Kouga catchment in bad waters?

A resilience study of fruit farmers' water management practices in the Kouga catchment, South Africa

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Facilitated by livinglands

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Preface

This research stems from my personal interest in the social side of ecosystem management. During my BSc biology I became interested in the functioning of ecological systems, and the management of such systems. However, I also realized that management can only succeed with sufficient social support. Although an ecologist can have all sorts of ideas that will (in theory) improve the functioning of ecological systems, such ideas cannot be successfully implemented if there is no support from society. A holistic perspective is necessary to decide upon the most suitable way to deal with the ecosystem. The social aspects of ecosystem management are therefore just as important (or maybe even more important) than the ecological management solutions. After all, it is people that decide upon management of the land.

While looking for interesting thesis topics, I came into contact with Living Lands. This organization shares my vision on ecosystem and landscape management and offered me a research opportunity as part of the project ''mobilizing civil society to support living landscapes in the Kouga catchment''. Part of this project is to interact with local landowners and institutions in the Kouga catchment, to understand their vision on landscape management and to identify opportunities for sustainable landscape management. For this purpose, the project facilitates research on the landscape in the Kouga catchment, which feeds the project and informs local people on 'their' landscape. This research contributes to this purpose by investigating how the fruit farmers in the catchment (who are the biggest landowners) manage the water resources in the area. It is one of the first research activities that has been undertaken in the area, and will hopefully pave the way for follow-up research in the Living Lands philosophy.

Besides the interesting and relevant research topic, the experience of working abroad really appealed to me. The country of South Africa fascinates me because of its natural beauty and turbulent history. For me, ''the experience'' has always been just as important as the eventual goal of writing this report. As a result, I enjoyed my six months stay to the fullest. This does not mean I did not work. On the contrary, the positive atmosphere motivated me to really give the best of myself.

I would like to thank the whole Living Lands team for providing me with the opportunity for this wonderful experience. In particular, I would like to thank my supervisor Dieter van den Broeck for his help during the work, for supporting my activities and for feeding my brain with new thoughts in a positive way. In addition, I am very grateful to have worked with Clara and Ebie, with whom I shared many good moments. I believe we really were a good team! Writing this thesis would not have been possible without the help and guidance of Sietze Vellema and Todd Crane, who have been of great help in the process of writing both the research proposal and the eventual report. Last but not least I would like to thank all the people in the Kouga catchment who have been willing to help me with my research. I hope I can give back something by providing you with the result of my study, that is, the report that is lying in front of you.

Marijn Sandbrink
Wageningen, Februari 2013

Summary

This case-study looks at how fruit farmers in the Kouga catchment manage for social-ecological resilience with regard to water. Water scarcity is predicted to become the greatest constraint to development in South Africa. As a result, the pressure on water resources in the Kouga catchment is increasing significantly. Fruit farmers, being the biggest water consumers in the catchment, are faced with the challenge of water management in a rapidly changing environment. Resilience theory provides an analytical lens to study changes in a system.

Resilience is the 'capacity of a system to absorb disturbance and re-organize while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks' (B. Walker, Holling, Carpenter, & Kinzig, 2004). Folke et al. (2003) identified four parameters that are relevant to building resilience. These are (1) learning to live with change and uncertainty, (2) nurturing diversity for reorganization and renewal, (3) combining different types of knowledge for learning and (4) creating opportunities for self-organization. These parameters are used in the context of water management to see if, and how the fruit farmers manage for social-ecological resilience.

Data about these four parameters were mainly gathered through semi-structured interviews and stakeholder dialogue interviews with fruit farmers and other actors that are involved in water management. Ethnographic techniques and document analysis have provided additional data. The data (e.g. fruit farmers' practices/rules/routines) are analysed by using the adaptive cycle, an analytical tool that describes phases of development within social-ecological systems (see chapter 2.1). The adaptive cycle is used to analyse fruit farmers' management practices as part of an evolving SES and to see whether fruit farmers' water management is focussed on conservation (absorbing disturbance) or reorganization. In this study, the fruit farmers are seen as part of the Kouga catchment SES and are deemed to be able to influence the systems' organization, functioning and outcomes. Resilience/system theory has proven to be useful to describe the Kouga catchment social-ecological system as an 'arena' in which the fruit farmers (and other actors) move to position themselves.

The research has found that fruit farmers' water management practices in the Kouga catchment are framed by a changing legal environment (post-apartheid), increasing downstream water demands, increasing prices of water and electricity, unpredictable extreme weather events and the presence of high water consuming IAPs. The fruit farmers recognise these system dynamics as factors to take into account when making management choices. Furthermore, the research has found that when it comes to managing for social-ecological resilience, the fruit farmers are in a bilaterate, Janus-like position. On individual farm level, the farmers are re-organizing in terms of irrigation management and water conserving practices. On institutional level, on the other hand, the focus is on conservation of old rules and routines. Scale-dynamics and path-dependency have divided the Kouga catchment into several subsystems that largely determine the institutional characteristics and the management choices that fruit farmers make. In terms of water management, the Kouga catchment can therefore not be seen as one social-ecological system, but rather as a set of subsystems.

List of abbreviations

ANC	African National Congress
ANT	Actor Network Theory
BEE	Black Economic Empowerment
CFR	Cape Floral Region
DA	Democratic Alliance
DWAF	Department of Water Affairs and Forestry
EC	Eastern Cape Province
FA	Farmers' Association
GDP	Gross Domestic Product
HDI	Historically Disadvantaged Individual
IAP	Invasive Alien Plant
IB	Irrigation Board
KKEFF	Kou Kamma Emerging Farmer Forum
LEFCO	Langkloof Emerging Farmer Cooperative
LFA	Langkloof Farmers' Association
NMBMM	Nelson Mandela Bay Metropolitan Municipality
NRM	Natural Resource Management
NPO	Non-Profit Organization
NWA	National Water Act
R	Rand (= national currency of South Africa)
SA	(Democratic Republic of) South Africa
SES	Social-ecological System
UnIEP	Uniondale Integrated Empowerment Project
WC	Western Cape Province
WfW	Working for Water
WMA	Water Management Area
WUA	Water User Association

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1. Introduction

This research looks at the way(s) fruit farmers in the Kouga catchment (Eastern Cape, South Africa) manage the available water resources, from a resilience perspective. This introduction will elaborate on the most important background information about water management in the context of South Africa, the problem statement and the research questions that will be addressed in the research. Furthermore, the main research objectives and outline of the report will become clear. The concept of resilience in ecosystem management, which is central in this report, is introduced by telling the story of Easter Island.

1.1 The story of Easter Island

Everybody knows the famous head-shaped statues of Easter Island, the Pacific Island west of Chile. More than 600 stone statues with an average size of over twenty feet high are scattered across the island’s 150 square miles. The statues are evidence of a socially and technologically advanced society that once inhabited the area. Until now, the origins of these stone creations remains a mystery. Theories about the origins range from extraterrestrial visits to the idea that Easter Island is the sole remnant of a lost civilization that sunk into the Pacific. Clive Pointing argues that Easter Island is an example of the dependence of human societies on their environment and the consequences of irreversibly damaging this environment (Pointing, 2007).

Crop production on Easter Island took very little effort and the people had plenty of free time. This time was spent on ceremonial activities such as burials, ancestor worship and to commemorate past clan chiefs. Such ceremonies centred around so-called *ahu* (large stone platforms), around which one to fifteen of the famous stone statues were erected. Competition between several clan groups on the island contributed to an increase in size, as well as the number of ceremonial sites, which were seen as a symbol of status. When the society on Easter Island was at its peak, around 1550, it suddenly collapsed, leaving over half the statues only partially completed (Pointing, 2007).

Figure 1. Statues on Easter Island (WikipediA, 2013)

According to Pointing, the explanation for this sudden collapse is to be found in excessive deforestation of the Island between the initial settlement and the collapse in 1550. As the population on the Island increased, trees were cut for the purposes of agriculture, fuel, houses, canoes, etc. However, most wood was used to transport the enormous statues to the ceremonial sites (sliding the statues on the wood). As the competition between clans to erect statues grew, the pressure on timber resources grew, which lead to a completely deforested Island around

1600. This resource base was insufficient to support the 7,000 people and the wood demanding ceremonies. The ceremonial life diminished, population numbers dropped drastically and the island's society returned to more primitive conditions (Pointing, 2007).

The story of Easter Island can be used to exemplify the interaction between humans and nature, and the importance of particular threshold moments (when no sufficient trees where available anymore) for the development of the Island. At a certain point in time, the inhabitants of Easter Island were no longer able to keep their environment in a desired state, and a shift took place into a less desirable state. Similar threshold moments have shown to be catastrophic for other ancient civilizations such as the Aztecs (introduction of disease by the Spanish) and the Mesopotamians (poisoning of agricultural fields due to irrigation practices). These examples provide valuable lessons for current ecosystem management, which are taken into account in the resilience perspective.

1.2 The resilience perspective

The resilience perspective is increasingly used as an approach for understanding the dynamics of social-ecological systems (Carl Folke, 2006). A social-ecological system (SES) is 'a multi-scale pattern of resource use around which humans have organized themselves in a particular social structure (distribution of people, resource management, consumption patterns, and associated norms and rules)'(Resilience Alliance, 2013). Social-ecological resilience is defined as 'the capacity of a system to absorb disturbance and re-organize while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks' (B. Walker et al., 2004). The resilience perspective emphasizes non-linear dynamics, thresholds, uncertainty and surprise, how periods of gradual change interplay with periods of rapid change and how such dynamics interact across temporal and spatial scales (Carl Folke, 2006).

Resilience theory began as a radical challenge to equilibrium-based paradigms, especially those that supported centralized top-down management control of natural resource systems, or conventional ecosystem management. Conventional ecosystem management is characterized by attempts to increase control of ecosystems and resources. The typical response of conventional ecosystem management to erratic or unexpected ecosystem behaviour was more control. This has become known as the command-and-control paradigm of ecosystem management and is based on the assumption that ecosystem dynamics are linear and predictable (Holling & Meffe, 1996). However, an increasing recognition has emerged that the command-and-control approach can result in unforeseen and undesirable consequences, because it does not account for the complexity, uncertainty and surprise that are inherent of ecosystem dynamics (Holling & Meffe, 1996; Pahl-Wostl et al., 2007). The story of Easter Island provides an illustrative example in this respect. Two fundamental errors have been identified in conventional ecosystem management. These are (1) the idea that ecosystem responses can be predicted and controlled and (2) the separation between social and ecological systems (C Folke et al., 2002).

The concept of resilience was introduced by ecologist C.S. Holling in the late ’60s and early ‘70s, who identified multiple stability domains in natural systems. In the original definition, resilience was defined as ‘the capacity to persist within a stability domain in the face of change’ (Holling, 1973). Influences from complexity science have shaped many facets of resilience thinking, such as the inevitability of surprise. Resilience theory has co-evolved with the development of the theory of complex adaptive systems and encompasses a diversity of ideas about what factors influence non-linear dynamics in complex adaptive systems.(Sendzimir, 2001). This has resulted in the idea of social-ecological systems, in which ecological problems are viewed as embedded in complex systems. This perspective considers the delineation between social and natural systems artificial and arbitrary (Berkes, Colding, & Folke, 2003).

Although the concept has its foundations in ecology, a resilience perspective of coupled social-ecological systems has developed in the ‘90s and the early 21st century (Berkes et al., 2003). Here, resilience is defined as ‘the capacity of a system to absorb disturbance and re-organize while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks’ (B. Walker et al., 2004). It is suggested that managing for social-ecological resilience enhances the likelihood of sustaining desirable pathways for development in changing environments where the future is unpredictable and surprise is likely (B. Walker et al., 2004). The capacity to manage change has been understudied in past research (Berkes et al., 2003) and is therefore addressed in this research. Folke et al. (2003) identified four factors that are relevant to building resilience. These are (1) learning to live with change and uncertainty, (2) nurturing diversity for reorganization and renewal, (3) combining different types of knowledge for learning and (4) creating opportunities for self-organization.

1.3 Background: water in South Africa

South Africa (SA) is a semi-arid country, which means that mean annual rainfall is less than half of the worldwide mean annual rainfall. SA has been classified as the 30th most dry country of the world and climate predictions foresee less rainfall, longer periods of drought and more severe storm events in future southern Africa (Greeff, 2010). The natural scarcity of water is reinforced by other factors (FAO, 2001):

- Most of the main metropolitan areas and industrial growth centres have developed around mineral deposits and harbour sites and are far removed from fresh water sources.
- Irrigation developments were established in regions when water was still relatively abundant. Now, water has become scarce in these regions.
- Water requirements far exceed availability in several catchment areas

Water is predicted to become the greatest constraint to development in SA, with 98,6% of surface water resources already committed for use (DWAF, 2009a). Currently, twelve of the nineteen water management catchments in SA experience a water deficit (Greeff, 2010). A limited amount of water is available for a wide range of purposes including agriculture, industry and drinking water. The current economic development and population growth, in combination with the predicted impacts of climate change, will increase the pressure on the water resources in the near future. Although the estimates on future water requirements in SA are uncertain, the country will reach the limit of its economically usable fresh surface water resources and water supply limitations will be encountered on a countrywide basis (FAO, 2001).

Currently, agriculture is responsible for the major share of water use in SA. Irrigated agriculture and stock watering account for more than 50% of total water usage (FAO, 2001; Perret, 2002). The agricultural sector is important to the South African economy. The sector in itself represents only 4% of SA's GDP and 14% of the labour force (Perret, 2002). However, through linkages with input supplies, service provision, processing and marketing, the share of agricultural economy to the GDP is ±30% (Backeberg, 2005).

The transition from apartheid to post-apartheid marked the upheaval of political, social and racial circumstances in the country. This transition also marked a major change in the administration of water rights. During the apartheid regime, water policies were to a large extent orientated towards irrigated agriculture by white commercial farmers (Perret, 2002). As a result, most of the country's water supplies are in the hands of a minority (FAO, 2001). Since the 1994 regime change, government policy has shifted focus. Now, policy is focussed on redressing the inequalities of the past and the availability of (drinking) water to all South African citizens (FAO, 2001; NWA, 1998). This shift in focus has resulted in a wide range of policy changes, especially with regard to organized agriculture.

Invasive alien plants (IAPs) form an additional constraint to water availability in SA. Many studies have emphasized the negative impact of IAPs on water resources in SA (DWAF, 2012b; Greeff, 2010; Hosking & Du Preez, 2002, 2004). The South African government recognizes IAPs as one of the main treats to water resources. Furthermore IAPs pose a threat to biological diversity, the ecological functioning of natural systems and the productive use of land (DWAF, 2012b). Around 10% of South Africa is estimated to be covered by IAPs at this moment and this number is growing exponentially (DWAF, 2012b).

1.4 Problem statement

The Kouga catchment SES is highly dependent on water as delivered by the Kouga river and its tributaries. The river provides drinking water and farmers in the area, mainly deciduous fruit producers, need the water from the river to irrigate their orchards. In addition, the Kouga river supplies the citrus farmers in the downstream Gamtoos valley, and the inhabitants of the Nelson Mandela Bay Metropolitan Municipality (NMBMM), including the city of Port Elisabeth.

Figure 2. Kouga dam while overflowing. The Kouga dam is an important source of water for Port Elizabeth and the Gamtoos Valley (Gamtoos Tourism, 2013)

Currently, the pressure on water resources in the Kouga catchment is increasing, due to growing downstream demand. Water has been defined as the largest challenge for the Cacadu District (Cacadu District Municipality, 2011), of which the Kouga catchment is part. Management of the resource therefore becomes increasingly important. Fruit farmers, being the biggest water consumers in the catchment (DWAF, 2004), are faced with the challenge of water management in a context of regular occurrence of extreme weather events (rain, drought, hail) and an increasing set of government regulations towards water use. Furthermore, they are challenged by the presence of high water consuming IAPs, which have expanded significantly over recent decades.

The performance of deciduous fruit trees, i.e. crop yield, fruit size, fruit quality, storability and long-term productivity is highly dependent on irrigation (Naor, 2006). Therefore, the fruit farmers in the ever evolving SES require the capacity to act upon social-ecological change in an environment that is characterized by disturbances and surprise. Managing for social-ecological resilience is suggested to enhance the likelihood of sustaining desirable pathways (B. Walker et al., 2004).

1.5 Research questions

This study centres around the following main research question:

'How do fruit farmers in the Kouga catchment manage for social-ecological resilience with regard to water management?'

To answer this question, several sub research questions require an answer. One needs to know:

(1) *Which system characteristics influence fruit farmers' management practices?*

(2) *Do fruit farmers in the Kouga catchment*

   a. *Learn to live with change and uncertainty?*
   b. *Nurture diversity for reorganization and renewal?*
   c. *Combine different types of knowledge for learning?*
   d. *Create opportunities for self-organization?*

1.6 Research objectives

Development objectives

The main objective of the research is to contribute to the Living Lands project 'Mobilizing civil society to create Living Landscapes in the Kouga catchment'. Living Lands is a South African foundation that aims to conserve and restore so called 'living landscapes'. These are 'areas with a variety of healthy natural ecosystems and land-uses and which are home to diverse ecological, agricultural and social systems' (Living Lands, 2011). In order to do so, it engages with (local) stakeholders - including among others landowners, governmental bodies and other organizations – to create partnerships that function as learning networks. Living Lands aims to feed this process by facilitating research to address relevant questions that arise during the process. Water security is one of the most obvious issues in the Kouga catchment.

The Living Lands project started in 2012 with a rather blank sheet. That is, only limited, rather basic information was available about the Kouga catchment. This study aims to provide more detailed information about the ways commercial fruit farmers manage for social-ecological resilience with regard to water management, as well as more general information about the Kouga catchment SES. The results from this research will hopefully inform, guide and inspire future research in the Kouga catchment and contribute to the formation of living landscapes.

Scientific objectives

The resilience perspective on SESs is a relatively new and quickly developing branch in science, as well as policy. Theory building for resilience thinking cannot rely on classical scientific approaches (B. H. Walker, Anderies, Kinzig, & Ryan, 2006). In classical scientific approaches, basic facts/laws are formulated from testing hypotheses through conducting controlled experiments. In the study of SESs, however, variables cannot be tightly controlled and manipulated and replication is practically impossible (B. H. Walker et al., 2006). Theory building therefore relies on the comparative analysis of multiple case-studies that focus on resilience in SESs (Asah, 2008; B. H. Walker et al., 2006). This study will investigate to what extent a resilience perspective can explain how fruit farmers in the Kouga catchment deal with social-ecological change. The specific insights from the Kouga catchment will add to the body of case-studies that informs theory building for resilience.

1.7 Outline report

I present the thesis in ten chapters. The first chapter serves to introduce the reader to the study by providing a background to the topic, a problem statement, research questions and research objectives. The second chapter will elaborate on the theoretical framework underlying the research and describes the research methodology.

Chapter three provides a case-study of fruit farmers' water management practices in a selected area in the Kouga catchment (Haarlem) to provide more tangible insight in the context of fruit farming in the Kouga catchment and to introduce the major issues with regard to water management. These issues are further outlined in chapters 4-7, which describe fruit farmers management practices on the basis of four factors that have been identified as relevant for building resilience (C. Folke, Colding, & Berkes, 2003):

- chapter 4: Learning to live with change and uncertainty
- chapter 5: Creating opportunities for self-organization and renewal
- chapter 6: Combining different types of knowledge for learning
- chapter 7: Nurturing diversity for reorganization and renewal

The remainder of the report will discuss the findings and open a theoretical debate on the value of a resilience lens to study how fruit farmers act upon social-ecological change. Finally, conclusions will be drawn with regard to the research questions. Furthermore, it presents some recommendations for the Living Lands project ‘Mobilizing civil society to create living landscapes in the Kouga catchment’.

2. Theoretical framework & research methodology

2.1 Theoretical framework

In this thesis, I use a resilience approach to explore how deciduous fruit farmers' act upon changes in the Kouga catchment SES. In other words, how do fruit farmers manage for social-ecological resilience? The main theoretical foundations of the thesis are to be found in resilience theory and theories of complex adaptive systems. Since the late '60s, both theories have co-evolved as a response to conventional ecosystem management (Sendzimir, 2001). Folke et al (2003) identified four parameters that are relevant to building resilience. These factors are (1) learning to live with change and uncertainty, (2) nurturing diversity for reorganization and renewal, (3) combining different types of knowledge for learning and (4) creating opportunities for self-organization.

Conventional ecosystem management

Conventional ecosystem and natural resource management (NRM) were usually negotiated and agreed upon among a limited set of scientific and governmental actors. Such negotiations have often resulted in blueprint approaches to NRM (Backeberg, 2005; McGee, 2004; The World Bank, 2006). In these approaches, an implicit assumption was embedded that nature is linear and predictable and can therefore be controlled by humans. This has become known as the so-called command-and-control paradigm (Pahl-Wostl et al., 2007). Many of the conventional views of ecosystem management can be characterized by a strong focus on ecological goals, while neglecting the social and human aspects, or the other way around (McClure, 2010; Pretty & Ward, 2001; Schultz, Folke, & Olsson, 2007). Such approaches produce technical end-of-pipe solutions that deal with individual problems in isolation, with a focus on the short-term. Undesirable consequences can manifest themselves at the longer term (Pahl-Wostl et al., 2007). Folke et al. (2002*)* recognizes two fundamental errors that underlie past approaches towards ecosystem management. First, many approaches were based on the implicit assumption that ecosystem responses could be predicted and controlled. Secondly, ecological and social systems were considered to be separate systems which can be treated independently (C Folke et al., 2002). The first assumption is rooted in a strong belief in mankind's growing scientific understanding of ecosystems and faith in tools and techniques to control ecosystems. This set of knowledge and skills was suggested to be sufficient to keep ecosystems in their desired state or equilibrium. The second view originates from Enlightenment thinking, in which humans are separated from the environment (Berkes et al., 2003). *Unfortunately,* management that is based on these assumptions rarely accounts for context-specific dynamics of SESs. Furthermore, blueprint approaches often fail to account for environmental surprises and shocks (Adger, Brown, & Tompkins, 2005).

