., Enghoff,M. & Poulsen,M.K. (2007) Increasing conservation management action by involving local people in natural resource monitoring. *Ambio*, **36**, 566-570.

Jick,T.D. (1983) Mixing qualitative and quantitative methods: Triangulation in action. *Qualitative Methodology* Sage publications, California.

Johnson,C.T. (1982) The art of hut building in the Transkei. *Veld and Flora*, **108**, 109-110.

Jones,S. & Carswell,G. (2004) *Environment, Development and Rural Livelihoods*. Earth Scan, London.

Jones,B.K. (1986) Inventory and monitoring process. *Inventory and monitoring of wildlife habitat* (ed. by Cooperider A.Y., Boyd R.J. and Stuart H.R.), U.S Department Bur Land Manage Centre, Denver.

Koch,E. (2004) Political economy, governance and community-based natural resource management. *Rights, resources and rural development: Community-based natural resource management in Southern Africa* (ed. by C.Fabricius, E.Koch, H.Magome and S.Turner), pp. 66-77. Earthscan, London.

Kotwal,P.C., Omprakash,M.D., Gairola,S. & Dugaya,D. (2007) Ecological indicators: Imperative to sustainable forest management. *Ecological Indicators*, **8**, 104-107.

Kouplevatskaya-Yunusova,I. & Buttoud,G. (2006) Assessment of an iterative process: The double spiral of re-designing participation. *Forest Policy and Economics*, **8**, 529-541.

Kremen,C., Raymond,I. & Lance,K. (1998) An interdisciplinary tool for monitoring conservation impacts in Madagascar. *Conservation Biology*, **12**, 549-563.

Krupnik,I. & Jolly,D. (2002) *The earth is faster now: Indigenous observations of Arctic environmental change*. Arctic Research Consortium of the United States, Fairbanks, Alaska, U.S.A.

Lasiak,T.A. (1992) The shellfish-gathering practices of indigenous coastal people in Transkei, South Africa. *Biological Conservation*, **56**, 245-264.

Lawrence,A., Paudel,K., Barnes,R. & Malla,Y. (2006) Adaptive value of participatory biodiversity monitoring in community forestry. *Environmental Conservation*, **33**, 325-334.

Lindenmayer,D.B. & Likens,G.E. (2009) Adaptive monitoring: A new paradigm for long-term research and monitoring. *Trends in Ecology and Evolution*, **24**, 482-486.

Liu,J., Dietz,T., Carpenter,S.R., Folke,C., Alberti,M., Redman,C.L., Schneider,S.H., Ostrom,E., Pell,A.N., Lubchenco,J., Taylor,W.W., Ouyang,Z., Deadman,P., Kratz,T. & Provencher,W. (2007) Coupled human and natural systems. *Ambio*, **36**, 639-649.

Low,A.B. & Rebelo,A.G. (1996) *Vegetation of South Africa, Lesotho and Swaziland*. Department of Environment and Tourism, Pretoria.

Lynam,T. & Stafford Smith,M. (2004) Monitoring in a complex world- seeking slow variables, a scaled focus, and speedier learning. *African Journal of Range and Forage Science*, **21**, 61-78.

Mafa . Feasibility assessment of PFM projects in the Nqabara Administrative Area. Final Report to GTZ Transform. 2003. South Africa, Danida and DWAF.
Ref Type: Report

Mafa . Nqabara community management plan. 2005. Pretoria, GTZ Transform.
Ref Type: Report

Manona,C. (1995) *The collapse of the 'tribal authority' system and the rise of the civic organizations*. Rhodes University, Grahamstown.

Marks,S.A. (1994) Local hunters and wildlife surveys: A design to enhance participation. *African Journal of Ecology*, **32**, 233-254.

Marschke,M. & Sinclair,A.J. (2009) Learning for sustainability: Participatory resource management in Cambodian fishing villages. *Journal of Environmental Management*, **90**, 206-216.

Martin,G.G. (2001) *Human ecology: Basic concepts for sustainable development*. Earthscan publications, Sterling, VA.

Maurel,P., Craps,M., Cernesson,F., Raymond,R., Valkering,P. & Ferrand,N. (2007) Concepts and methods for analysing the role of Information and Communication tools (IC-tools) in social learning processes for river basin management. *Environmental Modelling & Software*, **22**, 630-639.