Complex adaptive systems

In recent decades, a system perspective has entered the scene of ecosystem management. System thinking comes from the shift in attention from 'the part' to 'the whole'. A system can be defined as an assemblage of objects united by some form of regular interaction or interdependence (Mele, Pels, & Polese, 2010). In ecosystem management, a growing recognition has emerged that nature is not linear and predictable. An increasing body of literature recognizes that ecosystem management is complex and frequently confronted with uncertainty and abrupt change (Berkes et al., 2003; C. Folke, Hahn, Olsson, & Norberg, 2005; Hahn, Olsson, Folke, & Johansson, 2006; Lebel et al., 2006; Olssen, 2003). A complex adaptive systems perspective has therefore gained momentum as a response to linear thinking. This perspective acknowledges the limited human ability to predict ecosystem behaviour and responses (Pahl-Wostl et al., 2007). Theories of complex systems emphasize nonlinearity, uncertainty, emergence, scale and self-organization as important properties of systems (Berkes et al., 2003; Rammel, Stagl, & Wilfing, 2007). To fully address a problem one needs to understand the parts in relation to the whole (Berkes et al., 2003). Rather than viewing problems as individual cases, they are seen as part of a complex whole. A social system can therefore not be seen as closed from its physical environment, as there is always interaction in some way. Currently, NRM is more and more approached from a systems perspective, which recognizes the multilateral interactions between people and the complex relationship between people and nature (Keen & Mahanty, 2006; Rammel et al., 2007).

Social-ecological system

SES thinking, in which ecological problems are viewed as embedded in a complex system, has emerged (D. Armitage, Marschke, & Plummer, 2008; Berkes et al., 2003). SES theory offers a framework to integrate insights from both social and natural sciences to understand complex issues (e.g. climate change). A social-ecological system is 'a multi-scale pattern of resource use around which humans have organized themselves in a particular social structure (distribution of people, resource management, consumption patterns, and associated norms and rules)' (Resilience Alliance, 2013). The delineation between social and natural systems is considered artificial and arbitrary. Instead, SES literature proposes a human-in-ecosystem perspective. Therefore, focus is not put on either ecological or on social change, but rather on SESs change, where humanity and nature are perceived as interdependent and interactive (Berkes et al., 2003). A SES changes constantly, either gradually or abrupt (Backeberg, 2005). SES theory therefore embraces uncertainty and unpredictability as a reality to be taken into account. Berkes et al. (2003) state that 'the social-ecological system is impacted by change and deals with it as a function of its capacity to adapt to change and shape it'. The role of learning (both as a means and as an end) within these systems becomes more and more recognized in SES literature (Anderies, Janssen, & Ostrom, 2004; Berkes et al., 2003; Hahn et al., 2006; Olsson, Folke, Galaz, Hahn, & Schultz, 2007). Although the boundaries of SESs are not always clearly defined, the systems are more or less place-bound (Smith & Striling, 2010).

Resilience

Resilience is the ‘capacity of a system to absorb disturbance and re-organize while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks’ (B. Walker et al., 2004). This definition reveals the bipartite meaning of resilience. On the one hand, resilience includes a reactive component (absorbing disturbance). The reactive component corresponds to the original definition of ecological resilience: the capacity to persist within a stability domain in the face of change (Holling, 1973). In other words, ‘conserving’ the system as it is. On the other hand, resilience embraces a pro-active component, that is, re-organization following disturbance. Folke (2006) states that ‘resilience is not only about being persistent or robust to disturbance. It is also about the opportunities that disturbance opens up in terms of recombination of evolved structures and processes, renewal of the system and emergence of new trajectories’. The two components of resilience become visible in the adaptive cycle, which describes four phases of development within SESs. These phases include periods of exponential change (r-phase), periods of growing stasis and rigidity (K-phase), periods of readjustments and collapse (Ω-phase) and periods of re-organization and renewal (α-phase) (Gunderson & Holling, 2002). In itself, resilience is neither good nor bad and does not reflect progress or a move towards sustainable development: a social-ecological system that is in an undesirable state can still be very resilient.

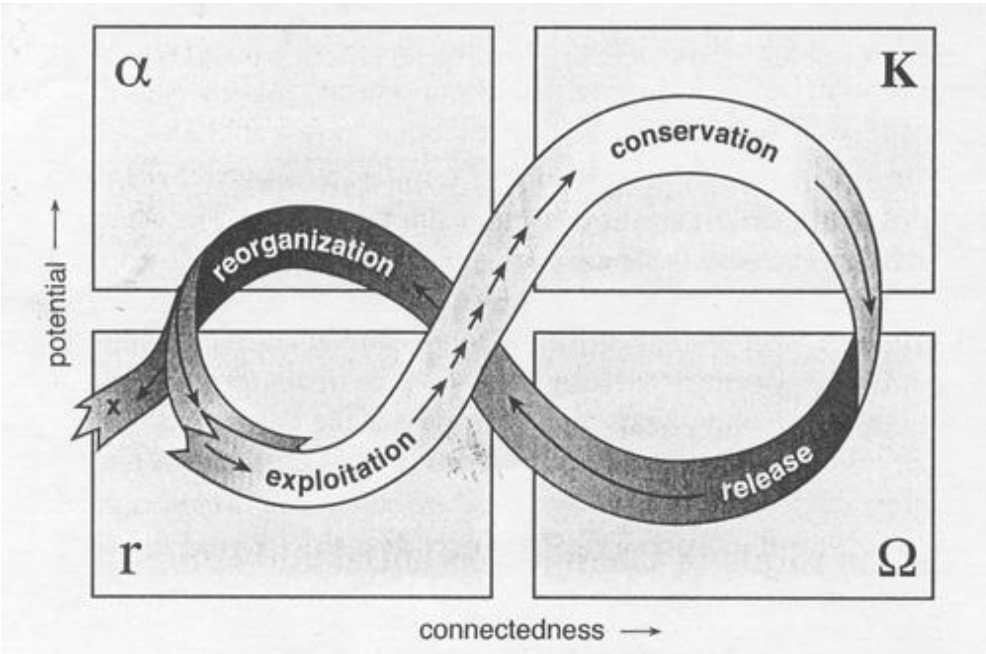

Figure 3. The adaptive cycle (Gunderson & Holling, 2002)

The so-called front-loop of the adaptive cycle (r and K phases) depicts the reactive component (absorbance) of resilience, while the back-loop (Ω and α phases) emphasizes initiative (reorganization after disturbance). Looking back at the story of Easter Island (chapter 1.1), the period of population growth, statue building and ceremonial activities can be used to exemplify the front-loop of the adaptive cycle. The society collapsed (Ω phase) when insufficient timber was available for development. This phase was the starting point for the back-loop of the adaptive cycle, which involved reorganization (α phase). In the case of Easter Island reorganization involved returning to more primitive conditions (Pointing, 2007). However, the reorganization phase can also be the moment for new innovative approaches towards ecosystem management. Conventional ecosystem management usually focussed on the r and K phases and to a large extend neglected the Ω and α phases (Carl Folke, 2006). The concept of resilience recognises both the front-loop and the back-loop as important dynamics in social-ecological systems. Hence, disturbance becomes part of development. Several factors have been identified that contribute to a system's resilience (C. Folke et al., 2003).

Four factors for social-ecological resilience

Folke et al. (2003) suggest that four factors are relevant for building resilience. These factors are (1) learning to live with change and uncertainty, (2) nurturing diversity for reorganization and renewal, (3) combining different types of knowledge for learning and (4) creating opportunities for self-organization. These parameters are theoretically constructed by integrating results from numerous case-studies and cannot be directly observed or measured (Asah 2008). Nevertheless, the factors manifest themselves through several indicators, which can be empirically studied. The four factors serve as a point of departure to study how fruit farmers in the Kouga catchment manage for social-ecological resilience in the context of water management. Here, the parameters are outlined briefly. A more detailed description can be found in the chapters of this thesis that deal with each parameter specifically.

(1) Learning to live with change and uncertainty

Adaptability is an important contributor to the resilience of a SES (C. Folke et al., 2010). Literature emphasizes the importance of environmental feedback learning, where past experiences guide ecosystem management. Incorporating feedback from ecosystems, instead of ignoring it, helps to increase adaptive capacity and to avoid the command-and-control strategies of conventional ecosystem management (Olssen, 2003). Knowledge, practices and social mechanisms that address disturbance, surprise and crisis are prerequisites to deal with social-ecological change (Berkes et al., 2003). Learning to live with change and uncertainty demands for the development of so-called social/institutional memory: a memory of past events that provides the tools and codes of conduct to fall back on when an unexpected event happens (Berkes, 2007); it is important for linking past experiences with present and future policies (C. Folke et al., 2005).

(2) Nurturing diversity for reorganization and renewal

Berkes (2007) presents the idea of diversity as that it 'provides the seeds for new opportunities in the renewal cycle'. In his notion of diversity he includes social, economic and ecological diversity. Simply spoken, diversity spreads risks and increases options for response. From a social perspective, diversity should be understood as diversity in partnerships and social relations as a source for reorganization and renewal, as increasing the diversity of actors/actants has the potential of bringing new thinking. A combination of both horizontal and vertical ties in the social network is preferable. Bridging ties can play a role in bringing together different actors and knowledge. Weak ties in a network have shown to be promising for the arise of new ideas, for they connect actor and/or actor groups that do not communicate frequently (Borgatti, Mehra, Brass, & Labianca, 2009; Davidson-Hunt, 2006; Granovetter, 1973; Prell, Hubacek, & Reed, 2009)

(3) Combining different types of knowledge for learning

Berkes et al. (2003) emphasize the 'significance of peoples' knowledge, experience and understanding about the dynamics of complex ecosystems, their inclusion in management institutions, and their complementarity to conventional management' (Berkes et al., 2003). Complex issues (like climate change) often manifest themselves at different scales and demand for integration of knowledge from different sources. Combining expert knowledge with local/experiential knowledge is suggested to increase the capacity to learning, as it brings together actors that have different relative strengths in terms of knowledge and background (Berkes, 2007).

(4) Creating opportunities for self-organization

Literature on adaptive governance stresses the importance of locally organized responses to ecosystem dynamics (C. Folke et al., 2005). The ability to self-organize is considered to be an essential element of adaptive capacity (Olssen, 2003). The presence of local institutions and (learning) organizations is key to effective response and adaptation (Berkes, 2007). Disturbances of ecosystems can be a trigger towards reorganization and new forms of self-organization within SESs (Olssen, 2003). Both formal (institutionalized) and informal networks play a role in the development of institutional memory and should be taken into account.

2.2 Research methodology

Research design

This qualitative research aims to get more insight in the way how deciduous fruit farmers manage for social-ecological resilience with regard to water management. The research addresses the case of the Kouga catchment SES, South Africa. The focus is on commercial fruit farmers because they can be seen as the most influential ecosystem managers in the area (based on land ownership in the Langkloof and their economic/social importance to the area).

Data were gathered primarily through semi-structured in-depth interviews and stakeholder dialogue interviews (Presencing Institute, 2008) with actors in the Kouga catchment SES. The primary focus is on commercial fruit farmers. Other actors that are relevant to fruit farmers' water management were included in the research, based on the principle of 'following the actors' (Steins, 2001). Additional data were gathered through ethnographic techniques, document analyses and literature study.

The adaptive cycle will be used to analyze the data that are gathered on the basis of the four factors that are identified as relevant for building resilience: (1) learning to live with change and uncertainty, (2) nurturing diversity for reorganization and renewal, (3) combining different types of knowledge for learning and (4) creating opportunities for self-organization (C. Folke et al., 2003).

An important note should be made with regard to the context in which the research takes place. Although some 'coloured' farmers are currently involved in fruit farming in the Kouga catchment, they are still a minority. As a result, the term 'commercial fruit farming' is in most cases equal to 'white commercial fruit farming'. Most of the interviewed actors in this research are white. Taking into account the recent history of apartheid in SA, and the cultural differences that exist between white and coloured people, this might frame the results of this study. The views of the coloured majority in the Kouga catchment are underrepresented in this study.

Study area

General information

The Kouga catchment is situated on the boundary of the Eastern Cape (EC) and Western Cape Provinces (WC) of SA. From west to east, the Kouga catchment ranges around 110 km. The range from North to South is ± 25 km. Most of the Kouga catchment area falls within the Kou-Kamma Local

Municipality, which is part of the larger Cacadu District Municipality in EC. In the West, a small part of the catchment is on the property of George Local Municipality, which is part of the Eden District Municipality in WC.

The total surface area of the catchment is 282,040 hectares, of which the largest part is owned by private land-owners (190,000ha), another part by the state (83,400ha) , and part is communal (6,482ha). The largest part of the catchment is mountain land and natural vegetation covers the bulk of the area, namely around 93%. Cultivated areas (±6%) cover another substantial part. The remainder is accounted for by wetlands and water bodies, and urban and residential purposes (Powell & Mander, 2009). Most deciduous fruit farming takes place in the Langkloof. This study focuses on this valley, which is the centre of social and economic activity in the catchment. The landscape in the valley is dominated by fruit orchards. Several towns and residential areas are situated along the R62, the main (and only) road through the Langkloof. From West to East, these towns are Avontuur, Haarlem, Misgund, Bruinklip (residential area), Louterwater, Krakeel, Joubertina, Ravinia (residential area) Twee Riviere and Heights.

Figure 4. Study area. South Africa (upper left) and the Kouga Catchment (boundary in dots) with the Kouga river and Eastern Cape / Western Cape provincial boundary (white line).

The Kouga River is the main source of water for the people in the Kouga catchment, both for purposes of drinking and irrigation. It originates from the Tsitsikamma Mountains in the South, and the Kouga Mountains in the North. Both mountain ranges have a west-east orientation, with the Kouga river flowing in between them, until it sharply bends to the North to merge with the

Baviaanskloof river. Together, these two rivers supply the Kouga Dam Reservoir, which has a capacity of 128,7 million cubic meters (DWAF, 2009a). From the Kouga dam, the water is canalized through the Gamtoos valley (Jansen, 2008), where the water is of great importance to intensive citrus farming. The canal ends up in the Loerie dam reservoir, which provides drinking water to the densely populated and quickly expanding NMBMM (including Port Elisabeth) (Jansen, 2008).

Climate

According to the Köppen classification the climate in the Kouga catchment is of the Mediterranean type with warm, dry summers and cold, wet winters (Van der Waal, 2009). Temperatures above 40°C can be measured in summer, while frost can occur in winter. The Tsitsikamma mountains in the South and the Kouga mountains in the North greatly influence climate characteristics. These mountains act as a water trap for rain that comes from the ocean (DWAF, 2009a; Haigh, Bosman, Jones, & Illgner, 2004) and mediate wind flow. Therefore relatively large climatic differences can be identified in a small area.

Climate in the South-Western region of EC (of which the Kouga catchment is part) tends towards a bimodal pattern with rainfall peaking in autumn and spring. The western part of the Kouga catchment is situated close to a winter rainfall zone and therefore receives more winter rain (Haigh et al., 2004). Rainfall data measured in the town of Joubertina show that mean rainfall peaks in the month August (Van der Merwe, Gqodwana, & Mntambo, 2012). Mean annual rainfall in the Kouga catchment increases towards the West, with ±300mm/year in the Heights area (East) to ±800mm/year in the area around Haarlem and Avontuur (West) (Haigh et al., 2004). Data from Jansen (2008), based on 20 measure locations, indicate a mean annual rainfall of 500mm. Other studies have calculated a mean annual rainfall of ±550mm for the whole Kouga catchment (DWAF, 2009a; Hosking & Du Preez, 2004). The climate in the Langkloof is ideal for deciduous fruit farming.

Cape Floral Region

The Kouga catchment is known for its natural beauty. From an ecological point of view, the area is particularly interesting because of the large variety of plant species. The Kouga catchment is part of the Cape Floral Region (CFR), which is the one of the most species-rich areas in the world and has therefore acquired the status of UNESCO World Heritage Site (UNESCO, 2012). The Kouga catchment accommodates a very high variety of plant species and is therefore of great ecological importance. Thirty eight vegetation classes are present in the catchment. The largest part is covered by a form of fynbos (Powell & Mander, 2009). For a more detailed description of the flora in the Kouga catchment, see Veerkamp (2012).

History of fruit farming

For more than a century, deciduous fruit farming has been practiced in the Langkloof, making it the second biggest production area of SA. In 1903, Alexander Baldie was the first one to start farming apples in the Kouga catchment, around the town of Misgund. The story goes that he gave away some young apple trees to his neighbours, which initiated deciduous fruit farming in the Kouga catchment (Van Huyssteen, 2008). Now, - with the Baldie family still running a successful deciduous fruit business in Misgund - fruit farming is the main economic activity in the Langkloof and includes apples, pears, oranges, apricots and peaches. After Eskom (national electricity company) implemented its rural electrification programme in 1980, massive expansion of orchards under irrigation occurred because of the availability of electric pumps to transport the water (DWAF, 2004(a)). Due to relative isolation and limited infrastructure, the development of the production region was not as fast as in production areas in the WC. However, the first decade of the 21st century has again shown a rapid expansion of investment in infrastructure development and new orchard plantings (HORTGRO, 2011).

During apartheid, fruit farming in the Langkloof was the exclusive domain of white commercial farmers. The coloured community earned an income as labourers for the white landowners. After the regime change in 1994, the SA government supported emerging farmers to start fruit farming businesses in the Langkloof. Several emerging farmers are currently active in the Langkloof, with variable success. However, most land is still owned by white farmers.

Figure 5. Fruit orchards and farm dams in the Langkloof (helicopter view)

Sampling

Eight initial respondents (commercial fruit farmers) were selected in consultation with earlier students in the study area and the regional agricultural extension officer for the Department of Rural Development & Land Reform. Respondents were selected on the basis of perceived differences (e.g. farm size, geographic location, commercial/emerging farmer; etc.). Variation within initial interviewees reduces the chance of overlooking alternative views.

A significant part of the semi-structured interviews was attributed to the actor-networks that are important for the fruit farmers' water management, because of their relevance for building social-ecological resilience (e.g. 'combining different types of knowledge for learning' and 'creating opportunities for self-organization'). The initial interviewees were asked to name their relationships to other actors with respect to water management. Besides human actors, also non-human actors are taken into account. These actants include for example tv-programmes, websites, journals and magazines. On the basis of insights and emerging properties from the initial interviews, new respondents were selected, including other actors than fruit farmers. The process of data collection was therefore 'controlled' by the emerging theory and allowed for ideas to be refined (Jack, 2005). This strategy fits the notion of 'following the actors' as proposed by Steins (2001).

Semi-structured interviews (fruit farmers)

Twenty semi-structured in-depth interviews with commercial fruit farmers form the main source of data on which this study is based. The interviews took place on the farms and took between 30 minutes and 3½ hours (depending on the time that was available to the respondent).

At the start of every interview, interviewees were asked to elaborate on issues of water management (problems, challenges, particularities) on their property, and the Kouga catchment in general. This interpretative approach allows for the interviewees to frame the issues that are relevant to them (Green & Thorogood, 2009). It provides insight to the important social-ecological dynamics with regard to water management in the Kouga catchment (e.g. narratives about weather events that occurred in the area, the importance of changing regulations and the difficult working relationship with the SA government). The issues as defined by the respondents served as input for the rest of the interview.

A large part of the interviews focused on fruit farmers' actor-networks with regard to water management. A so called 'name generator' aims to uncover with whom the fruit farmers do (not) connect when faced with issues of water management (as defined by themselves). Name generators involve asking focal actors for the names of people to whom he or she is connected in a particular way (Hawe, Webster, & Shiell, 2004). 'Name interpreter' questions try to uncover the characteristics of the named actors. A focus on actor-networks can uncover to whom the fruit farmers are connected in the context of water management, and for what reason. It provides an insight in 'the social side' of the Kouga catchment SES and helps to answer the questions how fruit farmers in the Kouga catchment 'combine different types of knowledge for learning' and 'create opportunities for self-organization'.

At the end of the interview, respondents were asked to indicate whether or not they were in contact with the persons/organizations listed on a recall list. A methodological choice was made to provide this list only after the interview, as not to influence the interviewees. The recall list provides an efficient tool to obtain actor-network data and proved to be a useful safety net in case not all questions could be covered (for whatever reason) during the interviews itself. After nine interviews with farmers, the recall list was revised according to the insights from preliminary data analysis. That is, actors that were repeatedly mentioned by farmers during the interviews were added to the list, while non-mentioned actors were removed.

Stakeholder dialogue interviews

Thirteen stakeholder dialogue interviews were performed with actors in the Kouga catchment, as part of the Living Lands project 'Mobilizing civil society to support living landscapes in the Kouga catchment (Living Lands, 2012). These actors include fruit farmers as well as other relevant actors in the SES. Stakeholder dialogue interviews are intended to 'engage the interviewee in a reflective and generative conversation' (Presencing Institute, 2008). The method was developed as part of theory U, which is a theory of organizational learning and (collective) leadership. Living Lands follows the principles of Theory U to create a collective learning process around landscape management among actors in the Kouga catchment. The stakeholder dialogue interviews focussed on the respondents' perception of landscape and their vision on the Kouga catchment as a whole. In fact, the respondents were asked to describe the Kouga catchment SES from their point of view, and to indicate their challenges, problems and frictions in the SES. Compared to the semi-structured interviews, the stakeholder dialogue interviews left more room for manoeuvre for the respondents, because the topic of dialogue was broader (focus was on 'the landscape' instead of 'water management'). In practise, however, 'water' and IAPs became the recurring theme of dialogue, because of their vital relevance for the Kouga catchment SES.

Although the stakeholder dialogue interviews were originally not performed with the aim to contribute to this research, they have provided valuable insights into the questions and challenges that actors in the Kouga catchment face. For that reason, the obtained data are included in this study.

Semi-structured interviews (actors other than fruit farmers)

Semi-structured interviews were performed with the relevant actors that were mentioned by the fruit farmers (e.g. technical advisors, Working for Water, government bodies) to identify the position of these actors and to uncover what role they play in the SES. Furthermore their relationship with the fruit farmers is investigated to see what knowledge and/or resources they provide to the fruit farmers with regard to water management. These interviews have proven to be useful to hear different perspectives and to provide a more complete picture of the issue of water management.

Overview interviews

Figure 6 provides an overview of the respondents of the interviews. The table indicates where in the catchment the respondents are situated.