Mayaux,P., Holmgren,P., Achard,F., Eva,H., Stibig,H.J. & Branthomme,A. (2005) Tropical forest cover change in the 1990s and options for future monitoring. *Philosophical Transactions of the Royal Society B: Biological Sciences*, **360**, 373-384.

McAllister,P.A. The rituals of labour migration among the Gcaleka. 1979. Grahamstown, Rhodes University.
Ref Type: Thesis/Dissertation

McAllister,P.A. (2001) *Building the Homestead: Agriculture, labour and beer in South Africa's Transkei*. Ashgate, Aldershot.

Mckenzie,b. & Cowling,R. (1979) *The grasslands of the Dwesa Nature Reserve, Habitat Working Group*. University of Cape Town, Cape Town.

Mentis,M.T. (1992) How old are South Africa's grasslands? *Nature and dynamics of forest-savannah boundaries.* Chapman & Hall, London.

Mezirow,J. (1996) Contemporary paradigms of learning. *Adult Education Quarterly*, **46**, 158-173.

Mikkelsen,B. (2005) *Methods for development work and research*. Sage, New Delhi.

Millennium Ecosystem Assessment (MEA) (2005) *Ecosystems and human well being: Synthesis report*. Island Press, Washington D.C.

Misiko,M., Tittonell,P., Ramisch,J.J., Richards,P. & Giller,K.E. (2008) Integrating new soybean varieties for soil fertility management in smallholder systems through participatory research: Lessons from western Kenya. *Agricultural Systems*, **97**, 1-12.

Moll,E.J. (1974) *A preliminary report on the Dwesa Forest Reserve, Transkei*. Wildlife Society of Southern Africa, Pinetown, South Africa.

Moller,H., Berkes,F., O'Brian Lyver,P. & Kislalioglu,M. (2004) Combining science and traditional ecological knowledge: Monitoring populations for co-management. *Ecology and Society*, **9**. R3-online

Mostert,N. (1992) *Frontiers, the epic of South Africa's creation and the tragedy of the Xhosa people*. Pimlico, London.

Mucina,L. & Rutherford,M.C. (2009) *The vegetation of South Africa, Lesotho and Swaziland*. SANBI, Pretoria.

Mueller-Dombois,P. & Ellenberg,H. (1974) *Aims and methods of vegetation ecology*. John Wiley and Sons.

Muller,N.D. & Mpela,V.N. (1994) *The population of Transkei by magisterial district (1910-1975)*. Bureau for African Research and Documentation, Umtata.

Muro,M. & Jeffrey,P. (2006) A review of participatory test and evaluation approaches for water management. *Water Science and Technology: Water Supply*, **6**, 1-8.

Nare,L., Love,D. & Hoko,Z. (2006) Involvement of stakeholders in the water quality monitoring and surveillance system: The case of Mzingwane Catchment, Zimbabwe. *Physics and Chemistry of the Earth, Parts A/B/C*, **31**, 707-712.

Noss,A.J., Oetting,I. & Cuellar,R. (2005) Hunter self-monitoring by the Isoseno-Guarani in the Bolivian Chaco. *Biodiversity and Conservation*, **14**, 2679-2693.

Nott,C., Davis,A. & Roman,B. (2004) The Torra Conservancy in Namibia. *Rights, resources and rural development: Community-based natural resource management in Southern Africa* (ed. by C.Fabricius, E.Koch, H.Magome and S.Turner), Earthscan, London, U.K.

O'Connor,T.G. (1995) *Acacia karroo* invasion of grassland: Environmental and biotic effects influencing seedling emergence and establishment. *Oecologia*, **103**, 214-223.

Obura,D.O., Wells,S., Church,J. & Horrill,C. (2002) Monitoring of fish and fish catches by local fishermen in Kenya and Tanzania. *Marine and Freshwater Research*, **53**, 215-222.

Olsson,P., Folke,C. & Berkes,F. (2004) Adaptive co-management for building resilience in social-ecological systems. *Environmental Management*, **34**, 75-90.

Ostrom,E. (2008a) Frameworks and theories of environmental change. *Global Environmental Change*, **18**, 249-252.

Ostrom,E. (2008b) Tragedy of the ecological commons. *Encyclopedia of Ecology* (ed. by E.J.Sven and F.Brian), pp. 3573-3576. Academic Press, Oxford.

Ostrom,E. (2008c) The challenge of common-pool resources. *Environment*, **50**, 8-20.

Pahl-Wostl,C. (2007) The implications of complexity for integrated resources management. *Environmental Modelling & Software*, **22**, 561-569.

Pahl-Wostl,C., Tabara,D., Bouwen,R., Craps,M., Dewulf,A., Mostert,E., Ridder,D. & Taillieu,T. (2008) The importance of social learning and culture for sustainable water management. *Ecological Economics*, **64**, 484-495.

Palmer,R., Fay,D., Timmermans,H., Lewis,F. & Viljeon,J. (2002) *From conflict to negotiation: Nature-based development on the South African Wild Coast*. Human Sciences Research Council, Pretoria.

Peires,J.B. A history of the Xhosa, c. 1700-1835. 1976. Grahamstown, Rhodes University.
Ref Type: Thesis/Dissertation

Pilgrim,S., Smith,D. & Pretty,J. (2007) A cross-regional assessment of the factors affecting ecoliteracy: Implications for policy and practice. *Ecological applications*, **17**, 1742-1751.

Pollard,S. & du Toit,D. (2009) Integrated water resource management in complex systems: How the catchment management strategies seek to achieve sustainability and equity in water resources in South Africa. *Water SA*, **34**, 671-680.

Ranganath,B.K., Diwakar,P.G., Gowrisankar,D. & Jayaraman,V. Participatory watershed development using eo inputs - A working model for poverty alleviation and improved livelihood in rural India. AIAA 57th International Astronautical Congress, IAC 2006 4, 2222-2234. 2006. Valencia. AIAA 57th International Astronautical Congress, IAC 2006. 2-10-2006.
Ref Type: Conference Proceeding

Rao,N. & Robinson-Pant,A. (2006) Adult education and indigenous people: Addressing gender in policy and practice. *International Journal of Educational Development*, **26**, 209-223.

Rasmussen,G.A. & Voth,K. (2001) *Repeat photography: Monitoring made easy*. Utah State University Extension, U.S.A.

Reed,M., Fraser,E.D., Morse,S. & Dougill,A.J. (2005) Integrating methods for developing sustainability indicators to facilitate learning and action. *Ecology and Society*, **10**, R3-online.

Rhiney,T. (1982) *Judging physical condition in live ungulates*. John Wiley and Sons.

Robbins,P. (2004) *Political ecology: A critical introduction*. Blackwell publishing's, Malden, Mass.

Robbins,P. (2003) Fixed categories in a portable landscape: The causes and consequences of land cover categorisation. *Political ecology, an integrative approach to geography and environment-development studies* (ed. by K.S.Zimmerer and J.Bassett), Guilford Press, New York.

Rosenstrom,U. & Kyllonen,S. (2007) Impacts of a participatory approach to developing national level sustainable development indicators in Finland. *Journal of Environmental Management*, **84**, 282-298.

Salafsky,N. & Margoluis,R. (1999) Threat reduction assessment: A practical and cost-effective approach to evaluating conservation and development projects. *Conservation Biology*, **13**, 830-841.

Schmidt,J. & Hewitt,A. (2004) Fuzzy land element classification from DTMs based on geometry and terrain position. *Geoderma*, **121**, 243-256.

Schreiber,E.S., Bearlin,A.R., Nicol,S.J. & Todd,C.R. (2004) Adaptive management: a synthesis of current understanding and effective application. *Ecological Management & Restoration*, **5**, 177-182.

Scoones,I. (1999) New ecology and the social sciences: What prospects for a fruitful engagement? *Annual Review of Anthropology*, **28**, 479-507.

Shackleton,C.M., Parkin,F., Chauke,M.I., Downsborough,L., Olsen,A., Brill,G. & Weideman,C. (2009) Conservation, commercialisation and confusion: Harvesting of *Ischyrolepis* in a coastal forest, South Africa. *Environment, Development and Sustainability*, **11**, 229-240.

Shackleton,C.M. & Gambiza,J. (2008) Social and ecological trade-offs in combating land degradation: The case of invasion of a woody shrub (*Euryops floribundus*) at Machubeni, South Africa. *Land Degradation & Development*, **19**, 454-464.