		Area/subcatchment									
		Twee Riviere	Joubertina	Krakeel	Louterwater	Apies-rivier	Misgund	Ongelegen	Haarlem	Avontuur	Outside catchment
Semi-structured interviews	# fruit farmers	2	2	1	2	4	4	2	4		
	# other actors		a, b, c	d							e,f,g
Stakeholder dialogue interviews	# fruit farmers				4	1	2	1	2	1	
	# other actors		a, b, c							h	

a. Regional extension officer Department of Rural Development & Land Affairs
b. Regional disaster manager
c. Regional Working for Water manager
d. Soil scientist, private soil consultant
e. Private irrigation consultant
f. Regional ecologist Eastern Cape Parks & Tourism Board
g. Private consultant 'tree architecture'
h. Chairperson Avontuur Farmers' Organization

Figure 6. Overview interviews

Documents

A document analysis was performed to identify the information content of the non-human actors, which generally consist of the agricultural magazines 'Zachte Vruchte Joernaal', 'Landbou Weekblad', 'SA Irrigation' and 'Farmer's Weekly'. These magazines were screened for their 'water-related' articles to determine what information fruit farmers could potentially draw from these sources. In addition, newspaper articles that address the recent floods and droughts in the Langkloof are analyzed to place events in a time-path and see how processes unfolded over time.

Ethnographic techniques

Ethnography studies people's actions and accounts in everyday contexts (Hammersley & Atkinson, 2007). Besides formal interviews, participant observation was used as a method for data collection. In participant observation, the researcher takes part of the social world of the people that are studied (Hammersley & Atkinson, 2007). Several meetings of Farmers' Associations (FAs) were visited, as well as meetings of the Formosa Liaison Forum (a forum to discuss all sorts of emerging issues in the Langkloof). Observations during such visits provide insight in how people actually act (and interact) with other actors in a real-life situation. Observations about ''what people do'' complement data about ''what people say'' (e.g. during interviews).

Analysis

In this study, resilience is understood as the capacity of the Kouga catchment SES, as a whole, to respond to disturbance and shocks while maintaining essential functions. Nelson et al. (2007) state that most adaptation studies take an actor-centred view, while resilience theory is systems orientated (Nelson, Adger, & Brown, 2007). In this study, the fruit farmers are seen as part of the Kouga catchment SES and are deemed to be able to influence the systems' organization, functioning and outcomes. This actor-in-system view respects the ideas of systems thinking without rejecting individual actors' agency. The gathered data are used to analyse how fruit farmers in the Kouga catchment manage for social-ecological resilience with regard to water management.

One chapter will - by providing a case-study - outline the most important social-ecological dynamics in the Kouga catchment. Four individual result chapters will elaborate on the factors that have been identified as prerequisites for building resilience: (1) learning to live with change and uncertainty, (2) nurturing diversity for reorganization and renewal, (3) combining different types of knowledge for learning and (4) creating opportunities for self-organization (C. Folke et al., 2003). During the data gathering process of this research, these four factors were used as a guiding tool to look for ways how the local fruit farmers in the Kouga catchment manage for social-ecological resilience. The data that were yielded through this search (e.g. fruit farmers' practices/rules/routines) are analyzed by using the adaptive cycle (see chapter 2.1). The adaptive cycle is used to analyse (1) dynamics in the Kouga catchment SES, (2) fruit farmers' management practices as part of an evolving SES and (3) to see whether focus in fruit farmers' water management choices/practices is on conservation (r and K

3. The case of Haarlem

3.1 Introduction

An interesting case within the Kouga catchment is the case of Haarlem. It provides an example of how fruit farmers - together with other actors - act upon changes in the SES and reorganize water management in the aftermath of disturbances. Haarlem is a town in the uppermost quaternary catchment (L82A) of the Kouga River system. The upper catchment is institutionally and practically very far removed from all downstream activity, and administratively in a different province, so both institutional governance and land and water use strategies have a de facto level of separation (Mayson, 2010). However, the commercial fruit farmers face roughly the same challenges with regard to water management. These are extreme weather events (and their consequences), a resource that is becoming increasingly scarce (and the inherent competition for water), the presence of IAPs and a changing legal environment. The goal of this chapter is to introduce the reader to these social-ecological dynamics and to the fruit farmers' responses. Furthermore, the case illustrates an example of the mismatch between social and ecological systems, and the role of (artificial) system boundaries in such mismatches. In the remaining chapters of this thesis, the case of Haarlem will serve as a point of reference.

3.2 Outlining the context

General information

The upper catchment (L82A) is the most western quaternary of the Kouga river system. Here, the Groot river originates, which flows eastwards and is then called Kouga river. From West to East, L82A stretches an area of ±25km. The major town in L82A is Haarlem, which was established as a mission station in 1856. During apartheid, Haarlem was a 'coloured' village, divided in 404 smallholder plots (±4280m²) (Mayson, 2010). Since then, the village has been extended with houses from the governmental Reconstruction and Development Programme, a government housing programme. In the upper catchment, fruit farming is the major economic activity and mainly takes place on white-owned commercial farms. Contrary to the EC part of the Langkloof, no big commercial fruit companies (with multiple farms) are active in the upper catchment.

Small-scale farmers (members of the coloured community) around Haarlem have gradually moved away from fruit farming and now grow vegetables. Both the commercial and the small scale farmers derive their water from the Haarlem dam, which is the main source of water for the region. A pipeline system provides water to Haarlem, Ongelegen and Avontuur. The water from Haarlem dam is used for both irrigation and drinking water. Some suggest that the upper catchment is degraded through unmanaged water extraction and polluted return flows. Furthermore, the quaternary is heavily invaded with IAPs, which impact on water quantity and quality (Mayson, 2010). The EcoStatus of the Kouga river in the upper catchment is classified as 'poor' (C.A.P.E., 2010).

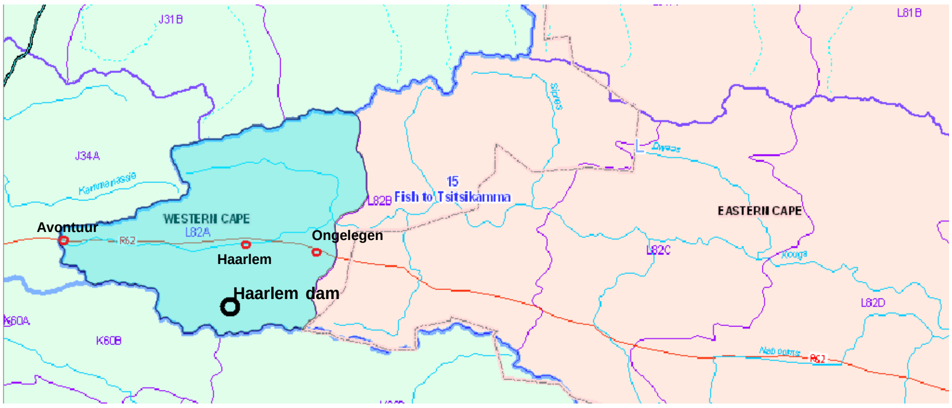

Figure 7. The upper catchment L82A(blue) with the position of Avontuur, Haarlem, Ongelegen and the position of the Haarlem dam. The EC/WC boundary lies East of Ongelegen.

Western Cape ←→ Eastern Cape

The uppermost part of the Kouga catchment (Avontuur, Haarlem and Ongelegen) falls under the jurisdiction of the WC (see figure 7). In the quasi-federalist system of SA, each province has its own legislature, premier and executive councils. WC is the only of nine SA provinces that is ruled by the Democratic Alliance (DA), which can mainly count on support from white SA citizens (Kotzé, 2001). The other eight provinces, including Eastern Cape, are under an African National Congress (ANC) government, which is mainly supported by black and coloured SA citizens (Kotzé, 2001). The DA is generally perceived as a more liberal party, compared to the ANC (Kotzé, 2001). Besides a different province, the upper catchment is also in a different district municipality (Eden) and Local Municipality (George). As a result, fruit farming in the upper catchment takes place in a different political and legal context. Fruit farmers therefore have to interact with other government actors, compared to the farmers in EC.

Extreme weather events

Since 2006, the upper catchment has been struck by several natural disasters. Floods hit the area in 2006, 2007 and (more localized) in 2011. The floods caused major damage to dams and other forms of infrastructure (see figure 8a,b,c) Fires burned down part of the area in 2007, 2008 and 2012 (see figure 8d,e). Hail caused devastation in 2006 (see figure 8f). During the period 2008-2011, the upper catchment suffered from drought conditions. These natural disasters have caused large-scale financial damage. E.g., the 2006 hail destroyed the crops of seven fruit farms around Haarlem, with a potential crop of R25 million. The 2007 floods destroyed over more than 100 farm dams (Mayson, 2010). Moreover, the events have social impacts in terms of employment numbers.

The accumulated damage of these natural shocks is larger than the sum of its parts. E.g., the damage of the 2006 floods was exacerbated by the 2007 floods, because temporary repairments of infrastructure were hit once again. Furthermore, damaged dams lead to limited water storage capacity. Consequently, the impact of the 2008-2011 drought was bigger. In 2010, after two years of drought, this lead to water use restrictions, because not enough water was stored to meet all needs. In 2011, 20-30% of all farm dams were still not repaired (Agri-Avontuur, 2011).

State assistance (from WC government) in the aftermath of these natural disasters was limited or absent, and was not focussed on commercial fruit farmers, who are the biggest employers of the area. After the 2006 floods, for example, state money was only available for communal dams (dams that are used by more than one owner). Privately owned farm dams did not qualify for state assistance. Less than R3 million was allocated to the fruit farmers in the Langkloof. After the 2007 floods, no financial assistance was given at all.

a. Dike burst after 2006 floods (1)

b. Dike burst after 2006 floods (2)

c. Damaged bridge after 2007 floods

d. 2007 Fire


e. 2007 Fire


f. Damaged trees after 2006 hail

Figure 8. Extreme weather events around Haarlem.

Invasive Alien Plants (IAPs)

The upper catchment is heavily invaded with IAPs. Infestation with IAPs will most likely lead to an increase of mulch and surface cover, which will subsequently lead to a decrease of surface runoff. As IAPs spread, the biomass increases and uses more and more soil moisture. The impacts of IAPs include an overall reduction of water yield, as well as a decrease in the baseflow (Mander et al., 2010). It is expected that the impacts of alien vegetation on the Kouga river will increase significantly before 2020 (C.A.P.E., 2010).

Figure 9. Black wattle (small trees) and pines (big trees) next to the dirt road to Haarlem dam.

The results of a VEGRAI (Vegetation Response Assessment Index) show that the Kouga river just downstream Haarlem is 'seriously modified' and that alien invasion and clearing (removal of IAPs) have had a serious negative impact on the river. Furthermore, there is a high potential for further invasion with alien vegetation (C.A.P.E., 2010). An IHI (Index of Habitat Integrity) analysis in the same study shows that dams, roads, weirs and causeways in the Haarlem area have resulted in an inundation, flow modification and bed- and channel modification. Abstraction for irrigation has caused flow modification and impacts on water quality through eutrophication (polluted return flows). In addition, the study concludes that IAPs, agriculture and floods have caused river bank erosion and a decrease of indigenous vegetation (C.A.P.E., 2010).

3.3 Fruit farming around Haarlem

Challenges

Around Haarlem, fruit farming is the main economic activity and is the main source of income for a large amount of labourers that work on the commercial fruit farms. In recent years, the fruit farmers around Haarlem are experiencing though times.

'We are not in an easy environment. We have political issues and agriculture in South Africa is struggling. We don't get a lot of help from our government, we're sort of acting on our own'

'A lot of things are deteriorating in the Langkloof: our crime rate is on the increase, our road infrastructures are collapsing, the medical clinics aren't running as smooth as they used to'

In general, the respondents recognise negative dynamics in the area around Haarlem in terms of social and economic conditions. A term that reoccurs when the farmers describe the area is 'deterioration'. One farmer notes that *'in three years from now, I don't want to be worse off than now'*, which indicates the 'mood' that the farmers are in at the moment. At this point, the main challenge for the commercial fruit farmers around Haarlem is to keep their farms up and running in the context of a worldwide economic crisis, rising prices of water, fuel and electricity, a changing legal/political environment and in the aftermath of several natural disasters. Given the economic importance of fruit farming around Haarlem, the whole community in the area is to a large extent dependent on the success/failure of commercial farming enterprises, especially in terms of employment, a fact that is stressed by the fruit farmers.

‘The main challenge is to keep the farm profitable with rising prices of fuel and electricity’

‘The biggest concern is to keep on farming, so our quality of life does not degrade’

‘Most of the guys in the area are basically focussing on surviving the economic crisis’

‘I have seen over the last two or three years quite a negative backwards movement of our labour’

Managing water

The western part of the Kouga catchment receives relatively much rainfall compared to downstream areas (Haigh et al., 2004). The fruit farmers in the Haarlem water scheme indicate that, under normal circumstances, there is sufficient water available for irrigating their orchards. They think that it is a matter of proper management.

‘With proper management, there is a lot to gain’

According to the chairperson of the local Irrigation Board (IB) (for explanation about the IB, see paragraph 3.4), 95% of the Haarlem water scheme uses drip irrigation or micro-irrigation. Both practices are regarded as relatively water efficient. 5% Of the water users in the Haarlem IB (mainly the small-scale vegetable farmers) still makes use of the less efficient sprinkler or flood irrigation. Haarlem IB aims to replace these inefficient practices with micro or drip irrigation. The commercial fruit farmers believe that a lot can be improved in the Haarlem township (where the farm labourers live) with regard to efficient water use. Currently, the IB is in a project together with the Department of Agriculture, to educate the small-scale farmers in Haarlem about efficient water use. Furthermore, the fruit farmers see a need for more water storage capacity in the Haarlem township. They indicate that this is a responsibility of George Local Municipality.

‘The problems are mainly in our townships, they don’t have well maintained systems. I definitely want to see better maintenance of systems in the towns’

Furthermore, the chairperson of Haarlem IB is a proponent of mulching, and encourages other farmers to mulche as well. He states that *‘now only 5-10% of the farmers around Haarlem are mulching to save electricity and fuel. It must be getting widespread and used by all of us’*. Farmers who mulch spread the chipped black wattle wood under the fruit orchards. The chipped wood has a high water holding capacity and prevents evaporation. A mulching machine is required for this practice. Only one farmer in Haarlem owns such a machine himself, while others have to hire one.

The clearing of IAPs is another way to save water. Given the aliens' high water use (Hosking & Du Preez, 2002), the clearing of these trees (black wattle in particular) prevents 'water loss'. On their own farms, most farmers clear alien trees themselves, when time and money are available. However, the clearing of IAPs is not seen as a priority, and is mainly seen as a responsibility for the government, more particularly the Working for Water initiative: an initiative that was launched by the government in 1995 with the specific aim to clear IAPs.

'Over the years we've been clearing, but we can only do so much. I can't stop a certain section of my farming just to do that'

Given the importance of irrigation water for fruit farming, and the importance of the fruit farming economy for Haarlem, it can be said that the management of water is of vital importance to the upper catchment. Therefore, the fruit farmers have organized themselves in the Haarlem irrigation board, which manages the water that is derived from the Tsitsikamma mountains and captured in the Haarlem dam. An extensive pipeline system provides water from the Haarlem dam to the water users around Haarlem.

'The Haarlem dam is the heartbeat of the region'

3.4 The Haarlem Irrigation Board

The role of the IB

The farmers around Haarlem have organized themselves in the Haarlem IB, which comprises of eighteen farmers. Besides farmers, George Local Municipality is represented in the IB. The main task of the IB is to distribute water, maintain infrastructure and to regulate payments of water users. The Haarlem IB meets four times a year to discuss emerging issues. Once a year, the IB meets with all the water users in the scheme.

History of the Haarlem IB

A major difference between the fruit farmers in Haarlem and the downstream areas lies in the fact that the Haarlem farmers have collectively invested heavily in a water storage dam (Haarlem dam). In the end of the 1980's, the farmers around Haarlem recognized that no further expansion of business was possible without a big dam to capture winter rain. A lot of meetings with relevant actors in the area lead to a plan to build such a dam in 1988. The dam was constructed in 1991 and has a capacity of 4,560,000m^3 of water. This is a very large capacity compared to the other water storage dams in the Langkloof. E.g., the Formosa dam (Louterwater) and the Joubertina dam have capacities of 1,680,000m³ and 208,000m³, respectively. From the Haarlem dam, water is piped (by gravity force) to water users in Haarlem, Ongelegen and Avontuur. The Haarlem water scheme consists of 24km of pipeline. The system is regulated by control valves and water use is registered by water meters. The IB hires a civil engineer to manage the infrastructure and check the water meters on a monthly basis. Water use is known for all the water users in the water scheme. Each water user within the Haarlem water scheme receives a total of 5040m³ water per hectare, per year. The Haarlem IB has water rights for an area of 890ha, or 4,485,600m³ water/year (890ha × 5040 m³/ha/year). The water infrastructure of Haarlem IB is regarded as the most efficient system in the Kouga catchment. The construction costs of the dam were financed by bank loans. The rates for water users in the Haarlem IB are therefore higher than in other IBs, because the IB has to repay its debt to the bank, as well as the regular tariffs to DWAF.

Water users in the Haarlem IB

The costs of the Haarlem dam were afforded in a collective effort of the commercial farmers (2/3) and the government (1/3) and is the dam is now privately owned by the Haarlem IB. The water system provides water for more than 800ha of commercial fruit orchards, around 40 small-scale (subsistence) farmers and the system delivers drinking water to the community of the Haarlem township. The water from Haarlem dam is allocated to commercial farmers (±60%), ±40 small-scale subsistence farmers (±20%) and a government farm (±15%). The remaining 5% is for domestic use of the Haarlem community. Government officials from both George Local Municipality and Eden District Municipality are member of the Haarlem IB to represent the interests of the Haarlem small-scale farmers and the (coloured) Haarlem community.

The multiple interests (drinking water versus irrigation water) became apparent when water restrictions were implemented by the Haarlem IB in response to drought conditions in 2009. One respondent notes that water restrictions affected him because 20ha of orchards did not have sufficient water for fruit growth and it took the trees two years to recover. He says that during these water restrictions, water remained available for the Haarlem township. He adds that *'this is right: people go before the cattle and plants of the farmers'*. Others confirm this opinion: *'for the poor, there must always be free water'*. However, they indicate that this is a responsibility of George Local Municipality: *'The Municipality is responsible for looking after the needs of the township'.* The chairperson of the Haarlem IB notes that since the original plan for developing a dam was negotiated (late 1980s), the eighteen farmers and other actors within the IB have been cooperating well.

'Back then, there was a lot of meetings. Since then, cooperation has been good in the Haarlem IB. The only problem is to get the new people involved'

The formation of a Water User Association (WUA)

Under the 1998 water act, water users are legally obliged to form so-called Water User Associations (WUAs) (NWA, 1998). Currently, the Haarlem IB is in the process of transforming into a WUA. The primary aim of a WUA is to manage water management activities on behalf of a group of stakeholders within a resource area (DWAF, 2002). In this respect, there is no fundamental difference with the role of the IB that is in place now. The difference with an IB is that a membership of a WUA is not dependent on land ownership. WUAs are supposed to represent the needs of all water users, including less powerfull actors such as women, labourers and other Historically Disadvantaged Individuals (HDIs). The chairperson of the Haarlem IB notes that the needs of the water users around Haarlem were already taken into account when they developed the Haarlem water scheme.

'We are already doing everything that we're supposed to do. It's just under the wrong name. We've already settled the thing with the Haarlem township. We've agreed about their housing water and their agricultural water'

For the Langkloof, the government suggests a overarching WUA that includes all the current IBs and the unofficial water schemes, as well as all the other water users in the Langkloof. However, the Haarlem IB does not agree with this idea, because they believe that 'their' water is managed relatively well. They do not want to be part of the problems that arise in a bigger WUA and prefer to turn the Haarlem IB in a WUA, without incorporating other IBs.

'Now, they're building new townships in Misgund and Louterwater. Before they started building houses, they haven't gone to the IBs to ask what water is available for housing. Where are they gonna get the water for 200 to 400 households? I don't want to be part of that fight'

'I don't want to be part of their system to manage water use. They haven't got flow meters. They have nothing. In some places they even have open furrows'

'It's just too big an area for one governing body'

'For our area, a big overhead body provides no benefit'

3.5 Responses to disasters

Actors working together

Besides good relationships between actors within Haarlem IB, the IB has good relationships with other institutions in the area. The IB has a good (working) relationship with Agri-Avontuur (the local FA), a local NPO (UnIEP), the WC government departments and Eden District Municipality.

'In our area, we are working very well together'

After the 2006/2007 floods, the spillway of Haarlem dam was damaged. During an IB meeting with all the water users, it was decided to hire a consultancy company to investigate the damage of the dam. The company calculated a damage of R1,3 million. With the results of the consultant, the IB went to Eden District Municipality to ask for financial help. Eden assisted the IB by providing R800,000 from disaster funds. The rest of the damage was paid by the members of the IB.

'Our biggest advantage is that our farmers have felt climate change. It brought our community together very strongly'

'We became more aware about water. We experienced first hand that when you open a tap, there is no water'

The role of UnIEP

An important role in the Haarlem area is played by a local Non-Profit Organization (NPO), namely the Uniondale Integrated Empowerment Project (UnIEP). The initiative was initiated by a rather unlikely couple of former 'enemies': a former senior military officer of the Apartheid state and a Reverend of the United Reformed Church in the townships of Uniondale. UnIEP exists as a resource for local upliftment and as the co-ordinator and fund-raiser for various separate projects (UnIEP, 2012). UnIEP is concerned about the social environment, human development and commercial/environmental sustainability.

'We try to do as much as possible to connect the three dots of economy, social responsibility and environmental impact'

To achieve this, UnIEP is involved in all kinds of projects (e.g. aftercare centres, youth development, HIV) (UnIEP, 2012). The NPO functions as a bridging organization between different actors. It strongly cooperates with organized agriculture in the upper catchment. There is a good relationship (on a personal basis) between the chairperson of Haarlem IB and UnIEP. One of the founders of UnIEP (the former apartheid servant) is also the chairperson of the Agri-Avontuur FA and is involved with the ward committee as a representative for agriculture and the labourers. The NPO therefore has contacts in both George Local Municipality and Eden District Municipality. Furthermore, the NPO connects actors within the upper catchment with actors outside of the catchment (e.g. government departments). After the recent natural disasters, UnIEP also became involved in the issues of water management and IAPs. The NPO assists farmers in fund-raising and connects relevant actors.

Task teams

The recent natural disasters have caused troubles for a wide range of actors in the upper catchment. Floods, droughts, hail and fires have had direct effects on organized agriculture, (e.g. poor harvests, infrastructure damage, economic damage). Agriculture is the main economic driver of the upper catchment. As a result, the extreme weather events have indirect social impacts in the form of unemployment and loss of income to many farm labourers. In the case of drought, it is obvious that everybody in the area is affected, as water is vital to all actors as a necessity of life.