Shackleton,C.M., Shackleton,S.E., Buiten,E. & Bird,N. (2007) The importance of dry woodlands and forests in rural livelihoods and poverty alleviation in South Africa. *Forest Policy and Economics*, **9**, 558-577.

Shackleton,S.E. & Campbell,B.M. (2007) The traditional broom trade in Bushbuckridge, South Africa: Helping poor women cope with adversity. *Economic Botany*, **61**, 256-268.

Shackleton,S.E., Shackleton,C.M., Netshiluvhi,T.R. & Mathabela,F.R. (2005) The contribution and direct-use value of livestock to rural livelihoods in the Sand River catchment, South Africa. *African Journal of Range & Forage Science*, **22**, 127-140.

Shackleton,C. & Shackleton,S. (2004) The importance of non-timber forest products in rural livelihood security and as safety nets: A review of evidence from South Africa. *South African Journal of Science*, **100**, 658-664.

Shackleton,C.M., Shackleton,S.E. & Cousins,B. (2001) The role of land-based strategies in rural livelihoods: The contribution of arable production, animal husbandry and natural resource harvesting in communal areas in South Africa. *Development Southern Africa*, **18**, 581-604.

Sheil,D. (2001) Conservation and biodiversity monitoring in the tropics - realities, priorities and distractions. *Conservation Biology*, **15**, 1179-1182.

Shriver,D.M. & Randhir,T.O. (2006) Integrating stakeholder values with multiple attributes to quantify watershed performance. *Water Resources Research*, **42**. R8-online

Sims,L. & Sinclair,A.J. (2008) Learning through participatory resource management programs: Case studies from Costa Rica. *Adult Education Quarterly*, **58**, 151-168.

Sinclair,A.J., Diduck,A. & Fitzpatrick,P. (2007) Conceptualizing learning for sustainability through environmental assessment: Critical reflections on 15 years of research. *Environmental Impact Assessment Review*, **28**, 415-428.

Smith,P.D., Chehhetri,B.B.K. & Regmi,B. (2003) Meeting the needs of Nepal's poor: Creating local criteria and indicators of community forestry. *Journal of Forestry*, **101**, 24-30.

Spellerberg,I. (2005) *Monitoring ecological change*. Cambridge University Press, Cambridge, U.K.

Statistics SA . 2001 Census Data for Mbhashe, Ward 17. http://www.statssa.gov.za/census2001/atlasward2/index.html . 2001.
Ref Type: Electronic Citation

Stenseke,M. (2009) Local participation in cultural landscape maintenance: Lessons from Sweden. *Land Use Policy*, **26**, 214-223.

Stringer,L.C. (2009) Testing the orthodoxies of land degradation policy in Swaziland. *Land Use Policy*, **26**, 157-168.

Stuart-Hill,G., Diggle,R., Munali,B., Tagg,J. & Ward,D. (2005) The event book system: A community-based natural resource monitoring system from Namibia. *Biodiversity and Conservation*, **14**, 2611-2631.

Sultana,P. & Thompson,P. (2004) Methods of consensus building for community-based fisheries management in Bangladesh and the Mekong Delta. *Agricultural Systems*, **82**, 327-353.

Sutherland,W.J., Pullin,A.S., Dolman,P.M. & Knight,T.M. (2004) The need for evidence-based conservation. *Trends in Ecology and Evolution*, **19**, 305-308.

Tengberg,A., Ellis-Jones,J., Kiome,R. & Stocking,M. (1998) Applying the concept of agro-diversity to indigenous soil and water conservation practices in eastern Kenya. *Agriculture, Ecosystems & Environment*, **70**, 259-272.

Thabrew,L., Wiek,A. & Ries,R. (2009) Environmental decision making in multi-stakeholder contexts: Applicability of life cycle thinking in development planning and implementation. *Journal of Cleaner Production*, **17**, 67-76.

Ticheler,H.J., Kolding,J. & Chanda,B. (1998) Participation of local fishermen in scientific fisheries data collection: A case study from the Bangweulu Swamps, Zambia. *Fisheries Management and Ecology*, **5**, 81-92.

Tippett,J., Searle,B., Pahl-Wostl,C. & Rees,Y. (2005) Social learning in public participation in river basin management--early findings from HarmoniCOP European case studies. *Environmental Science & Policy*, **8**, 287-299.