The actors in the upper catchment have developed a strategy to collectively act upon extreme weather events: a task team. This strategy has been applied for the first time after the 2006 floods and has been applied ever after if natural disasters occurred in the area. UnIEP is present to coordinate the task team and has the capacity to role out social support projects after any disaster.

Directly after the occurrence of such an event, the task team is called together to discuss a strategy to act. The task team consists of (1) representatives of specific actors/interests in the upper catchment, (2) specialists in specific areas and (3) any other actors that can have a positive influence on the task-team (depending on the kind of event). The task team includes representatives of the Haarlem town, commercial agriculture, small subsistence farmers, nature conservation/forestry, women and farm labourers. Specialists include among others a fire specialist, an engineer, a social specialist, the chairperson of the Haarlem IB and an insurance specialist.

The task team aims to analyse what exact damage is present and what needs to be done. On the basis of this analysis, the task team develops a plan with tangible actions 'on the ground'. This plan will show how the task team thinks they can manage the aftermath of natural disasters. During the development such plans, all involved actors are updated about the progress by a newsletter. Figure 9 shows part of the newsletter that was distributed after the 2006 hail. It shows which farms were affected by the hailstorm (figure 10a), which actors are involved in the task team (figure 10b) and which actors are in the daily management of the task-team (figure 10c). Furthermore, the newsletter informs all involved actors about the actions that have been taken and about results that have been achieved.

FEIT

#1. 7 Plase is deur 'n verwoestende haelstorm getref die 20ste November 2006.

a. **Highview**
b. **Greylock**
c. **M.C.Loock Boerdery**
d. **Langfontein Ontwikkelings Trust**
e. **Strydom Landgoed**
f. **Ongelegen (D. Scheepers)**
g. **J.Baldie & Sons (Weskaap gedeelte)**

a. The newsletter describes which farms (a-g) were affected by the 2006 hailstorm

#2. Uit vorige ondervinding weet ons dat dit maande kan neem om hulp op die grond te kry, en dat indien die hele betrokke gemeenskap nie gekoördineerd optree nie, word baie mense mis gekyk, en ontvang dan geen hulp nie. Daarom is daar op die 29ste November 2006 'n verteenwoordigende Taakspan op die been gebring om te help koordineer.

Die Taakspan bestaan uit: 3 Kommersieële Boere
3 Haalem Klein Boere
6 Plaaswerkers (1 uit elke streek)
2 Persone van Langfontein Trust
1 Persoon van LBK
2 Raadslede
1 Amptenaar van Eden Rampbestuur

b. The newsletter describes the members of the task team (3 commercial farmers, 3 Haarlem small-scale farmers, 6 farm labourers, 2 representatives from Langfontein Development Trust, 2 council members and 1 civil servant of Eden Disaster Management)

#3. Om die Taakspan vaartbelyn te maak het hulle 'n Dagbestuur, en Hul bestaan uit die volgende: 1 Kommersieële Boer (Dave Hodgson)
1 Haarlem Boer (Gert McClune)
1 Plaaswerker verteenwoordiger (Fanie Douw)
1 LBK verteenwoordiger (Piet Swart)
2 Verteenwoordigers van Langfontein Ontwikkelings Trust
Ursula Adams en Dries Stander
2 Raadslede Martin Wildemann en Helen Loff
1 Rampbestuur amptenaar (Wendy Young)
Om seker te maak dat inligting vinnig beskikbaar kan wees, koopteer die Dagbestuur die Plaas eienaars en 'n werker verteenwoordiger soos benodig

c. The newsletter indicates who is in the daily management of the taskteam (1 farmer from Haarlem, 1 farm worker representative, 2 representatives from Langfontein Development Trust, 2 council members and 1 civil servant of disaster management)

Figure 10. Sections from a task-team newsletter after the 2006 hailstorm

Only after finishing an 'on-the-ground-plan', the task team engages with the government institutions that are relevant in the specific case. These can be Municipalities or WC provincial government departments (e.g. disaster management, department of agriculture, department of water affairs, department of labour, etc.). The plan will outline how government can assist, either financially or by other means.

'We never go to the government without a plan. It won't work'

Figure 11. Slide from a powerpoint presentation that was held by in the Cape Town council chamber for the national disaster management and the WC department of agriculture. The slide describes the process of the task team after the 2006 hail event.

Longer term solutions

Next to the immediate formation of a task-group in response to extreme weather events, the actor/interest groups in the upper catchment also work together to develop long-term plans. Examples include initiatives of UnIEP and the Agri-Avontuur FA. Both organizations develop and present proposals/suggestions for the region (upper catchment) to government institutions. These long-term plans include suggestions for the management of both water and IAPs.

An example of this is a UnIEP bid for an alien clearing project. Instead of solely relying on WfW teams to clear IAPs, actors in the upper catchment take on the task themselves. The mission of this project is outlined in figure 12. This mission stresses the importance of including all relevant actors in both the development and the implementation of plans. After consulting actors in the upper catchment, the bid defines priority areas for alien clearing, and possible secondary uses of IAP wood.

'Alien eradication, if done correctly, can actually have a positive economic impact on the region'

The proposal outlines in detail what is needed/requested from the funding institution. Furthermore, it defines what contribution the landowners in the upper catchment will make to the project. Besides the benefit of alien clearing, the project also provides employment. This is of particular importance in the aftermath of natural disasters, when employment numbers dropped. Linking IAP clearing and job creation is a concept that is also pursued by government initiatives such as WfW, and can therefore count on support. In addition, the proposal stresses the importance of finding secondary products out of IAP biomass. Several options are listed: mulch for fruit trees, woodgas as alternative energy, wooden fence spars and poles, furniture, wooden planks for flooring and ceilings, fire wood and charcoal.

''Our aim is to put in place a holistic alien clearing project with partnerships with ALL the role players in our area. ALL role players must be involved from the planning stage all the way through and ALL must take ownership of the project. It must be a logical sustainable project with maximum utilisation of secondary products of the aliens cleared. It must be an environmental, social and economic success story that can be replicated elsewhere.''

Figure 12. Mission UnIEP alien clearing proposal (UnIEP, year unknown)

The mode of operation of actors in the upper catchment can also be illustrated by a document of the local FA (figure 13). The Agri-Avontuur FA compiled a 'plea to the Western Cape cabinet for participation in the rejuvenation of our region' (Agri-Avontuur, 2011). This plea is based on input from a number of group representatives.

''Input in the following pages has been gathered in over the last few years. Attempts have been made at various times to implement actions and projects listed. A few have been started, but have not been completed. Input was supplied by many group representatives. These include Agri Avontuur members, Haarlem Boerevereniging, Southern Cape FPA, Ward 24 Ward Committee Nominees, Councillor's Gert MaClune and Alex Wildemann, New Farmers Mr C. Fortuin and N.Thyssen, The Haarlem Irrigation Board, Middle Keurbooms Conservancy, Tourism products in the rural area, Farm Worker representatives, Tuinroete Agri and their workers, Noll Adrenelien, Mr Gary Oliver and Uniondale Integrated Empowerment Projects (Co-ordinators for the EPWP in Uniondale)''

Figure 13. Section of Agri-Avontuur 'plea to the Western Cape cabinet for participation in the rejuvenation of our region' which states the actors that provided input for the document.(Agri-Avontuur, 2011).

The plea addresses a wide range of issues (infrastructure, water, transport, health, education, social development, tourism, economic development, safety and security, housing, sport and recreation) (Agri-Avontuur, 2011). It is a request for assistance/support from government's side, to address these issues. Once again, the importance of water to the area becomes apparent: twelve of the twenty pages in the document are dedicated to water, while the other ten issues are addressed in only eight pages.

The proposal pleads for more water holding capacity to sustain long periods of drought. During the 2008-2011 drought, some water users (Haarlem small-scale farmers) in the Haarlem IB were disadvantaged in terms of irrigation supply (Agri-Avontuur, 2011). The plea stresses explicitly that increased water holding capacity is only demanded to ensure water availabitility, not to increase water use.

‘Water storage capacity can be the only key between success and failure in terms of farming and human survival in terms of domestic water’ (Agri-Avontuur, 2011)

On the short term (2011-2016), the plea proposes to repair all damaged dams in the area and to increase water storage capacity through bigger dams (on farms) and rainwater storage tanks (for every household). Furthermore, the plea states that it is desirable that no new boreholes will be dug for agricultural purposes, because this runs the risk of dry-up of springs. (Agri-Avontuur, 2011). For the medium and long term (2016-2025), the plea also presents several suggestions (figure 14).

i. Irrigation techniques need to be adapted to suite the new climate. Mulching is an example of this. By using alien plant material such as black wattle, chopping it into mulch and putting it around the fruit trees, agriculture can save up to 50% on their water usage.

ii. Fruit trees planted in the 100 year flood plains must be relocated to new lands to prevent losses and soil losses during floods.

iii. A concerted effort needs to be activated to create marshes that can hold back water and release it slowly.

iv. Working for Water projects must be expanded and secondary industries such as mulching and nurseries must be created. The mulch can be sold to fruit farmers to save water and indigenous trees can be planted to stabilize river and stream banks. Currently projects have been done in the Holledrift river, Kammanassie river source and also in the Keurbooms river. Planning of these projects must be coordinated with Agriculture to have maximum affect on water conservation.

v. Riverbank rehabilitation is urgently required to prevent the silting up of weirs and dams. This must coupled to soil erosion conservation, as this too leads to silt deposits in dams.

vi. All households in the rural area should utilize their bath, shower and wash basin (grey water) water to water their gardens.

Figure 14. Section of Agri-Avontuur ‘plea to the Western Cape cabinet for participation in the rejuvenation of our region’ which states recommendations for the medium and long term (5-15 years) (Agri-Avontuur, 2011)

3.6 Obstacles to effective management

Western Cape or Eastern Cape?

Haarlem is part of the Kouga catchment, which means that all the water flows towards the Kouga river and eventually ends up in the Kouga dam, which provides water users in the EC. It is part of the Fish-to-Tsitsikamma Water Management Area (WMA15) (DWAF, 2004(a)), which is managed by the Eastern Cape DWAF. Legally, however, Haarlem falls under the jurisdiction of WC. This creates some problems, in particular with regard to alien clearing by WfW. One fruit farmer tells an anecdote about contacting WfW for the clearing of IAPs:

'When I contact Eastern Cape DWAF for the removal of black wattle they will send teams. However, these teams will stop at the Western Cape border and call their supervisors that Haarlem is in the Western Cape. The problem is that DWAF in Eastern Cape constantly has new managers, so the problem repeats itself constantly. The Western Cape, on the other hand, argues that we are in the Eastern Cape catchment area. The only thing that WC DWAF wants is to get hold of the water tax.'

In the context of water management and IAP clearing, the same respondent states that it would have been better if the provincial borders would be the same as the catchment boundaries. Besides the provincial boundary, the fruit farmers indicate that political and governmental issues also hinder effective water management.

Political and government issues

'If you want to get things done, the political road is a road to disaster'

'Politics is seeing who can lie the best without being caught'

'The political situation on the land is not good, the racial issue is always there. The political issue is always there'

The quotes illustrate a general discourse among fruit farmers in the Kouga catchment. Although apartheid has officially been left behind, its remnants are still visible in SA's social dynamics. Since the 1994 regime change, the relationship between commercial farmers and the government has not changed for the better. The commercial farmers feel accused of irresponsible water management.

'At this stage, we are seen as the dark horses in the game, while 85% of the farmers that I know is conservationist by heart'

The respondents indicate that they do not have a lot of confidence in the government bodies that are responsible for water management. Especially DWAF and the local municipality do not have a good reputation among the farmers.

'DWAF is a bad ministry, which only interest is to get water tax from the farmers'

'DWAF is incompetent'

'If we run a business like they run a municipality, we would get broke'

Time & money

As outlined (paragraph 3.3), the fruit farmers' financial position has worsen and their main objective is to keep their farm viable and to make a profit out of farming. Obviously, efficient water management is one of the most important aspects of fruit farming around Haarlem. However, time and money are not always available to fulfil all wishes.

A good example is the repairing of the damaged infrastructure after the 2007 floods. Although the farmers would like to repair as fast as possible, not all farmers could bring up the financial necessities. Another example is the clearing of IAPs, which is not seen as a priority practice by the farmers. Only if time and money are available, they will clear priority areas on their own farms.

3.7 Conclusion

Water management around Haarlem

The case of Haarlem provides a concrete example of fruit farmers' water management activities. The case uncovers some of the main system characteristics that frame fruit farmers' management practices. In the first place, it shows that not only fruit farming, but the region as a whole is dependent on proper management of water. In practice, the farmers are the ones that manage the water resources through the Haarlem IB. However, where water management used to be a farmers' business during apartheid, the fruit farmers now cooperate with other actors in the system and are trying to form a WUA. Results show the role of extreme weather events as a trigger for new forms of self-organization, that is, task-groups with representatives of different actor-groups, including commercial fruit farmers. In the formation of these task groups, the role of UnIEP in bringing together different actors becomes apparent. By combining knowledge and insights from all actors, the task-group puts together an 'on-the-ground-plan' to tackle the problem (e.g. hailstorms, floods, droughts, etc.). On the longer term, the actors work together to develop plans for water security and the clearing of IAPs. The role of UnIEP can be seen as that of a bridging organization (Olsson et al., 2007).

The relationship between farmers and government bodies is an important obstacle to efficient water management. The farmers do not have a lot of confidence in the government and feel accused of irresponsible water management. Furthermore, Haarlem's geographical location (under jurisdiction of WC, but in an EC catchment area) creates problems in terms of government responsibility. Here, a mismatch between social (political, legal) and ecological (catchment) dynamics can be observed (Cumming, Cumming, & Redman, 2006; Olsson et al., 2007).

Haarlem in relation to the Kouga catchment as a whole

From a system perspective, one could say that the upper catchment is part of a separate political, legal and institutional system, when compared to the downstream quaternary catchments. From an ecological point of view, on the contrary, the upper catchment is connected by river flows to the downstream areas and only artificially demarcated from them by provincial boundaries. Taking an economical perspective, the upper catchment is part of the Kouga catchment SES, as it is characterized by deciduous fruit farming as the main economic driver, like the downstream areas.

From the case of Haarlem, it has become clear that the four factors of Folke et al. (2003) are useful to uncover how fruit farmers create new opportunities for self-organization (task-groups) and cooperate with other actors as they learn to live with change and uncertainty (e.g. extreme weather events). It also shows that the work of a bridging organization (UnIEP) allows for actors to combine different types of knowledge and to nurture diversity (the different actors/experts in the task-teams).

The area around Haarlem only covers a small part of the Kouga catchment and the differences with downstream areas are obvious. Therefore, the results of the case-study cannot be extrapolated to the other parts of the catchment. However, they can serve as a point of reference to compare social-ecological dynamics to downstream areas and to throw light on the notion of scale in SESs (Cash et al., 2006). In the remaining chapters of this thesis, the scope of analysis will be expanded from the upper catchment to the Kouga catchment SES as a whole. The four factors of Folke et al. (2003) will be used to search for ways in which fruit farmers manage for social-ecological resilience with regard to water management.

4. Learning to live with change and uncertainty

4.1 Introduction

This chapter describes the first parameter that is suggested to be relevant for building resilience: learning to live with change and uncertainty (C. Folke et al., 2003). The chapter describes changes and uncertainties with regard to fruit farming and water management in the Kouga catchment. Subsequently, it describes how the fruit farmers respond to these changes/uncertainties. The presence of 'a memory of past events' is suggested as an prerequisite for 'learning to live with change and uncertainty' (C. Folke et al., 2005) and will be investigated as such. In this thesis, 'learning' is retraced from fruit farmers' practices and pronouncements.

4.2 Framing 'learning to live with change and uncertainty'

Learning in ecosystem management

The notion of learning plays an increasingly important role in the management of SESs. A paradigm shift has been observed in policy and science in recent decades. The traditional linear model, in which knowledge production was the exclusive domain of expert scientists, has been replaced by a more interactive model, in which innovations arise from learning-based processes among a larger group of actors (D. Armitage et al., 2008; The World Bank, 2006). Over time, several approaches towards NRM emerged that view natural resource management as an iterative process that leaves room for learning and replanning over time (D. Armitage et al., 2008; Biggs & Matsaert, 1999; Stringer et al., 2006). The role of learning (both as a means and as an end) is also recognized in SES literature (Anderies et al., 2004; Berkes et al., 2003; Hahn et al., 2006; Olsson et al., 2007). Westley (2002) states that 'the capacity to deal with the interactive dynamics of social and ecological systems requires learning environments and networks of interacting individuals and organizations at different levels to create the right links, at the right time, around the right issues' (Westey, 2002 in (Olsson et al., 2007)).

Memories of past events

Accepting uncertainty and surprise as an inevitability in ecosystem management is considered central to learning in SESs (Berkes, 2007; Berkes et al., 2003; C. Folke et al., 2005). Learning from social-ecological feedback (past experiences) can guide future responses to unexpected events. A memory of past events is therefore suggested as an important prerequisite for adequate responses (D. R. Armitage et al., 2009; C. Folke et al., 2005; Pahl-Wostl et al., 2007) and can materialise as rules of conduct in a specific event (Berkes, 2007). A 'memory of past events' can therefore be studied as an indicator of 'learning to live with change and uncertainty'.

South Africa

In the context of SA, the notions of change and uncertainty seem to be inherent to life. Major transformations have taken place since the Apartheids regime was replaced by the post-apartheid government lead by Nelson Mandela in 1994. The privileged legal position of white commercial farmers during apartheid is not respected anymore, and policies have promoted social equity for all SA citizens. Water policies are focussing on equal distribution of water among South African civilians, including HDIs (NWA, 1998; Perret, 2002). Fruit farmers have to adapt to these new legislations. Furthermore, uncertainty resides in the scarcity of the water resource itself (DWAF, 2009a; Greeff, 2010), and the variable weather patterns in the Kouga catchment (Van der Merwe et al., 2012).

4.3 Uncertainties

Weather uncertainties

As outlined in the previous chapter, water management in the Kouga catchment takes place in a context of the regular occurrence of extreme weather events. Floods and droughts occur regularly but vary greatly in intensity and consequences. Since 1937, the department of Rural Development & Land Reform takes weather measurements, including rainfall data. These data show excessive average monthly rainfall at several occasions since the measurements started, including May 1944, August 1974, March, May and August in 1981, July 1983, November 1996. Furthermore, droughts have been documented on regular occasions (Van der Merwe et al., 2012). Nothing in these data suggests a more regular occurrence of such events in recent decades, compared to earlier decades (figure 15).

Decade	# wet months (>70mm rainfall)	# dry years (<370mm rainfall)
1940-1949	12	**1**
1950-1959	21	**1**
1960-1969	17	**1**
1970-1979	16	**3**
1980-1989	17	**3**
1990-1999	18	**1**
2000-2010	**18**	**4**

Figure 15. Occurrence of extreme wet and dry periods in the Kouga catchment since 1940

Although the rainfall data suggest otherwise, there is a general feeling amongst the fruit farming community that the weather has become more variable compared to earlier decades. This can be explained by the fact that extreme rainfall events can be characterized as so-called flash-floods, in which very large quantities of rain come down in very short time-spans. *'In the past we had regular light rains ensuring a constant supply. Now we have short bursts of flood rain and very little in between'*

Furthermore, there are relatively large differences in rainfall on a relatively small area. Such small-scale differences are so big that one farmer can experience a very severe rain and/or hailstorm, while his/her neighbour receives little or no rain at all (Fruit farmer, *personal communication*). Monthly rainfall averages are of little information to analyse such short events, so it could well be true that rainfall events have become more severe, like the fruit farmers claim.

The succeeding floods and droughts are well alive in the memory of elderly respondents, who mentioned the floods of 1981 and 1996. The younger generation of farmers mentions more recent experiences. All of the respondents mentioned the 2006 and 2007 floods, which are considered to be the largest floods in living memory (HORTGRO, 2011). Although the rainfall data from dept. of Rural Innovation and Land Reform indicate more severe incidents in 1981, this is not generally reflected in the respondents' accounts of extreme weather events. The memory of the 2006 and 2007 floods is still fresh and reinforced by the dry period that followed in 2008, 2009 and 2010, which is referred to as 'the worst drought in living memory' by the chairperson of the Langkloof Farmers' Association (LFA) (The Gremlin, 2011). Sixteen respondents personally experienced damage from the combination of floods and droughts. All but one recognized the damaging impact of the weather events for the whole Langkloof.

The floods mainly damaged water infrastructure such as farm dams, weirs, pipelines, pumps and valves. The floods flushed away (parts of) dams, pipelines and ditches. Dams got obstructed by materials that got dragged along by the water (e.g. IAPs that grow in the riverbanks). Furthermore, orchards were lost and the water caused soil erosion in the orchards. Many fruit farmers struggled to repair their infrastructure immediately for both reasons of money (it is expensive to repair infrastructure) and time (the farmers were busy with harvesting season and did not have time and manpower to repair damaged infrastructure). This resulted in limited water storage capacity in the years afterwards. Until now, not all damage has been repaired yet.

In 2008, 2009 and 2010 the Langkloof experienced very dry conditions (figure 16). A series of three dry years (rainfall<370mm/year) in a row is exceptional, since it did not occur since 1937-1940 (Van der Merwe et al., 2012). Combined with the limited water storage capacity, this led to a smaller fruit harvest. In 2008, the consequences were limited because there was still water stored from earlier seasons. In 2009 and 2010, however, the lack of water had serious consequences for the fruit farmers. Fruits were smaller and of less quality because of insufficient water provision (Alani, 2010).

Although a big part of the harvest could still be used for juice production, the quality was insufficient for the export market. This has resulted in large economic losses (Alani, 2010) and the firing of labourers.

'I became in debt and had to fire people because of financial issues'

Rainfall	
2006	**785,2mm**
2007	**715,8mm**
2008	**330mm**
2009	**351,7mm**
2010	**364,7mm**
2011	**614,7mm**
Average (1937-2011)	**472mm**

Figure 16. Annual rainfall (2006-2011), adapted from Van der Merwe et al. (2012)

Quotes like 'it's the worst drought in hundred years', 'I've never seen so much water', 'the last five years have been though' and 'the next war in South Africa will be around water' illustrate how the recent weather circumstances are alive in the memory of the fruit farming community. They realise that uncertainty is an inevitable part of fruit farming. One fruit farmer notes that 'the biggest mistake I made during the last five years is relying on the past. You cannot predict natural disasters'. Another one says that 'as a farmer, you have to accept weather changes'. However, the majority of respondents thinks that under 'normal circumstances' there is sufficient water for organized agriculture. They stress that if the water resource is managed properly, there will not be shortages.