Toderi,M., Powell,N., Seddaiu,G., Roggero,P.P. & Gibbon,D. (2007) Combining social learning with agro-ecological research practice for more effective management of nitrate pollution. *Environmental Science & Policy*, **10**, 551-563.

Topp-Jorgensen,E., Poulsen,M.K., Lund,J.F. & Massao,J.F. (2005) Community-based monitoring of natural resource use and forest quality in montane forests and Miombo woodlands of Tanzania. *Biodiversity and Conservation*, **14**, 2653-2677.

Townsend,W.R., Randall Borman,A., Yiyoguaje,E. & Mendua,L. (2005) Cofan Indians monitoring of freshwater turtles in Zabalo, Ecuador. *Biodiversity and Conservation*, **14**, 2743-2755.

Turner,S. (2004) Community-based natural resource management and rural livelihoods. *Rights, resources and rural development: Community-based natural resource management in Southern Africa* (ed. by C.Fabricius, E.Koch, H.Magome and S.Turner), pp. 44-65. Earthscan, London.

United Nations . The Millennium Development Goals report. 2008. New York, United Nations Department of Economic and Social Affairs.
Ref Type: Report

United Nations Environment Programme (UNEP) . Gems Water. www.gemswater.org. 2009.
Ref Type: Electronic Citation

Uphoff,N. & Langholtz,J. (1998) Incentives of avoiding the tragedy of the commons. *Environmental Conservation*, **25**, 251-261.

Uychiaoco,A.J., Arceo,H.O., Green,S.J., Cruz,M.T., Gaite,P.A. & Alino,P.M. (2005) Monitoring and evaluation of reef protected areas by local fishers in the Philippines: Tightening the adaptive management cycle. *Biodiversity and Conservation*, **14**, 2775-2794.

van den Hove,S. (2006) Between consensus and compromise: Acknowledging the negotiation dimension in participatory approaches. *Land Use Policy*, **23**, 10-17.

Van Rijsoort,J. & Jinfeng,Z. (2005) Participatory resource monitoring as a means for promoting social change in Yunnan, China. *Biodiversity and Conservation*, **14**, 2543-2573.

Van Wyk,B. & Gericke,N. (2000) *People's plants: A guide to useful plants of Southern Africa*. Briza Publications, Pretoria.

Vernooy,R. & McDougall,C. (2003) Principles of good practice in participatory research: Reflecting on lessons from the field. *Managing natural resources for sustainable livelihoods: Uniting science and participation* (ed. by B.Pound, S.Snapp, C.McDougall and A.Braun), pp. 113-141. Earthscan, London.

Walker,B., Holling,C.S., Carpenter,S.R. & Kinzig,A. (2004) Resilience, adaptability and transformability in social-ecological systems. *Ecology and Society*, **9**, R5-online.

Wallace,W. (1971) *The logic of science in sociology*. Aldine, Chicago.

Walters,M., Milton,S.J., Somers,M.J. & Midgley,J.J. (2005) Post-dispersal fate of *Acacia* seeds in an African savannah. *South African Journal of Wildlife Research*, **35**, 191-199.

Weather SA . Precipitation data for Dwesa - Bos weather station [0104497 2]. MS Excelfile dated 16 May 2006. www.weathersa.co.za . 2006a.
Ref Type: Electronic Citation

Weather SA . Ladygrey001.csv. www.weathersa.co.za . 2006b.
Ref Type: Electronic Citation

Western,D. (2004) The challenge of integrated rangeland monitoring: Synthesis address. *African Journal of Range and Forage Science*, **29**, 129-136.

WfW . Working for Water Programme. www.dwaf.gov.za/wfw/default.asp . 2009.
Ref Type: Electronic Citation

Wiber,M., Charles,A., Kearney,J. & Berkes,F. (2009) Enhancing community empowerment through participatory fisheries research. *Marine Policy*, **33**, 172-179.

Wolfenberg,E., Edmunds,D., Buck,L., Fox,J. & Brodt,S. (2001) *Social learning in community forestry*. CIFOR, Bogor, Indonesia.

Yin,R. (2003) *Case study research*. Sage, London, U.K.

Zar,J.H. (1998) *Biostatistical analysis*. Prentice Hall, Upper Saddle River, New Jersey, U.S.A.