'Under normal circumstances, the Langkloof has more than enough water for organized agriculture. I do believe that through managing the resource better, there is a lot to gain.'

Financial uncertainties

Although no exact numbers are available, the damage of the recent floods and droughts is estimated to be R56 million (€5,6 million) (Spoormaker, 2012). After the 2007 floods, the farming community applied for flood relief money through the two active FAs in the Kouga catchment. Financial help from the state was considered essential to do the necessary infrastructure repairments, which are expensive. In order to qualify for flood relief money, the area needs to be officially declared as 'disaster area'. According to the chairpersons of the FAs, they applied for flood relief money after the flood. Since then, the FAs have been negotiating for flood and drought relief money. However, the farmers did not yet receive any money. In the meantime, the farmers repaired the damage on their own costs without certainty about financial help from the government.

On May 3rd and 4th of 2012, a delegation from the department of Agriculture, Forestry and Fisheries visited the area. Together with the chairpersons of the FAs they visited several farms to identify the damage. This delegation agreed that the 2007 flood indeed was a disaster, which means it qualifies for disaster fund money. The government now has to decide how much financial compensation is available for the Langkloof (George Herald, 2012). Although there is no certainty about the amount of money, it seems that the farmers will receive some form of compensation. The slow progress of government processes is a source of frustration to the fruit farmers in the Langkloof. However, according to one farmer 'the farmers know now that there is not a lot of government money available for quick infrastructure repairments, so they do it themselves now' (Spoormaker, 2012).

Legal uncertainties

During recent decades, major changes have taken place with regard to water policy. Historically, irrigation development was a mechanism of the apartheid state to achieve political and economic goals (Vaughan, 1997). During the apartheid regime, water policies were orientated towards irrigated commercial agriculture and access to water was practically unlimited for (white) commercial farmers (Perret, 2002; Vaughan, 1997). After the political reform in 1994, water policy and legislative reform is taking place gradually. Emphasis in water policy is now placed on social equity (to compensate for inequities during Apartheid), water use efficiency/sustainability and decentralization of water management (Backeberg, 2005). The principle of riparian ownership of surface water, in which water is owned by the landowner of the water source, is abandoned. The 1998 National Water Act states that farmers need to officially register their water use at DWAF. With regard to the decentralization of water management, the 1998 NWA is supporting the establishment of so-called Water User Associations (WUAs). These are local platforms in which water management is negotiated and practiced by the water users themselves (NWA, 1998).

The fruit farmers in the Langkloof indicate that water policy is unclear. A majority of the respondents mention the lack of communication with DWAF. Moreover, 45% of the respondents explicitly state that DWAF is incompetent. Unclearity exists in particular with regard to the formation of a WUA. All the farmers have heard about the government plans to form such a WUA. However, the majority does not know what this means for their personal situation, or what is expected from them. The fruit farmers think that the large differences between water users in the Langkloof are a hurdle towards forming a WUA.

Increase of IAPs

Almost all fruit farmers in the Langkloof have both old and recent aerial pictures of their land. On these photos, one can see an enormous increase of IAP cover. All the respondents mention the increase of IAP cover as a major concern. The first and foremost issue that fruit farmers highlight when talking about IAPs is their water use. Compared to the indigenous fynbos vegetation, these invasive alien plants are taller, faster growing and reproducing, evergreen and adapted to optimise water consumption (Hosking & Du Preez, 2004). Fruit farming is largely dependent on the availability of sufficient water to irrigate the orchards. It comes as no surprise that most of the farmers perceive the presence of IAPs as a problem for their land and the Kouga catchment in general. Although no exact numbers about water use are available, the threat of IAPs is generally recognised among the farming community. A second issue that farmers mention with regard to IAPs is the fact that they block the rivers and the infrastructure to transport water (canals, dams, etc.). Compared to indigenous vegetation, IAPs have shallow rooting systems that are not able to withstand floods. During floods, trees get dragged along with the water and create blockages. The removal of such blockages demands for both money and manpower, because it is a costly and time-consuming activity.

In the Kouga catchment, one particular tree has become the symbol of the bad characteristics of AIPs, the infamous *Acacia Mearsnii*, more commonly known as ‘’’black wattle’’. Besides black wattle, other alien invasive species such as *Pinus ssp* and *Hakea ssp* are present. The latter is seen by some as an ‘upcoming species’, indicating the possibility of future expansion. Together, these three species are mentioned most by local landowners, with black wattle most frequently. Other alien invasive species occur as well, but are not generally recognized as a problem.

Due to the above mentioned inconveniences, IAPs have gained a status of ‘enemy’ amongst the fruit farming community in the Kouga catchment. It is a topic that is discussed on regular occasions and recognised as one of the major challenges for the (near) future. Quotes from local fruit farmers nicely illustrate their resent towards IAPs.

’It’s an ugly tree’

‘They are useless’

’It irritates me to drive through the black wattle’

‘They spoil the whole world’

The SA government also recognized the problem of IAPs and responded by launching the Working for Water (WfW) programme in 1995. The programme specifically concentrates on alien eradication to secure water provision, biological diversity and ecological functioning of natural systems. In addition, the programme embraces a social upliftment component by providing jobs. Several WfW projects have been initiated in the SA catchment areas; the Kouga project being one of them. (DWAF, 2012b).

Available data from DWAF suggest that 12,5% of land surface area in the Kouga catchment is invaded by IAPs at 100% density (DWAF, 2009a). Uncertainty resides in the question whether or not the spread of IAPs can be stopped and/or reversed. Actors in the Kouga catchment doubt if (and how) the problem can be solved. A recent study calculated that at the current rate of clearing, it will take 696 years before the whole Kouga catchment is cleared, assuming no further spread (McConnachie, Cowling, van Wilgen, & McConnachie, 2012).

fruit farmers' quotes about the quick growth rate of IAPs

'When you cut one, you get 10 back. After a fire, you get 100 new ones'

'Black wattle regrows when you cut it'

'Black wattle grows very rapidly, especially when enough water is available'

fruit farmers' quotes about the clearing of IAPs

'I think WfW is not winning the battle'

'The fight will never be won'

Upstream-downstream competition for water

Competition for water has been raised frequently a concern to the local fruit farmers in the Kouga catchment. This feeling has been reinforced by the recent droughts. In times of drought, water resources are insufficient to meet all needs (DWAF, 2004). People are concerned about securing 'their' water resources, especially considering future generations. The pressure on water from the Kouga river is likely to increase in the near future. Downstream water demand is growing significantly, especially because of population growth in the NMBMM (including the city of Port Elizabeth) and the intensive citrus farming in the Gamtoos valley (Jansen, 2008).

Besides population growth, Port Elizabeth currently experiences a quick growth of industry. Downstream water demand is expected to increase by ±30% once the Coega IDZ industrial site in Port Elizabeth, which is currently under construction, becomes fully operational (DWAF, 2009a). As a result, water has been defined as the largest challenge for the Cacadu District Municipality (Cacadu District Municipality, 2011), of which both the Kouga catchment and the city of Port Elizabeth are part. Many water policies have been implemented in recent years to monitor water use and to secure water provision to Port Elizabeth. These policies have consequences for water users in the catchment areas (NWA, 1998).

'We're in the catchment area of PE, the big challenge lies here'

'Now, we're not allowed to build dams because of PE'

'All the water must go to PE'

'The Gamtoos Valley and PE take water from our catchment'

'One thing that is bothering me is that from PE side there is a lot of pressure not to expand water storage capacity, while golf courts are built at the same time'

In the Kouga catchment, deciduous fruit farming accounts for the largest part of water consumption. In the year 2000, 26,5 million m³ water was used for agricultural irrigation. The total water requirements (also including urban and rural water use) were 27,9 million m³. In the same year, 63,6 million m³ flowed downstream out of the catchment (DWAF, 2004(a)). Many farmers feel threatened by the increasing downstream water demand and think that the government wants to take 'their' water.

'The government only comes with threats: if you don't do this, then…. The government sees farmers as a threat, but we have to produce food and jobs'

This is in sharp contrast with the time of the apartheid regime, when water policies were orientated towards irrigated commercial agriculture and access to water was practically unlimited (Perret, 2002). In the previous water act, access to water was often linked to land ownership (DWAF, 2004(b)). One of the biggest changes in the 1998 National Water Act is that water is since then considered as a common asset (NWA, 1998). The current South African Water Act states that catchment management authorities can terminate water use licences when farmers misuse or mismanage their allocated water resources (Myburgh, 2011). Although the farmers generally recognise the downstream need for more water, they do not agree with government policies. There is a general feeling that new government regulations are only focussing on restricting water use by farmers in the Kouga catchment, while alternatives to secure water are not considered.

As a country, SA depends mainly on surface water (DWAF, 2004(b)). Management of river catchment areas therefore becomes of huge significance. One of the most important regulations is the 1992 law that prohibits people to build any new dams that exceed a storage capacity of 10,000m³ in the Kouga catchment. No new licences will be issued to allocated water resources, unless circumstances are exceptional (DWAF, 2004(a)).This measure means that farmers have access to the same amount of water as they did in 1992. However, a highly competitive economic market forces them to scale up their business to remain economically viable. Many small enterprises have been bought up by bigger farmers in recent years and the number of fruit farmers in the Kouga catchment has decreased significantly, while the cultivated area has increased. In other words, farms have grown to remain competitive. The wish to expand their business prevails among many deciduous fruit farmers. This wish is hindered by the limited amount of water that is legally available for agriculture.

'Since 1992 we were told you can't build a dam; you can't develop. So we can only replant old orchards. We can't build any more dams, because that water is earmarked for Port Elizabeth. But I don't see Port Elizabeth in the last 50 years having done anything to secure water except hammer the farmers in the Langkloof'

The fruit farmers indicate that they are already limiting their water use to a minimum. SA electricity prices have risen sharply during the last few years. Many farmers use this argument to support their claim that it makes no sense for them to use more water than absolutely necessary, because it costs them money. However, the farmers feel that the SA government is turning a blind eye to their efforts to optimise water use. In fact, the farming community feels blamed by the government. As a result, the competition for water by upstream and downstream users seems to create a feeling of mutual distrust between the SA government and the local farmers

'At the moment, we are seen as the dark horses in the game'

4.4 Fruit farmers' responses to social-ecological dynamics

Fruit farmers' responses to drought

The scarcity of the water resource is increasingly recognized by the fruit farmers. The memory of droughts and water restrictions, in combination with changing legislation makes water saving practices look attractive. Rapidly rising electricity prices should also be seen as a driver of more efficient water use, as becomes apparent through interviews (irrigation pumps consume much electricity).

‘Times of drought make people think about their practices. I now use water more economically and installed drip/micro irrigation systems instead of sprinkler or flood irrigation’

‘Droughts are good learning moments, because people discuss the issues and learn a lot from experience’

‘If you over irrigate these days, you’re stupid, because it costs you money. That’s why you take leaf samples and soil samples to see how much water is needed’

During the last two decades, the fruit farmers replaced water inefficient irrigation practices, such as flood and overhead irrigation, with more efficient irrigation systems. Especially drip and micro irrigation have become popular. Other responses to droughts include the use of mulch. Mulch (in the form of black wattle chips) is spread under the orchards for its high water holding capacity (it prevents evaporation). One respondent thinks it saves him around 40% of water and immediately links this to a 40% reduction of his electricity costs. However, the cost-effectiveness of mulch is debated among the fruit farmers because of high logistic costs.

Arguments in favour of mulching:

‘Mulching is helping for weed control and mulching is helping for water conservation. Your carbon is coming back and mulching even helps to bring down fertilizer and chemical use’

‘Mulch keeps the moisture in the soil and it provides compost for the orchards’

Arguments against mulching:

‘You can mulch black wattle, but those mulching machines are expensive. It’s easier to burn all the wood’

‘The costs of transporting mulch chips is high’

Some farmers make use of boreholes to use in times of drought. Boreholes are considered to be expensive and inefficient and are not preferred as a source of water. One farmer notes that he dug over more than 80 boreholes since the 1992 law forbid him to build more dams. Of these 80 boreholes, he can only use 30 to distract water. Boreholes are used to extract irrigation water as well as water for domestic use (Baselmans, 2011).

Fruit farmers' responses to floods

'Until four years ago I was not concerned. After the years of floods, droughts and hail I realised that it's a reality to take into account'. This quote comes from one of the farmers who was hit most severe by the floods, and shows how people learn from extreme events. Farmers took several actions to prevent large infrastructural damage, like in 2007. One of the strategies to prevent damage is to keep the canals and ditches open by removing IAPs, stones and other object that can be dragged along by strong currents. Farmers deepened the canals or they enlarged the wash-land. These actions provide more space for the river water, in case of big volumes. In one case, a farmer lost 20ha of orchards because these were planted in the floodplain. After this experience, he decided not to plant any orchards in floodplains anymore. This example is also mentioned by his neighbours, which shows how one farmer's experiences inform his colleagues.

The most obvious response after the recent floods is the repairing of damaged infrastructure. As in the case of Haarlem (figure 8a,b,c), infrastructural damage was ubiquitous in other areas of the Langkloof as well. The importance of the dams for irrigated fruit farming demands for quick repairments.

Alien clearing

Clearing of is the current strategy to fight IAPs. DWAF suggests that such clearing needs to take place in a coordinated way (DWAF, 2009a). However, fruit farmers in the Langkloof indicate that this is exactly what is lacking. Many actors are involved in alien clearing, including the fruit farmers themselves, municipalities and the WfW programme.

In the Kouga catchment, the majority of land is privately owned (Powell & Mander, 2009), mostly by farmers. Most alien clearing by WfW takes place on these private properties. However, both WfW and the landowners indicate that there is a lack of communication between the two parties. The activities of WfW are not communicated with the landowners and many landowners wonder what WfW is actually doing and achieving. Some of them do not know whom to contact when they need WfW. Alongside the efforts of WfW, a lot of landowners clear (part of) their land themselves. They often do this independently of WfW. Consequently, the clearing of IAPs does not take place in a coordinated way. On private land, WfW commits to initial clearing of aliens and three rounds of follow-up clearing. After these follow-ups, landowners are legally obliged to control IAPs on their property. WfW will still provide herbicides to the landowners. Many landowners complain about the lack of follow-up by WfW after initial clearing has been done. Furthermore, the landowners complain that the WfW teams leave the trees after cutting. During floods, several incidents occurred where such trees got dragged along the river and damaged dams and bridges.

Biological control is suggested as an approach to eradicate IAPs. No such control is currently practiced on significant scale in the Kouga catchment. The regional manager of WfW states that there have been some insect releases around Ongelegen. However, no assessment has been made on the proceedings of these biocontrol agents. One farmer's account nicely illustrates how the perception of black wattle has changed over the years and how people have learned. He tells that *'at a meeting about biological control in 1984, people did not want to introduce a beetle to fight black wattle because the tree was used for firewood and fuel'.*

At the moment, there is no way to use the wood from cut IAPs. Locally, the black wattle wood is used as burning wood by farmers and farm workers. On a larger scale, there is no way to make cutting of IAPs economically viable. Especially the transportation of the wood is too expensive to make a profit out of it. Fruit farmers are looking for ways to make cutting IAPs economically interesting. In this respect, mulching is an interesting opportunity. Black wattle wood can be chipped to small pieces and used as mulch. Again, respondents emphasize the transportation costs that come along with this practice.

4.5 Conclusion

Accepting uncertainty and surprise as an inevitability in ecosystem management is considered central to learning in SESs (Berkes, 2007; Berkes et al., 2003; C. Folke et al., 2005). For the fruit farmers in the Kouga catchment, major sources of uncertainty are unpredictable weather patterns and their financial consequences, a changing legal context and the impacts of alien vegetation.

A memory of past events is an important prerequisite for adequate responses (D. R. Armitage et al., 2009; C. Folke et al., 2005; Pahl-Wostl et al., 2007). The recent floods and droughts have contributed to the development of such memory. An understanding has evolved that the weather has become more variable and unpredictable, compared to earlier decades. Extreme weather events are expected to occur more frequently. Furthermore, slow negotiations for flood/drought relief money with the government have made the farmers realize that financial compensation for the infrastructural and economic damage by droughts and floods cannot be taken for granted. In general, the (white commercial) fruit farmers notice that support from the government has decreased since the 1994 regime change. Moreover, the farmers feel threatened by changing water laws, which are shifting from a focus on irrigated agriculture towards a focus on equity and sustainability (Perret, 2002). The fruit farmers indicate that new policies are unclear and not well communicated.

The above mentioned uncertainties are recognised by the respondents, who indicate that they need to take these factors into account in ecosystem management. This recognition contributes to a realization that water is a scarce and expensive resource, an insight has materialized in more efficient irrigation practices. Almost all farmers exclusively use localized irrigation systems (drip and micro). Some farmers use black wattle mulch to increase the water holding capacity of the soil. With regard to IAPs, uncertainty exists about the amount of IAPs that is present in the Kouga catchment and the spread of these species. Respondents observed a sharp increase in alien vegetation over the last decades and see the need to eradicate them, especially in view of the high water consumption of IAPs. Alien clearing now takes place at several levels: by the farmers themselves and by the WfW programme. Sometimes other actors (e.g. municipality) are involved as well. During the floods in 2006 and 2007, IAPs got dragged along by the rivers and caused damage to dams, bridges and other infrastructure. The farmers have learned from these experiences and now try to clear their streams from IAPs, to protect their infrastructure.

5. Creating opportunities for self-organization

5.1 Introduction

This chapter takes a look at how the fruit farmers in the Kouga catchment have organized themselves. Self-organization is considered to be an important denominator of the capacity to act upon social-ecological change (Berkes, 2007; Carl Folke, 2006; Olsson et al., 2007). Several institutions and informal networks are involved in the management of water in the Kouga catchment. Farmers have established water schemes in the different subcatchments to distribute and manage the water from the Kouga tributary rivers. In addition, the two active FAs play an important role, especially as representatives of the farmers towards the government. This chapter provides a description of these institutions and their rules and routines.

5.2 Framing 'creating opportunities for self-organization'

Literature on adaptive governance stresses the importance of locally organized responses to ecosystem dynamics (C. Folke et al., 2005). Folke (2006) states that 'adaptive processes that relate to the capacity to tolerate and deal with change emerge out of the system's self-organization'. In other words, the ability to self-organize is considered to be an essential element of adaptive capacity (Olssen, 2003).The lack of self-organization, on the contrary, negatively influences the capacity to act upon social-ecological change (Carl Folke, 2006). The presence of local institutions and (learning) organizations is considered to be key to effective response and adaptation to social-ecological change (Berkes, 2007). Disturbances of ecosystems can be a trigger towards reorganization and new forms of self-organization within SESs (Olssen, 2003), as can be seen in the formation of task-teams in Haarlem (see chapter 3). Both formal (institutionalized) and informal networks play a role in the development of institutional memory and should be taken into account.

5.3 Subcatchments & water schemes

Subcatchments

Fruit farming in the Kouga catchment mainly takes place in the Langkloof. This valley is situated between the Tsitsikamma and Kouga mountains and runs in a west-east direction. Several tributary rivers originate on the Tsitsikamma side in the South and flow down the mountains into the Langkloof. Surprisingly, these tributaries do not follow the Langkloof valley towards the East. Instead, they cross the valley in a south-north direction and 'break through' a parallel range of the mountains to merge with the Kouga river. This pattern of tributary rivers divides the Langkloof into several subcatchments, which are not physically linked by the main river. This ecological feature has social implications in terms of the institutions that developed around water management. Looking at subcatchments, nine areas can be identified within the Langkloof. From East to West, these are Heights, Twee Riviere, Joubertina, Krakeel, Louterwater, Apiesrivier, Misgund, Ongelegen and Haarlem. Each of these areas has its own source of water (tributary river) that originates in the Tsitsikamma mountains. In each area, institutions have developed to manage the water from these sources.

Large social and ecological differences exist between the different subcatchments. In some of them, farmers are the only water users (e.g. Apiesrivier and Ongelegen). Here, relatively little actors are involved in water management. In the Apiesrivier subcatchment, for example, all water users are fruit farmers (seven farms). In the Ongelegen subcatchment, there are even less (four) water users involved. Moreover, these actors share more or less the same objectives. That is, they have an interest in viable fruit farming. The situation of Haarlem is far more complex (see chapter 3). In this case, more actors have a stake in the water resources and irrigation is not the sole water using practice. Here, the water has to be divided among commercial farmers, small-scale subsistence farmers and a residential area. Especially the issue of clean drinking water becomes more relevant when residential areas are involved. This means that local municipalities become involved to represent the needs of the residential areas and the 'coloured community'. A fruit farmer from Krakeel states that *'the coloured community in Krakeel does not get enough water. We are helping them by pumping water into their reservoir. But this reservoir is leaking. Kou Kamma Municipality promised that they would repair the dam, which they did, but the reservoir is still leaking'*. Here, the problematic relationship between commercial farmers and government institutions (especially local municipalities) plays an important role once again. Furthermore, the contradictions between the 'rich' commercial fruit farmers and the 'poor' coloured community become visible. Besides Haarlem, also Joubertina, Krakeel, Louterwater, and Misgund include a town and/or township.

'Kou Kamma Municipality often makes promises, but nothing comes from it'

'Kou Kamma Municipality is not capable of looking after water infrastructure'

'The municipalities are non-existent in the Eastern Cape. They cannot function. They don't have the expertise'

Besides social differences, there are ecological differences between the subcatchments. Climate in the Kouga catchment tends towards a bimodal pattern with rainfall peaking in autumn and spring. The western part of the Kouga catchment is situated close to a winter rainfall zone and therefore receives more winter rain. From East to West, mean annual rainfall increases from ±300mm/year in the Heights area to ±800mm/year in the area around Haarlem and Avontuur (Haigh et al., 2004). Climatic differences demand for specific water regimes in the different subcatchments. The relevance of water storage capacity, for example, is more apparent in the eastern part of the Langkloof, where rainfall is limited. Furthermore, the impacts of droughts will be felt earlier in the eastern part of the Langkloof.

Water schemes

Farmers organized themselves in water schemes (like the Haarlem IB) to distribute the available water among all water users and to manage the resource. Historically, such water schemes were established during apartheid through local initiatives of white commercial farming communities that wanted to establish joint infrastructure (Perret, 2002). In the Kouga catchment, water schemes were set-up separately per subcatchment, because they extract water from different sources (different tributary rivers). Water schemes represent a form of self-organization that nicely illustrates social-ecological interaction: the presence of mountain ridges creates subcatchments and the flow of the Kouga tributary rivers eventually determines which actors are linked to each other by a particular resource, namely water. Collectively managed infrastructure such as dams, pipelines, ditches, etc. physically connect all water users in the same water scheme. Over time, rules and routines developed that institutionalized within the water schemes.

In a water scheme, so-called water turns are documented. That is, the amount of water that each actor receives, and when. These water turns are coupled to the property that each actor owns. Each property has rights for a certain amount of water. In many cases, the water turns were agreed upon long ago and have not been changed until now. A respondent in Ongelegen explains that arrangements about water in this subcatchment were negotiated around 1900 between the four farmers in the area. In Krakeel, the water rights have been allocated to properties in 1890. Until recently, each legal property had a separate water turn. Three years ago the actors in the Krakeel water scheme decided to put together the water turns of all properties that were owned by the same person, to make the water turns more manageable. Some of the water schemes are officially registered as Irrigation Board (IB) at DWAF and pay water tariffs to DWAF. Others are not officially registered, but do pay their water tariffs to DWAF collectively (e.g. Krakeel). Some fruit farmers are not even part of an irrigation scheme and extract their own water (and pay DWAF individually).

APIESRIVIER BESPROEIINGSRAAD BL.3

WATERBEURTE

Stroom 1: Voltyds Jay Dee Plase (360 uur per 15 dae)

	Stroom 2					Stroom 3			
Datum	Besproeier	Begin/ Einde	Beurt-Ure	Ure	Datum	Besproeier	Begin/ Einde	Beurt-ure	Ure
26 MRT	IB	**12h00**	72 =	12	26 MRT	JD	**12h00**	66 =	12
27 MRT	IB			24	27 MRT	JD			24
28 MRT	IB			24	28 MRT	JD			24
29 MRT	IB	12h00		12	29 MRT	JD	06H00		6
29 MRT	JD	**12h00**	72 =	12	29 MRT	RHO	**06H00**	76.5 =	18
30 MRT	JD			24	30 MRT	RHO			24
31 MRT	JD			24	31 MRT	RHO			24
01 APR	JD	12h00		12	01 APR	RHO	10H30		10.5
01 APR	M Waters	**12h00**	36 =	12	01 APR	RHO	**10H30**	54 =	13.5
02 APR	M Waters	24h00		24	02 APR	RHO			24
03 APR	The Falls	**00h00**	36 =	24	03 APR	RHO	16H30		16.5
04 APR	The Falls	12h00		12	03 APR	MON D	**16H30**	43.5 =	7.5
04 APR	MON D/**RH**	**12h00**	33 =	12	04 APR	MON D	16H30		16.50
05 APR	MON D/**RH**	21h00		21	04 APR	MON D/RH	**16H30**		7.5
05 APR	GD	**21h00**	81 =	3	05 APR	MON D/RH	12H00		12
06 APR	GD			24	05 APR	PP	**12H00**	81 =	12
07 APR	GD			24	06 APR	PP	12H00		12
08 APR	GD			24	06 APR	(PP) **JD**	**12H00**		12
09 APR	GD	06h00		6	07 APR	(PP) **JD**			24
09 APR	JD	**06h00**	30 =	18	08 APR	(PP) **JD**	21H00		21
10 APR	JD	12h00		12	08 APR	JD	**21H00**	39 =	3
					09 APR	JD			24
					10 APR	JD	12H00		12
10 APR	IB	**12h00**	72 =	12	10 APR	JD	**12h00**	66 =	12
11 APR	IB			24	11 APR	JD			24
12 APR	IB			24	12 APR	JD			24
13 APR	IB	12h00		12	13 APR	JD	06H00		6
13 APR	JD	**12h00**	72 =	12	13 APR	RHO	**06H00**	76.5 =	18
14 APR	JD			24	14 APR	RHO			24
15 APR	JD			24	15 APR	RHO			24
16 APR	JD	12h00		12	16 APR	RHO	10H30		10.5
16 APR	M Waters	**12h00**	36 =	12	16 APR	RHO	**10H30**	54 =	13.5
17 APR	M Waters	24h00		24	17 APR	RHO			24
18 APR	The Falls	**00h00**	36 =	24	18 APR	RHO	16H30		16.5
19 APR	The Falls	12h00		12	18 APR	MON D	**16H30**	43.5 =	7.5
19 APR	MON D/**RH**	**12h00**	33 =	12	19 APR	MON D	16H30		16.50

Figure 17. Water turn scheme of Apiesrivier IB for the period March 26th until April 25th. The figure describes when (date, time and period) the water users (besproeiers) in the Apiesrivier IB receive water from the pipeline system. One water user (Jay Dee Plase) constantly receives water from one stream (stroom 1) because this water user owns the largest amount of land. The other water users receive water fom stream 2 and 3 (stroom 2 and 3)

Irrigation Boards (IBs)

The water schemes of Joubertina, Louterwater, Apiesrivier, Misgund and Haarlem are officially registered as IBs. This means they are legal entities that are entitled to manage the water resource (NWA, 1998). Each IB in the Langkloof represents the water users that are part of the joint infrastructure. In the case of Apiesrivier the IB only consists of farmers. In all other cases, the IBs also include towns and/or townships, which are represented by either Kou Kamma Local Municipality (all the IBs in Eastern Cape) or George Local Municipality (Haarlem IB). Each water user is supposed to pay a regular fee to the operating IB for the water he/she uses. Part of this money is used to maintain infrastructure such as dams, weirs, pipelines, pressure valves, water meters, cut-off valves, etc. Another part goes to the Department of Water Affairs and Forestry (DWAF). Some IBs undertake coordinated efforts to clear IAPs. E.g., the Misgund-East IB has a coordinated system to clear dams and other infrastructure to prevent blockages. A similar cooperation is present in the Louterwater IB. In terms of actor-networks, IBs form the link between water users in the Kouga catchment and DWAF. The IBs pay a certain amount of money to DWAF for their allocated water. DWAF allocated water quota (specific cubic metres of water per hectare) to the IBs, based on rainfall, humidity, evaporation and the normal flow of the rivers (e.g. Haarlem IB receives 5040m^3/ha/year). From that point, DWAF expected the IBs to make decisions about water distribution by democratic voting (Vaughan, 1997). In other words, the day-to-day management of the water is legally in the hands of the IBs and the use of the allocated water is negotiated within the IBs. In times of drought, IBs can implement water restrictions for the members in the water scheme, as happened in the Haarlem IB in the season 2009/2010 (see chapter 3). Furthermore, water trading takes place between actors in the IB when farmers have a water surplus or when they cannot pay their water fees. Again, the case of Apiesrivier serves as an example. Here, one farmer could not pay his fee to the IB. The other farmers in the IB now use part of his water. The chairperson of Apiesrivier IB explains how the water is distributed among the five water users in the water scheme (also see figure 17):

‘There is a weir in the Apiesrivier. From the weir, the water goes into an 11km long pipeline system which distributes the water to the farms. There are always three water users who receive their water at the same time because the system splits the water in three’

Historically, most IBs were established through local initiatives of white commercial farming communities that wanted to establish joint infrastructure (Vaughan, 1997). Most farming enterprises are family businesses that go from father to son. Although this tradition is changing, it has created a long history of cooperation between neighbouring farms in the different subcatchments. Van Huyssteen (2008) describes the history and development of settlements in the Langkloof. From this book it becomes clear that the original pattern of settlement still has implications for fruit farmers’ social networks. Families that descend from the original white settlers are still ubiquitous in the Langkloof and are associated to specific areas/subcatchments. The Zondagh family owns most land around Avontuur, while the area around Krakeel is almost exclusively owned by members of the Strydom family. Other examples are the Kritzinger family around Misgund and the Gerbers in the Kouga mountains.

Currently the IBs are still largely managed by white commercial farmers. A concerned emerging farmer notes that '*Currently, there are seven water schemes that are mostly ruled by the white guys. They are the ones who make the decisions. These farmers are just thinking about fruits, while the community and the schools are struggling with drinking water. The IBs never went to the community to ask about their demands*'. As part of the 1998 National Water Act, the SA government promotes the formation of WUAs in which HDIs are better represented (NWA, 1998). For the Langkloof, the government suggests an overarching WUA that includes all the current water schemes (both IBs and unofficial water schemes), as well as all the other water users in the Langkloof. The idea is to develop a more integrated approach towards water management on a catchment level. Such institutions are suggested to better match the scale of ecological and social processes and to act as effective bridging organizations that operate across scales and sectors (B. H. Walker, Abel, Anderies, & Ryan, 2009). However, the IBs do not agree with this idea because the differences between the IBs/subcatchments are too big.

Major differences exist in the state of the infrastructure and the (amount of) actors involved in the different water schemes. Moreover, the different IBs fall under different provincial and municipal jurisdiction. The Haarlem IB and the Waboomsrivier IB (Joubertina) have invested in a system with closed pipelines, while other IBs have a system of canals and open ditches, where water loss is much bigger. A Haarlem farmer states that *'I don't want to be part of their system to manage water use. They haven't got flow meters. They have nothing. In some places they even have open furrows'*. Some of the IBs still have debts from infrastructure investments (e.g. Haarlem IB), while others are dept-free. Another farmer from Haarlem wonders how financial issues will be managed: *'some of the IBs have debt on their assets, while others haven't. How do you match those things in one big WUA?'*

The IBs of Joubertina, Misgund, Louterwater and Haarlem store their water in a dam, while the water schemes of Twee Riviere, Apiesrivier and Krakeel do not have a dam. The dam of Waboomsrivier IB (Joubertina) is owned by Kou Kamma Local Municipality, while the dams of Misgund, Louterwater and Haarlem are owned by the IB itself (DWAF, 2009b). Furthermore, the provincial boundary divides the Kouga catchment in an EC part and a WC part. Haarlem IB falls under the jurisdiction of WC and George Local Municipality, while the other IBs and water schemes are in EC, under the jurisdiction of Kou Kamma Local Municipality. The water turns are regulated differently per water scheme. Many respondents mention the extraordinary pattern of subcatchments to explain the differences between the water schemes. After several meetings the IB representatives decided that the differences between the different IBs are too big to unite them in one WUA. However, from government side, this wish is still present.

5.4 Farmers' Associations

FA represent another form of self-organization. The majority of the fruit farmers in the Langkloof is member of a FA. Two of these associations are active in the Langkloof. The farmers in the EC join the Langkloof FA (LFA), that comprises of ± 70 members. The farmers in WC (Haarlem and Avontuur) join the Agri-Avontuur FA, which also covers areas outside the Langkloof.

On a regular basis (four or five times a year), all kinds of issues are discussed during member meetings of the FAs. These meetings provide farmers with the opportunity to raise their issues and discuss them with colleagues. Furthermore, guest speakers are invited to these meetings to elaborate on current issues. The time after the meeting is used to socialise and have a drink at the bar. With regard to water management, the FAs are involved in the acquisition of flood relief money (figure 18) and the issue of IAPs. Respondents indicate that the FAs serve as institutions to represent the farmers and to coordinate contact between farmers, government and other institutions such as WfW. They see the FAs as a tool to raise their voice and to get attention from government. Moreover, the FAs represent the farmers in the media, as can be seen in figure 18.

Landbou weekblad

Die droogte en die ongunstige wisselkoers kan 'n verlies van sowat R200 miljoen vir vrugteboere in die Langkloof beteken.

Die **vrugtebedryf** in die **Langkloof** kan weens die ongunstige wisselkoers en die knou wat die droogte op vanjaar se oeste het, sowat R200 miljoen in buitelande valuta verloor, sê die Langkloof-boerevereniging.

Mnr. André de Wit, die voorsitter van die vereniging, sê vanjaar se oes het met tussen 30% en 35% gekrimp in vergelyking met verlede jaar.

"Sowat 80% van die vrugte is klaar geoes, maar die **droogte** het sy tol geëis. Die oes het weens klein of swak vrugte met tussen 30% en 35% gekrimp," sê De Wit.

Wisselkoers knou erg

Volgens De Wit besorg die swak **wisselkoers** van die rand teenoor die dollar - asook ander geldeenhede - vir hulle groot kopsere. "Die wisselkoers is tans 31% swakker as wat dit verlede jaar was, en dit knou ons erg. As jy die oes-afname en dié wisselkoers se invloed saam bereken, kos dit die land sowat R200 miljoen in buitelandse valuta. En dit nét uit vrugte uit die Langkloof!"

Hy sê die Oos-Kaapse regering is al verskeie genader met versoek om hulp met die skade aan damme. "As ons net die damme, wat tydens die vroeëre vloede beskadig is, kan regkry, sal ons die droogte makliker kan hanteer. Maar ons hoor niks van die regering nie", sê De Wit.

Hy sê Maandag het 12 mm reën oor 'n groot gedeelte van die Langkloof uitgesak, "maar ons wag nog vir die groot reën. Hy't nog nie gekom nie".

21 April 2010

a. Original newspaper article
The drought and unfavourable exchange rates could mean a financial loss of almost R200 million (€20 million) for the fruit farmers in the Langkloof. The fruit farmers in the Langkloof can lose R200 million in foreign currency because of the unfavourable exchange rate and the impacts of the drought on this year's harvest, says the Langkloof Farmers' Association. Mr. André de Wit, chairperson of the Langkloof FA, says that this year's harvest has declined with 30-35%, compared to last year. ''Almost 80% of the fruits are harvested, but the drought has had its consequences. The harvest has declined with 30-35% because fruits were too small or too weak.'' **Exchange rate is of big influence** According to De Wit the exchange rate of the Rand, compared to the US dollar – as well as other currencies – are of big concern of the Langkloof FA. ''The exchange rate is 31% weaker than last year, and this impacts on us. If you put together the impacts of the declining harvest and the exchange rate, this can cost the country almost R200 million in foreign currency. And this is only the fruits from the Langkloof!'' He says the Eastern Cape government has been approached several times to assist with the damage to dams. ''If we could only repair the dams that were damaged by earlier floods we would be better able to withstand droughts. But we hear nothing from the government'', says De Wit. He says that a large part of the Langkloof has had 12mm of rain last Monday. ''But we are still waiting for the big rain. It has not come yet.''
b. Translation of the newspaper article

Figure 18. Newspaper article from the 'Landbou Weekblad' (21st April, 2010) that shows the role of the Langkloof FA (1) as a representative organization for the fruit farmers and (2) in the acquisition of government assistance after flood damage.

During the past five years, both FAs have played a big role in attempts to acquire flood relief money from the government for the damage of the 2006 and 2007 floods. The FAs provide farmers with an opportunity to organize themselves with regard to the application of flood relief money. Members of the FAs recognize that they stand a better chance to actually achieve something when they apply for help collectively, instead of applying individually. With the same motivation, both FAs have joined strengths and are now together negotiating with the government. Until recently it has proven to be difficult to be eligible for flood relief money. However, on May 3rd and 4th of 2012, a delegation from the department of Agriculture, Forestry and Fisheries visited the area. Together with the chairpersons of the FAs they visited several farms to identify the damage of the floods and droughts. This delegation agreed that the 2007 flood indeed was a disaster, which means it qualifies for disaster fund money. The government now has to decide how much financial compensation is available for the Langkloof (George Herald, 2012). Although there is no certainty about the amount of money, it seems that the farmers will receive some form of compensation.

The FAs are also involved in the IAP issue. The issue of IAPs is regularly discussed within the FAs. In essence, these meetings boil down to discussions on how to mobilize subsidies from the government to bring in people to clear the IAPs. Although the fruit farmers recognise the negative characteristics of IAPs, self-organization with regard to this theme seems to be underdeveloped. From the fruit farmers' responses, it becomes clear that they see the clearing of IAPs mainly as a responsibility of the government. WfW was present on a meeting of the Agri-Avontuur FA in 2011. During this meeting the farmers and WfW agreed that WfW would supply the farmers with herbicide if the farmers would cut down IAPs. This herbicide is necessary to spray the stems after cutting, to prevent regrowth.

5.5 Conclusion

The presence of local institutions and (learning) organizations is considered to be key to effective response and adaptation to social-ecological change (Berkes, 2007; Davidson-Hunt, 2006). In the Kouga catchment, farmers have organized themselves on multiple scales.

On subcatchment level, IBs and unofficial water schemes have operated for decades. These institutions have organized around the several Kouga tributary rivers and are geographically demarcated from other subcatchments by mountain ridges. Water schemes represent a form of self-organization that nicely illustrates social-ecological interaction: the presence of mountain ridges creates subcatchments and the flow of the Kouga tributary rivers eventually determines which actors are linked to each other by a particular resource, namely water. The social and ecological situation is different in each subcatchment, which has framed the development of the IBs and water schemes. Relationships between actors in the water schemes are the result of long periods of cooperation and mutual dependency in the form of collectively managed infrastructure, which physically links all actors in the actor-network. As a result, strong horizontal relationships have developed between actors in water schemes. Mutual relationships of this type run the risk to develop into pathological path-dependence or 'lock-in' situations that block changes towards new forms of ecosystem management (Pahl-Wostl et al., 2007). This attitude seems to be present with regard to the formation of a WUA for the whole Langkloof. Such WUA is suggested by the SA government as a more integrated approach towards water management on a catchment level. Transboundary problems arise when river subcatchments are the exclusive scale of analysis and management (Pahl-Wostl et al., 2007). Institutions like WUAs are suggested to better match the scale of ecological and social processes and to act as effective bridging organizations that operate across scales and sectors (B. H. Walker et al., 2009). However, respondents stress the unique characteristics of 'their' subcatchment and emphasize the differences with other IBs and water schemes. According to the respondents these differences are insurmountable.

On a regional level, two FAs are active. The FAs cross subcatchment boundaries, but are more or less demarcated by provincial boundaries. The fruit farmers in the EC join the LFA, while the WC farmers (Ongelegen, Haarlem and Avontuur) join the Agri-Avontuur FA. These FAs are a platform for communication between colleagues and are seen as a mechanism to raise 'the farmers' voice' and mobilize (financial) resources. The FAs play an important role in attempts to acquire disaster fund money for the damage of the floods (2006 and 2007) and subsequent droughts (2008-2010). The FAs represent the farmers in negotiations with the government (e.g. WfW).

Literature on adaptive ecosystem management suggests that self-organization is an important denominator of the capacity to act upon social-ecological change (Berkes, 2007; Carl Folke, 2006; Olsson et al., 2007). In a way, the fruit farmers in the Kouga catchment support this statement by stressing that by collectively raising 'the farmers' voice' they get things done. However, literature stresses the role of self-organization to search for innovative ways to deal with social-ecological dynamics (C. Folke et al., 2005). With regard to water management, self-organization in the Kouga catchment is not aimed to pursue novel approaches towards ecosystem management. Rather, the IBs and FAs act as mouth-pieces to express specific interests, such as the acquisition of disaster fund money or the clearing of IAPs. These forms of self-organization even seem to inhibit novel approaches towards ecosystem management, because of path-dependency and lock-in situations (Pahl-Wostl et al., 2007).

6. Combining different types of knowledge for learning

6.1 Introduction

In this chapter, a closer look will be taken on the way fruit farmers in the Kouga catchment integrate different types of knowledge for learning. Here, the issue of scale becomes utterly apparent. Interactions within and across the local, regional and provincial scales determine to what extent fruit farmers are exposed to experiential and experimental knowledge. It becomes clear that social-ecological interaction and historical patterns of social interaction are framing current actor-networks. The role of horizontal and vertical relationships in actor-networks are uncovered, as well as the (potential) role of bridging organizations.

6.2 Framing 'Combining different types of knowledge for learning'

Knowledge at different scales

Ecosystem management requires knowledge of all aspects of SESs, to account for complexity. Such knowledge is unlikely to reside in one actor. Berkes (2009) states that knowledge for dealing with ecosystem dynamics is dispersed among local, regional and national actors. Berkes et al. (2003) emphasize the 'significance of peoples' knowledge, experience and understanding about the dynamics of complex ecosystems, their inclusion in management institutions, and their complementarity to conventional management' (Berkes et al., 2003). Complex issues (like water management) often manifest themselves at different scales and demand for integration of knowledge from different sources. Horizontal as well as vertical linkages in social networks are required to bridge scales and bring together knowledge from different sources (Adger et al., 2005; Berkes, 2009; Hahn et al., 2006).

Experimental and experiential knowledge

Combining experimental (conventional scientific) ecological knowledge with experiential (personal local observations) knowledge is suggested to increase the capacity to learning, as it brings together actors that have different relative strengths in terms of knowledge and background (Berkes, 2007). Experimental knowledge is valuable because it provides simultaneously observed data at a certain point in time. The downside of conventional science is the lack of time-depth in environmental data. Experiental knowledge, on the other side, can provide insight over a longer time-scale because it is based on local observations over a longer period of time. Such knowledge is useful in the study of processes like climate change, which demands for data over a longer time-path. Furthermore, experiental ecological knowledge is practical and place-based (Berkes et al., 2003).

Bridging organizations

Bridging organizations can facilitate the integration of knowledge from different scales by bringing together different actors (C. Folke et al., 2005) to 'create the right links, at the right time, around the right issues' (Olsson et al., 2007). Bringing together different persons, organizations, and institutions allows for these actors to explore different ideas about solving perceived problems (Imperial, 1999). It provides a mechanism to integrate experimental and experiential knowledge. The example of UnIEP in Haarlem shows how a bridging organization can bring different actors together (see chapter 3). For this study, the deciduous fruit farmers and other local actors that are living and/or working in the Kouga catchment are considered to possess experiental knowledge. Other actors, such as government institutions, private consultants and scientists are suggested to possess experimental knowledge.

6.3 Experiential knowledge

Historical connectedness to region

According to the fruit farmers themselves, experiential knowledge plays a big role in the management choices they make. The majority of the respondents has a long history in the Kouga catchment. From the respondents, fifteen have lived in the Kouga catchment for their whole life. Only two of the respondents live in the area for less than ten years. These numbers indicate a lot of working experience of the fruit farmers in the catchment area.

'You can't compare experience to study books'

Moreover, their historical connectedness with the area goes further back through family ties. At least half of the respondents took their business over from their parents or parents-in-law. Family firms are described as very effective institutes to transfer experiential knowledge (Royer, Simons, Boyd, & Rafferty, 2008). In the South African context, family farms in deciduous fruit farming are ubiquitous. 87% Of the fruit farmers in SA have fathers in the same business (Kritzinger & Vorster, 1997). In the Kouga catchment, some fruit farming enterprises have been run by the same family for over more than a decade.

Furthermore, fourteen of the respondents indicate that they constantly discuss their knowledge and practices with colleagues. Neighbours and other people in the same water scheme or IB are often mentioned as actors with whom the fruit farmers regularly discuss their profession. These actors are physically linked by either land and/or (water) infrastructure, which makes them mutually dependent. Other forums for discussion are the FAs. Respondents indicate that they discuss IAPs and water management on a regular basis during meetings of the FAs. In addition, the respondents mention the chairpersons of both the LFA and the Agri-Avontuur FA as actors with whom issues are discussed personally.

Obviously, the situation is different for the emerging farmers, who only got involved in fruit farming after the 1994 regime change through Black Economic Empowerment (BEE) programmes. On average, they have less experience in running a fruit farming business in the Kouga catchment. They cannot build on long personal experience as farm managers. In addition, they cannot draw on experiences from earlier generations within their family, because they are all first generation fruit farmers. However, as part of the BEE programmes, emerging farmers got introduced to fruit farming through mentorship by (former) commercial white farmers who did/do have experience in the area. Through this mechanism, knowledge and skills are transferred from the mentors to emerging farmers. A part of the emerging farmers currently runs its own enterprise, that is, without mentorship. Another part is involved in so-called joint-venture BEE projects, in which a mentor is still involved in farm management. The idea of these joint-ventures is to transfer management and ownership of the farm to emerging farmers, so that they can eventually run their own businesses.

A few indicators of experiential knowledge spring to the forefront when talking to local fruit farmers in the Kouga catchment. A clear perception on ‘climate change’ has developed, especially as a result of the recent natural disasters. Furthermore, the fruit farmers’ experiences of dealing with government institutions has created a rather negative view towards government, which influences their practices with regard to IAPs and water management.

Climate change

An opinion that the weather in the Kouga catchment is changing is widespread among the fruit farming community. Different views exist on whether or not these changes are the result of climate change. However, there is a consensus that the weather has become more variable and characterized by more extreme events such as rain and hailstorms. Farmers ground this statement by referring to specific events such as ‘the hailstorm from December 26st, 2011’ and observations, e.g. ‘I measured 465mm of rain within 63 hours’. The observation of weather variability is reinforced by the severe floods of 2006 and 2007, followed by three years of drought. Moreover, several hail storms have severely damaged fruit orchards locally. Floods, but especially droughts, are considered to be of huge impact on fruit farming.

Lack of government management

The fruit farmers in the Kouga catchment perceive drought as a combination of both environmental factors and (lack of) management. The absence of rain is an obvious driver of drought. Yet, there is a general perception among the fruit farmers that inadequate management from government's side is an important reason for the recent droughts. The following quotes refer to the functioning of the government.

> *'The management of water can be improved'*
>
> *'Because planning hasn't been done earlier, farmers now have to suffer'*
>
> *'I do think that through managing the resource better, there is a lot to gain'*

When the respondents are talking about management, they are mainly referring to technical/engineering solutions with regard to infrastructure. They believe that more water storage capacity is necessary in the Kouga catchment to prevent drought scenarios in the future and to secure the fruit harvest. Implicitly, the fruit farmers define a drought scenario as a situation in which there is not sufficient water to irrigate all orchards optimally. Their proposed solution to prevent such situations is simple and straightforward: more/bigger storage dams. However, this solution is prohibited by government regulations, which state that no dams with a storage capacity that exceeds 10,000m^3 are allowed in the Kouga catchment (DWAF, 2004(a)) . Besides building more dams, the fruit farmers suggest that the government invests more in maintaining infrastructure to prevent leaking of water. Alternatives to technical solutions, such as integrated catchment management (Falkenmark, 2004), are not suggested at all by the respondents. This is in sharp contrast with the vision of the government, which claims to pursue such integrated management strategies (DWAF, 2004(a)).

The respondents feel that the government's water management policy is failing. The main argument is that policy is not place-specific and does not account for the context-specific characteristics of the Langkloof. Furthermore, the fruit farmers feel that the government does not listen to them: *'we present workable plans to the government, but nothing is done with it'*.

The rise of IAPs

Aerial pictures of private property in the Kouga catchment show an enormous increase of IAPs during the last half decade. This indicates that IAPs are a relatively new phenomenon. Nevertheless, a large body of experiential knowledge has developed about the characteristics of IAPs. Farmers know which species occur in the area and where they occur. In addition, they have knowledge about the biology, the behavioural characteristics and the ecological dynamics of alien species.

The first and foremost example of IAPs in the Kouga catchment is ‘black wattle’ (*Acacia Mearnssi*). Black wattle has become widespread over the last twenty years (Versveld, 2012). All respondents mention this species as the most occurring species in the area. For fruit farmers, black wattle has become a synonym for IAPs, given the fact that respondents use the words interchangeably. Black wattle is infamous and has become the preliminary design for all the bad characteristics of IAPs. Besides black wattle, the respondents mention pines (*Pinus spp)*, hakea *(Hakea spp)*, poplar *(Populus spp)* and eucalyptus (*Eucalyptus spp)*. Black wattle, pines and hakea are mentioned the most as problematic for the area.

A clear perception is present about the distribution of black wattle and pines on the land. The fruit farmers point out that black wattle predominantly occurs close to water, such as river banks and ditches. For this reason, they form a problem for the fruit farmers, who have dams and extensive irrigation systems on their property. According to the farmers, pines mostly occur on higher altitudes, and are not prevalent in the lower situated Langkloof Valley. Relatively little is known about hakea. The respondents pinpoint that this species is new to the area. Quotes like *‘it wasn’t here before’* and *‘it’s an upcoming species’* show that hakea is recognized as a new invader.

In terms of biology, an understanding has evolved about seed dispersal and regeneration cycles. The respondents outline how black wattle seeds spread through water streams and link this to an upstream-downstream perspective: if black wattle is present upstream, it will invade downstream areas as well through seed dispersal. Control of black wattle can therefore only be effective in a process that starts upstream and progresses towards downstream areas. Furthermore, the farmers know that black wattle outcompetes the indigenous fynbos vegetation after disturbances such as floods, fires or human-induced disturbances, e.g. plowing. Over the years, farmers have observed the replacement of indigenous vegetation by IAPs, which is of major concern to them.

‘Aliens don’t look nice, I like this fynbos of ours’

‘The Kouga catchment has a unique ecosystem. We have to look after the environment in the Kouga catchment’

6.4 Experimental knowledge

Extension services

Government investments in research, development and extension in the Kouga catchment (and in the whole of SA) shifted focus since the 1994 regime change. In the past, experimental (conventional scientific) knowledge was produced by government institutions and distributed by extension officers from the department of agriculture. More money was available for research on resource protection (Van der Merwe, personal communication). For the Langkloof, place specific scientific knowledge was produced at an experimental farm of the Agricultural Research Council, near Louterwater. During post-Apartheid, the focus of the government policy has shifted towards supporting emerging farmers, which has led to a decrease of research and development activities (Van der Merwe, personal communication)The experimental farm is now used for a BEE project and no new knowledge is produced anymore. According to a local extension officer, the relationship between the extension officers and the white commercial farmers has deteriorated as a result of this policy shift. He also admits that the government *'has lost connection with recent research'* (Van der Merwe, personal communication). In practice, this means that white commercial farmers have to keep themselves updated about new developments. They do so by hiring private consultants, reading agricultural magazines and (to a certain limit) by consulting the internet. The bigger national companies even have their own research laboratories (e.g. Oudrif). Emerging farmers are still largely dependent on information from the government.

Private consultants

For the water management on their farms, almost all fruit farmers in the Langkloof hire private irrigation consultants. A hand full of such consultants is active in the Langkloof. Most of them have a long history in the area and know the area well. Longstanding relationships have developed with the fruit farmers, who have a tendency to remain loyal to their consultant. According to one consultant *'some farmers don't even ask for prices anymore'*. As a result, the consultants know the characteristics of the individual farms. Irrigation consultants advice fruit farmers on the type of irrigation system that suits their needs. In addition, they consult about period planning. That is, when (not) to irrigate. Soil type largely determines which irrigation management is suitable. E.g. A gravely soil demands for shorter periods of irrigation, but more periods. Solid soil needs longer irrigation periods, but less frequently. Soil largely determines pipe size. The advice that irrigation consultants provide is therefore based on soil chart study (Traupe, *personal communication*).

When new orchards are planned and new infrastructure needs to be installed, irrigation consultants work out plans for new irrigation systems. E.g., the thickness of pipes is dependent on soil type and slope. All new irrigation systems are designed to optimize water efficiency. In terms of water use, drip irrigation is more efficient compared to micro-irrigation, especially because drip is more efficient with regard to evapotranspiration. Micro has a 85% efficiency, while drip has a 90-100% efficiency (only if one irrigates too long it is less than 100% efficient). For organic farming, making use of mulch, micro irrigation is better (Traupe, *personal communication*).

'Together with my irrigation consultant I make a five-year plan for irrigation and we discuss period planning'

'I learned a lot from the guy... I learned to use drip irrigation to save water'

'We've learned a lot about irrigation. If the wind blows, we will not irrigate because the wind blows away the water'

'My irrigation consultant advices me about the size of nozzles and the distance between them'

'I used to irrigate large volumes of water for 10 hours. Now, I only irrigate for 4 hours, but it's more effective. I learned that 10 hours is too long because the water can no longer be absorbed by the soil and will just flow away. My electricity costs went down, while the quality of my products went up''

'He taught me about micro-irrigation'

Many respondents say that they learned a lot about irrigation systems from private irrigation consultants and have changed their systems accordingly. The demand for water saving irrigation systems has grown since it is not allowed to build new dams anymore (Traupe, *personal communication*). After the recent droughts, the demand for drip irrigation has grown. The irrigation consultants inform the fruit farmers about new micro/drip irrigation systems, e.g. the size of the nozzle and the distance between nozzles. New drip irrigation systems have double tubes to distribute the water on both sides of the fruit trees. This creates a bigger moisture reservoir under the tree. Furthermore, the spacing between each drip-point has become smaller, so water can be delivered more accurately to the trees (Traupe, *personal communication*).

Agricultural magazines & internet

Sixteen of the respondents say that they consult magazines to keep themselves informed about developments in (fruit) farming. The four most read magazines by fruit farmers in the Kouga catchment are Landbou weekblad (Agricultural Weekly), SA Vrugte Joernaal (Deciduous fruit journal), Farmer's weekly and SA irrigation. Both Landbou Weekblad and Farmer's weekly provide rather general information, some of which is scientifically grounded. More specific information is received from the SA Vrugte Joernaal and SA Irrigation, which focus specifically on deciduous fruit growing and irrigation, respectively. The SA Vrugte Joernaal publishes both popular and in-depth scientific articles on all aspects of fruit farming, ranging from market dynamics to new products/techniques.

This magazine is the most popular among the fruit farmers, given the fact that 75% of the respondents indicate that they read it. SA Irrigation focuses on policies, legislation and regulations with regard to irrigation. Furthermore, it provides articles on water conservation practices, engineering designs and management practices. Most respondents do not make use of the internet to get information. Only a minority of four (relatively young) fruit farmers indicate that they look for information on the internet. The information they obtain is mainly related to weather forecasts.

The IAP knowledge gap

A big knowledge gap exists with regard to experimental knowledge about IAPs in the Kouga catchment. From the fruit farmers' side, there is a big demand for context-specific scientific data about alien plants. Although a big body of literature is available on IAPs in SA (Dye & Jarmain, 2004; Hosking & Du Preez, 2002, 2004; Richardson & Van Wilgen, 2004), only limited scientific endeavours have been undertaken within the Kouga catchment boundaries (Carpenter, 1999; Power, 2011). Furthermore, this information does not seem to be available to local actors in the Kouga catchment, because the fruit farmers indicate that they are not aware of any scientific research.

On the question 'which information is missing', several issues come to the forefront. First, the respondents would like to have exact numbers about the water use of IAPs in the Kouga catchment. Studies on IAP water use exist, but water use is highly dependent on context-specific characteristics such as IAP density and the type of species (Dye & Jarmain, 2004). This brings us to another gap in experimental knowledge in the Kouga catchment: the mapping of the distribution of IAPs. Although consensus exists about the increase of IAPs over recent decades, the IAPs have never been mapped. Many respondents indicate that a map would provide much clarity to them. A third question that arises is how to control alien vegetation. The respondents raise the opportunity to use biological agents as a control mechanism. They have heard about biological control in other areas and want to know which possibilities exist for such control in the Kouga catchment. A fourth gap in experimental knowledge concerns secondary use of black wattle wood. Currently, nothing is done with the trees after they have been cut down. Local actors would like to know how they can make the practice of alien clearing economically viable. That is, they wonder how they can use the trees after cutting them down (also see figure 14).

6.5 Knowledge at different scales

Local, regional and provincial scale

Literature on SESs emphasizes the relevance of integrating knowledge from different scales (Berkes, 2009; Berkes et al., 2003; Olsson et al., 2007). The different interests of actors in the Langkloof and downstream water users make the issue of scale particularly interesting. Three distinctions in geographical scale can be made on the basis of emerging properties during the research. On a local scale, one can distinguish different subcatchments, each with its own water scheme and/or IB. On a larger regional scale, one can distinguish the Kouga catchment, as defined by the catchment boundaries. On a provincial scale one can notice a distinction between upstream water users within the Kouga catchment and downstream users in the Gamtoos Valley and Port Elizabeth, who are represented through policy actors. A combination of horizontal (within scales) and vertical ties (across scales) between actors is recommended for optimal integration of knowledge from different scales (Olsson et al., 2007). As described in earlier, communication on the local scale takes place between neighbours and/or members of the same water scheme or IB. On the regional scale, the FAs act as a forum for interaction between actors. However, not much communication takes place between actors on the local/regional scale and actors on the national scale.

Literature describes that transboundary problems arise when river sub-basins are the exclusive scale of analysis and management (Pahl-Wostl et al., 2007). This seems to be the case in the Kouga catchment, where local actors accentuate the differences between the different subcatchments and downstream water users. Berkes (2009) describes how differences between worldviews of local/regional actors on the one hand and actors on a larger scale on the other hand can cause friction, because problems and solutions are framed differently. In such cases, which are referred to as 'scale challenges', local actions, rules and routines can aggregate into large-scale problems (Cash et al., 2006). With regard to water management, a big difference across scales exists in the motivation to manage water resources in the Kouga catchment. On a local/regional scale, actors want to secure 'their' water resources to continue/expand their fruit farming activities and to leave a viable business to their successor, which is mostly a family member. On a provincial scale, policy actors are concerned about the water provision to the downstream users in the Gamtoos Valley and Port Elizabeth (DWAF, 2009a). As described earlier in this chapter, local/regional respondents frame the problem of water availability as a 'management problem'. They believe that there will be no water shortage if the right actions are taken (by the government). Actors on larger scales (provincial and national) frame the problem of water availability as an ecological problem and as an equity problem. That is, water is a scarce resource that needs to be accessible to all South African citizens (DWAF, 2012a). Here, the 'scale challenge' becomes strongly linked to politics. Not much interaction takes place between local/regional actors on the one side, and provincial/national actors on the other side. The respondents stress that government officials do not have the knowledge that is necessary to understand fruit farmers and the place-specific dynamics of the Kouga catchment SES.

'the government doesn't understand fruit farmers'

'negotiations with government are a waste of time: they ignore workable plans'

'they do not know enough of the matter'

Bridging organizations

Bridging/boundary organizations are suggested to play an intermediary role in addressing the 'scale challenge' by bringing together actors from different scales. These are organizations that specifically focus on this intermediary function (Adger et al., 2005; Olsson et al., 2007). A good example is the role that UnIEP plays in the upper catchment by bringing together local actors and government actors (see chapter 3). However, no other bridging organizations are currently active in the Kouga catchment. The role of the IBs comes closest to performing an intermediary function. The IBs form a link between the individual water users and the provincial departments of water affairs. According to the chairpersons of the IBs, this link is only there for pragmatic reasons: the IBs are legally obliged to pay water tariffs to DWAF. In the attempts to obtain flood relief money from the government, a bridging role is performed by the FAs, as described in the previous chapter.

From the stakeholder dialogue interviews, it becomes clear that the fruit farmers see the need for better communication with the government. They also indicate that a bridging organization could play an important role by taking away some of the tensions that exist between the fruit farmers and the government. The respondents recognize the value of a neutral intermediary to bring together all the actors. Such organization could also be of value for the purpose of IAP clearing. On a regional level, both the fruit farmers and the Kouga WfW programme are confronted with the challenge to eradicate IAPs. Although these actors are working in the same area, they both stress a lack of communication between the two of them. A WfW official states that *'there is no coordination between WfW and landowners about alien clearing'*. Knowledge/information is not transferred from WfW to the farmers and vice versa. The clearing strategy is not communicated to the farmers, so the farmers do not know what WfW is doing exactly. The farmers indicate a lack of information about priority areas for alien clearing. Furthermore, they would like to know where, and how much IAPs have been cleared by WfW.

Water User Association (WUA)

In recent years, there is a lot of unclearity about the formation of a WUA in the Langkloof. Water users are legally obliged to form WUAs that include all water users in a specific area (DWAF, 1998). The proposed role of WUAs is to create a community to pool financial and human resources in order to carry out more effectively water related activities (Perret, 2002). Most fruit farmers have heard that the government wants to establish a WUA that covers all the existing IBs and unofficial water schemes in the Langkloof. Such an institution would bridge the local and regional scales, as it brings together water users from several Kouga subcatchments in one organizational body. Furthermore, a WUA would provide a link with DWAF at the provincial scale. Nevertheless, no one really knows how the formation of a WUA is supposed to be unfolded and what is expected from them. During two meetings with all the IBs in the Langkloof, the IBs collectively decided that they were not in favour of one overarching WUA for the whole Langkloof because of the differences that exist between the different subcatchments and IBs (also see chapter 3). Now, several IBs and unofficial water schemes are setting up proposals to restructure towards a WUA (e.g. Krakeel water scheme, Haarlem IB). Until these proposals are approved by DWAF, the IBs will continue to operate. So far, no WUAs have been established in the Langkloof.

6.6 Conclusion

Complex issues (like water management) often manifest themselves at different scales and demand for integration of knowledge from different sources. Knowledge for dealing with ecosystem dynamics is dispersed among local, regional and national actors (Berkes, 2007). Horizontal as well as vertical linkages in social networks are required to bridge scales and bring together knowledge from different sources (Adger et al., 2005; Berkes, 2009; Hahn et al., 2006). Combining experimental (conventional scientific) ecological knowledge with experiental (personal local observations) knowledge is suggested to increase the capacity to learning, as it brings together actors that have different relative strengths in terms of knowledge and background (Berkes, 2007). Relationships between actors in the Kouga catchment are to a large extent framed by the ecological characteristics of the catchment and historical patterns of social interaction that have developed as a result of these ecological features. In this way, social-interaction determines to a large extent how fruit farmers (do not) combine different types of knowledge for learning.

On a local scale, strong horizontal ties have developed through family ties and longstanding cooperation between farmers in IBs and unofficial water schemes. These interactions can be seen as the result of social-ecological interaction, as social institutions have developed around the several Kouga tributary rivers, which are geographically demarcated from each other by mountain ridges. Relationships in IBs or water schemes can be characterized by a mutual dependency, because infrastructure is paid for and managed collectively. However, respondents mention other actors within the IBs as a ‘friend’ as well. Respondents recall that they often exchange knowledge with other members of the same water scheme. Experiential knowledge with regard to water management and IAPs has developed within the water schemes and is reinforced by the recent natural disasters. A consensus is present among the fruit farming community that the weather is becoming more variable and unpredictable. Furthermore, the aftermath of the floods and droughts has shown the farmers that they should not expect immediate help from government institutions. With regard to IAPs, experiential knowledge is present about species distribution and ecology.

FAs provide another forum for horizontal knowledge exchange. On a regional scale, the FAs act as forums interaction between (fruit) farmers. The FAs span the subcatchment boundaries and can be seen to bridge local (subcatchment) scales. All relevant emerging issues are discussed during general member meetings, which means that also water management and IAPs are discussed regularly, as they are of big influence on fruit farming in the Langkloof. With regard to water management and IAPs, the FAs are predominantly seen as a mechanism to combine forces and raise ‘the farmer’s voice’, in order to mobilize resources. In the process of obtaining disaster fund money, both FAs combined strengths for this purpose. The FAs act as bridging organizations with government institutions, but purely for pragmatic reasons.

Literature argues that the most effective solutions to complex issues emerge where collaboration facilitates strong actor-network development (Young, Borland, & Coghill, 2010). Vertical linkages between actors are important to include knowledge from scientists and policy actors, to bridge the local/regional and the provincial scale. Interaction between fruit farmers in the Langkloof and government is scarce, rather uncoordinated and characterized by mutual distrust. The fruit farmers indicate that the government is insufficiently informed about context-specific social-ecological dynamics in the Kouga catchment and criticise the government's top-down approach towards water and IAP management. Since the 1994 regime change, government investment in research and extension has increasingly focussed on emerging farmers, which has damaged the relationship with the white commercial farmers. who now have to keep themselves updated about new developments and techniques. Vertical linkages with private irrigation consultants are the main source of experimental knowledge. Especially knowledge with respect to water efficient irrigation practices is derived from such experts. Additional information of this kind is obtained from several agricultural magazines. Magazines also inform the fruit farmers on changes in rules and legislation. The use of internet as a source of knowledge is limited.

One can conclude that experiental knowledge flows within actor-networks in the Kouga catchment (FAs, IBs, families). On a local/regional scale, horizontal ties have developed that are important for knowledge exchange. Knowledge exchange across the provincial scale is limited. Experimental knowledge is almost solely derived from private consultants and to a lesser extent from agricultural magazines. A WUA, as suggested by the SA government, could act as a bridging organization to promote the integration of knowledge and to discuss the issues of water management and IAPs, which demand for an integrated approach. Until now, the farmers insist on the differences between the subcatchments and reckon it undesirable to unite the different IBs and water schemes in one overarching body. The limited interaction of fruit farmers with actors outside the local/regional scale runs the risk of lock-in situations as the result of path-dependency (Pahl-Wostl et al., 2007).

7. Nurturing diversity for reorganization and renewal

7.1 Introduction

This chapter deals with the nurturing of diversity for reorganization and renewal. Large ecological, social and economic diversity is seen as advantageous for resilience of SESs, especially in the phase of reorganization and renewal after disturbance (C. Folke et al., 2003).

7.2 Framing 'nurturing diversity for reorganization and renewal'

Berkes (2007) presents the idea of diversity as that it 'provides the seeds for new opportunities in the renewal cycle'. In his notion of diversity he includes social, economic and ecological diversity. Ecological diversity refers to the genetic, species and landscape levels of biodiversity. Economic diversity is about the range of economic options that is available. Social diversity is understood as the pool of relationships between actors in a network (Berkes, 2007).

Simply spoken, diversity spreads risks, creates buffers and increases options for response (C. Folke et al., 2003). In the process of reorganization and renewal (after disturbance), diversity plays an important role. Ecological (e.g. seed banks) and social memory become significant as a framework of accumulated experience that guides responses to change (C. Folke et al., 2003) and therefore affect the fruit farmers' capacity to manage for resilience. The absence of diversity is suggested to make SESs more susceptible to disturbance. E.g., the lack of ecological diversity will make simplified homogeneous landscapes more prone to opportunistic invasive organisms that may more easily shift between stability domains (C. Folke et al., 2003). Limited economic diversity reduces options to earn an income.

From an actor-network perspective, diversity should be understood as diversity in partnerships and social relations as a source for reorganization and renewal, as increasing the diversity of actors/actants has the potential of bringing new thinking. A combination of both horizontal and vertical ties in the actor-network is preferable. Bridging ties can play a role in bringing together different actors and knowledge. Weak ties in a network have shown to be promising for the arise of new ideas, for they connect actor and/or actor groups that do not communicate frequently (Borgatti et al., 2009; Davidson-Hunt, 2006; Granovetter, 1973; Prell et al., 2009).

7.3 Ecological diversity

Cape Floral Region

In terms of ecological diversity, there is a big difference between the Kouga catchment as a whole and the intensively cultivated Langkloof. The major part of the Kouga catchment (81%) is dominated by different forms of fynbos (Powell & Mander, 2009; Veerkamp, forthcoming). Fynbos is known for its species richness and high plant biodiversity (Cowling, Rundel, Lamont, Kalin Arroyo, & Arianoutsou, 1996). Furthermore, the fynbos biome is characterized by its high percentage of endism (UNESCO, 2012). The Cape Floristic Region, of which the Kouga catchment is part, has been prioritized for conservation as one of the 25 biodiversity hotspots worldwide (Myers, Mittermeier, Mittermeier, Da Fonseca, & Kents, 2000). It represents less than 0.5% of the area of Africa but is home to nearly 20% of the continent's flora (UNESCO, 2012). IAPs and agriculture are recognized as major threats to fynbos vegetation in SA (Cowling et al., 1996; Giliomee, 2003). In the Kouga catchment, fynbos occurs mostly in the mountains (Veerkamp, forthcoming), an area that is relatively undisturbed by human activities.

'I like this fynbos of ours'

Homogenized landscape

In the Langkloof valley, on the contrary, most of the land is under cultivation of deciduous fruits. In the Langkloof, ecological diversity is limited, especially when compared to the fynbos areas in the surrounding mountains. Large parts of the Langkloof consist of degraded landscapes (DWAF, 2009a). A history of farming has contributed to this property. Wheat and livestock farming have been practiced in the Kouga catchment since 1760. The 20th century has witnessed the upcoming of deciduous fruit farming (Van Huyssteen, 2008). Until 40 years ago, fruit farming was practiced in combination with sheep, cattle and wheat farming (Veerkamp, forthcoming). Now, a 100 year old tradition of command-and-control and optimalization of fruit production has resulted in a homogeneous landscape that is dominated by fruit orchards. The main deciduous fruits grown are apples and pears, but also peaches, plums, apricots and nectarines are produced. The wish to expand their agricultural activities is still present on the minds of some of the local fruit farmers.

'If I've got another two dams it would be nice because then I can expand a little bit more and I can maybe store water for drier times'

However, homogenization of landscapes leads to ecosystems that are more susceptible to disturbance (Scheffer, Carpenter, Foley, Folke, & Walker, 2001). It is suggested that simplified homogeneous landscapes are more prone to opportunistic invasive species (C. Folke et al., 2003). A study on large-scale intensive farming systems in the WC concludes that simplified agricultural landscapes (grapevines, fruit orchards and wheat fields) are more susceptible to currency values, consumer preferences, global market conditions, climate variation and uncontrollable pests. It provides a recent example of dropping export prices, which put apple farmers out of business. The research suggests that increased agrobiodiversity will enlarge the capacity to withstand such pressures, because 'not all eggs are put in one basket' (Giliomee, 2003). The study shows that simplified agricultural landscapes can have negative economic and ecological consequences. The results of the study support the notion of 'nurturing diversity for reorganization and renewal' (C. Folke et al., 2003). The 'Landbou Weekblad' article (figure 18) seems to confirm the results of the study in WC and shows that fruit farming in the Langkloof is susceptible to currency values, climate variation and uncontrollable pests (IAPs).

Invasive alien plants (IAPs)

IAPs are ubiquitous in the Kouga catchment (DWAF, 2009a) and form a threat towards biodiversity (DWAF, 2009a; Richardson & Van Wilgen, 2004; UNESCO, 2012). Farmers' accounts describe how IAPs have taken over indigenous fynbos vegetation during recent decades. One respondent tells that he had a fire on his farm, *'after which the wattle grew enormously'*. He explains that *'the fire heat initiates the seeds to grow out into plants'*. Especially after disturbances (e.g. fire) IAPs outcompete other vegetation in the early stages of biological succession. This leads to a loss of biodiversity. In general, disturbed or modified areas are more easily invaded than natural areas (Turpie & Heydenrych, 2000). Farming practices like ploughing, building dams and burning (mainly used in livestock farming) have disturbed the natural ecosystem, which has contributed to the spread of IAPs in the Kouga catchment (C.A.P.E., 2010). This has created an even more homogeneous landscape.

There is also a positive side to the presence of IAPs. For IAPs the positive sides include the provision of shade (for livestock) and their use as timber wood (especially black wattle). The farm labourers use the wood as building material (Baselmans, 2011). As a fuel source, it is used by the farm workers and in a recently started honeybush tea factory. The wood is usable to 'braai' (barbeque), which characterizes food culture in SA. One fruit farmer notes that black wattle is good for soil conditions, as it increases the amount of nitrogen and carbon in the soil. However, all these alternative uses are only drops in the ocean and cannot solve the problem of IAPs. Currently, people are looking for more alternative uses of IAPs, e.g. mulching (see chapter 4).

7.4 Economic diversity

Forms of economic diversity

Agrobiodiversity (diversification of crops) can also be seen as economic diversification, because a range of crops can function as a safety net for unexpected events (e.g. dropping export prices). It is one of the limited examples of economic diversification in the Langkloof. Fruit farming is the major economic driver and employs the majority of people in the Langkloof (Kou-Kamma Local Municipality, 2009). Furthermore, it supports related activities such as fruit processing, chemical manufacturers and distributors. Additional types of agriculture include livestock farming, vegetable farming, honeybush production and the production of essential oils. However, these forms of agriculture are far less represented in the Langkloof valley. Industry is limited to one fruit processing factory in Louterwater.

Decrease of farmers, increase of farm size

In the period 1994-2002, the number of commercial farms in SA dropped from 60,000 to 45,000 (Bernstein, 2012). The deregulation and liberalisation of SA agriculture has resulted in a more competitive market with 'winners' and 'losers'(Hall, 2004). In recent years, the Langkloof has also witnessed a sharp decrease of fruit farming enterprises. Small-scale businesses struggle to survive in the competitive economic environment and are bought by bigger organizations. The bigger enterprises grow bigger while small-scale farmers are obliged to sell their farm.

'After apartheid, some of the farmers have been able to reorganise and keep up, others have fallen away'

'There used to be much more farms, but small farms often are unviable'

'Fifteen years ago there were much more small farms. Now, all these farms have been bought up by bigger farms. Because it's not allowed to build dams, one strategy is to buy smaller farms to get more water rights'

In the EC part of the Langkloof, several big fruit farming enterprises are active (e.g. Dutoit, Souther Fruit Growers, Letabacop, Oudrif). These enterprises have bought multiple farms and do not have the same historical connectedness) with the region as do the family farms (see chapter 6). However, some of them are linked to national companies that do have more access to knowledge and resources, for example through their own Research and Development programmes. Oudrif, for example, is linked to ZZ2, a bigger operating national company which owns laboratories at the

University of Limpopo, where scientists are doing research on fruit farming. Some respondents take the bigger companies as an example for their own practices: *'I look at the Dutoits to see what they're doing. They know better'*.

Risk of unemployment

> *'The community in the Langkloof is reliant on the farms. If your farming is suffering and there's no money, in the end the community is going to suffer'*
>
> *'The fruit farmers are the biggest employers in the area and if they have to scale down, it is bad news for the whole area'* (DA, 2011)

These quotes from local farmers illustrate that the Langkloof is dependent on fruit farming and limited economic alternatives are available at this point. Kou Kamma Local Municipality recognises in its Local Economic Development Strategy that 'there is a high dependency on one sector which means that other sectors should be developed to diversify employment options in Kou-Kamma' (Kou-Kamma Local Municipality, 2009). Although the fruit farmers in the Langkloof have recently experienced some though years, they say that they try to keep all their permanent workers employed: *'I have to find ways to cut costs without cutting on my labour'*. Figure 19 shows how employment numbers are threatened by the recent natural disasters.

Langkloof fruit disaster will leave thousands unemployed

More than 70 000 rural dwellers and businesses in the Little Karoo are facing disaster because damage caused by the devastating 2007 floods has not yet been repaired. Farmers of Herold, Bo-Kammanassie, Noll, Haarlem, Avontuur, Langkloof, Uniondale, Rooirivier, Barandas and other parts of the district have been waiting for more than three years for government assistance to repair damage in excess of R180 million to storage dams, canals, pipe-lines and river-banks.

Despite the very welcome, widespread rains starting on Sunday, the internationally renowned deciduous fruit industry hovers on the brink of collapse. The industry contributes approximately R800 million annually to the national economy, while about 70% of the kloof's income is derived from fruit.

Figure 19. Part of an article that describes the relationship between fruit farming and employment rates. (Oudshoorn Info, 2010)

7.5 Social diversity: emerging farmers

Non-white fruit farmers

As stated earlier, commercial fruit farming in the Kouga catchment is mostly a white-man's business. However, since the abandonment of apartheid, several emerging farmers have started a fruit farming business in the Langkloof. Their goal is to become commercial farmers, with the help of the government.

'I had difficulties to get started after my mentor left. My labourers didn't trust me because I was a non-white manager. Some people's minds became stuck in apartheid….Now, the farm is going from success to success, with the assistance of the Department of Rural Development'

This quote comes from a relatively successful emerging farmer. The first part of the quote illustrates how racial prejudice became institutionalized in people's minds, even if they are from the same 'race'. The last part of this emerging farmer's quote marks an important difference with the white commercial farmers. While the commercial fruit farmers mention a difficult working relationship with the government, the opposite is true for emerging farmers. Since the 1994 regime change, government agricultural assistance programs have shifted focus from commercial farmers to emerging farmers. An emerging farmer notes that *'I developed a relationship with the governmental departments. The other farmers don't have access to these government functions'*. In general, the emerging farmers are more dependent on government assistance as well.

Many emerging farmers' initiatives are struggling to survive. The regional extension officer of the department of Rural Development & Land reform estimates that there are about 80 emerging farming projects (all types of farming) in the Kouga catchment 'in file', but *'most of them collapsed already or are at the point of collapsing'*. He states that there are about twenty projects that are *'more or less successful'*.

A self-proclaimed 'struggling' emerging farmer explains about the problems he faces: *'The land that most emerging farmers work is not the best land. It is often land that is bought by government after commercial farmers went bankrupt. The land isn't good in the first place, because it's old and non-commercial'*. Furthermore, he states that it is difficult to farm fruit for emerging farmers, because it is a capital-intensive form of farming and there is a high risk because of extreme weather events that can destroy the harvest. Therefore, he partly shifted to farming vegetables: *'the chances of success are bigger with vegetables, because you can alternate between different vegetables, and you are less dependent on the weather than can destroy the whole harvest, as in fruit farming'*.

Emerging farmers' self-organization

There is not a lot of interaction between the emerging farmers and the commercial farmers. During two meetings of the Langkloof FA, only two non-white farmers were present on the first meeting (out of a total of 46 participants), while none joined the second. Several initiatives are present in which emerging farmers work together, such as the Kou Kamma Emerging Farmer Forum (KKEFF) and the Langkloof Emerging Farmers Cooperative initiative (LEFCO).

The KKEFF was established in 2009 to represent the interests of emerging farmers towards the relevant government institutions, such as Kou Kamma Local Municipality, the department of agriculture and the department of rural development & land reform. In that sense, the role of the KKEFF can be compared to the role of the FAs.

The LEFCO initiative started as an initiative for emerging farmers in which members of the cooperative work co-operatively to uplift their farming and marketing practices. LEFCO's mission is to generate income for their co-op members and provide employment opportunities for residents in their rural community by producing high quality fruits and vegetables for sell to the export and local markets (LEFCO, 2004). It is managed by an elected steering committee, which manages five farms. According to the chairperson of the cooperative, the initiative failed because of *'a culture of not working together'*. Currently, the department of Agriculture wants to revitalise the LEFCO initiative.

Although both the KKEFF and the LEFCO particularly address emerging farmers, not all of emerging farmers are positive about these forms of self-organization. Some of them, particularly the more successful farmers, indicate that they think that the initiatives are not working out and feel more connected to the white commercial farmers. They are not member of either KKEFF or LEFCO. Furthermore, disagreements within LEFCO have shown to be problematic for proper functioning.

7.6 Conclusion

The Langkloof is highly dependent on the deciduous fruit farming. A long tradition of command-and-control has created a homogenized landscape in the Langkloof Valley that is organized around fruit farming. This creates economic and social risks, because many people are economically dependent on the success/failure of the fruit farms. If the fruit farming economy is struggling, the whole Langkloof risks rising unemployment numbers and social deterioration. Recent decades have shown that small-scale fruit farms have been bought up by bigger enterprises and that the area under orchards has expanded. In other words, diversity has decreased because fewer farmers cultivate more land. On the other hand, bigger national enterprises have bought farms in the Langkloof and bring in knowledge and expertise. Furthermore, emerging farmers have entered the fruit farming business. However, interaction between the commercial fruit farmers and the emerging farmers is limited and does therefore not contribute to knowledge exchange. The limited economic diversity also has implications for the ecological diversity. (Fruit) farming practices such as ploughing, burning and building dams has reduced the ecological diversity and provide an opportunity for IAPs to establish, spread and replace the original fynbos vegetation, which has a negative impact on water availability.

8. Discussion

8.1 Thoughts on theory

Holism, actors and agency in social-ecological systems

One of the central assumptions in SES theory is that systems have the capacity to adapt as a whole (Nelson et al., 2007). In other words, a system adapts in the way humans adapt to their environment. Here, adaptation is seen as a property of the system that results from the interaction between system components. Proponents of actor-centred approaches criticise such system approaches for being under-socialized because of neglecting human agency and well-being. They state that ''the pursuit of well-being, and what people perceive as a desirable way of life, is a major determinant of what people do and the decisions they make (Gough and McGregor 2007, McGregor 2009). As such, he pursuit of well-being has the power to facilitate, but also to restrict, adaptation at the local level, and can shape the overall resilience of the SES'' (Coulthard, 2012). In this study, the fruit farmers are seen as part of the Kouga catchment SES and are deemed to be able to influence the systems' organization, functioning and outcomes. This actor-in-system view respects the ideas of systems thinking without rejecting individual actors' agency. The gathered data are used to analyse how fruit farmers in the Kouga catchment manage for social-ecological resilience with regard to water management. The term ''managing for resilience'', which is used for this research, suggests active, conscious decision making by the actors involved. In this way, the research builds a bridge between system orientated approaches and actor-orientated approaches. A system, when seen in this way, is the product of individuals that manipulate components of the SES on the basis of their knowledge and goals (Nelson et al., 2007).

In this thesis, the Kouga catchment is seen as a SES. A SES perspective should, when used in a proper way, provide a 'helicopter view' of a particular system, and the interactions between components of the system under study. The strengths of a system perspective include a high degree of openness and flexibility to provide a broad-based analysis. This answers to a much heard critique on conventional ecosystem management approaches, namely that they have a reductionist view on ecosystem management (McClure, 2010; Pretty & Ward, 2001; Schultz et al., 2007). The downside of this holistic view in SES is that research runs the risk of becoming a 'study of everything' and that it may be too broad to build strong theory. This study tries to avoid this trap by focussing on a specific set of actors (the fruit farmers) and a specific theme (water management) within the Kouga catchment SES. As a result of this specific focus, certain components of the SES become more important for this research, while other components are less relevant. Despite the holistic view of a SES perspective, the focus on water management means that some characteristics of the SES are under-examined or excluded from analysis (e.g. the high rates of unemployment and alcoholism in the study-area). This does not imply that these issues are not important. A significant relation with water management, however, is not found in this research.

Factors Folke et al. (2003) as a guideline for description

This study shows that the concept of SESs is particularly useful for the description of the dynamics in the Kouga catchment and to support this with background information. In this thesis, the four factors of Folke et al. (2003) are used as a framework to present data, and to organize the thesis. The holistic nature of SESs can create difficulties during writing. For example, in making choices what (not) to include in the analysis. The four factors of Folke et al. (2003) create order in the complexity by providing a 'guideline' for description. The factors are theoretically constructed by integrating results from numerous case-studies on resilience (Asah, 2008), and can therefore be used as a point of departure in the researcher's search for ways in which actors (in this case the fruit farmers) manage for social-ecological resilience. On the other hand, this guideline is relatively loose and the factors still leave a lot of room for manoeuvre for the researcher: some obtained data are related to more than one factor and can be presented under different 'headings'. The four factors should therefore not be seen as a mere categorization, but rather as interacting tools for description and analysis. It is up to the researcher to find the best way to prioritise and present his/her data. Figure 20 summarizes the main results that have been found by using the four Factors of Folke et al. (2003).

Four factors of Folke et al. (2003) in the Kouga catchment social-ecological system	
Learning to live with change and uncertainty	Fruit farmers recognise uncertainty (e.g. extreme weather events, changing legislation, impact IAPs, downstream water demands, government assistance) and act upon it (e.g. water efficient irrigation practices, clearing of IAPs, Haarlem task-team).
Nurturing diversity for reorganization and renewal	A long tradition of command-and-control has created a homogeneous landscape in the Langkloof Valley, that is organized around fruit farming. This creates economic and social risks, because many people are economically dependent on the success of the fruit farms.
Combining different types of knowledge for learning	On local/regional scale, experiential knowledge flows within actor-networks in the Kouga catchment, where strong horizontal relationships have evolved (FAs, IBs, families). Knowledge exchange with actors outside the catchment is limited. Experimental knowledge about water management is mainly derived from private irrigation consultants. Fruit farmers' communication with government institutions is problematic and characterized by mutual distrust.
Creating opportunities for self-organization	Fruit farmers' water management is organized on subcatchment level, around the Kouga tributary rivers (water schemes / IBs). Fruit farmers stress the unique characteristics of 'their' subcatchment and emphasize the differences with other IBs and water schemes. On a regional scale, two FAs act as mouthpieces of the farmers to represent their interests.

Figure 20. Summary of results four factors Folke et al. (2003) in the Kouga catchment

Social-ecological resilience in the Kouga catchment

Resilience is the 'capacity of a system to absorb disturbance and re-organize while undergoing change so as to still retain essentially the same structure, identity and feedbacks' (B. Walker et al., 2004). Fruit farming is the most obvious characteristic of the Kouga catchment (and the Langkloof in specific) and it gives the region its identity. Moreover, it is the main economic activity and employs the majority of people in the Langkloof. For the Kouga catchment, the definition of resilience can therefore be rephrased into 'the capacity of the Kouga catchment SES to absorb disturbance and reorganize while undergoing change so as to still remain a viable fruit farming area'. The adaptive cycle (Gunderson & Holling, 2002) provides a resilience lens to analyse fruit farmers' water management practices.

The front loop of the adaptive cycle (r and K phases) can be used to describe the development of fruit farming and water management practices over time. Since the first fruit farming activities started in the Langkloof in the early 20th century, the area experienced gradual growth of production and expansion of fruit orchards (exploitation phase (r)). This development was supported legally and financially by the apartheid government, which created favourable conditions for white commercial farmers to optimise agricultural production in SA. As a result, legal access to water was practically unlimited for the fruit farmers in that time (Perret, 2002). In a tradition of command-and-control, and with state subsidies, the farmers built networks of infrastructure around the different Kouga tributary rivers, to manage the water resources that originate from the Tsitsikamma mountains. The infrastructure of these water schemes increased water holding capacity and enabled irrigation of increasing areas of fruit orchards. During the years of apartheid, the fruit farming industry in the Langkloof grew steadily and pressure on water resources built up. Over time, rules and routines developed in the different water schemes and the farmers became dependent of the collectively managed infrastructure (conservation phase (K)). Due to the success of the fruit farming industry, the area became more dependent on this industry in general, and the associated rules and routines in water management. Literature argues that ‘as the K-phase continues, resources become increasingly locked up and the system becomes progressively less flexible and responsive to external shocks’ (B. Walker et al., 2004). With some imagination, a comparison can be made with the statue building on Easter Island (see chapter 1.1), where increasing amounts of statues were erected until the timber resource was depleted and the society collapsed (Pointing, 2007). In the Kouga catchment, the SES is not at all collapsing. However, a number of social-ecological disturbances have recently impacted on fruit farmers’ water management practices. These disturbances, and the fruit farmers’ responses, can be described with the backloop of the adaptive cycle, consisting of the release (Ω) and reorganization (α) phase.

The period of growth and expansion of fruit farming in the Langkloof was slowed down with the abandonment of apartheid. No longer were the white commercial farmers priviliged by government. In the new legal context, all South African citizens received equal rights and access to water. This, in combination with population growth and urbanization/industrialization increased the pressure on the already scarce water resources of SA. New laws and regulations were implemented to limit farmers’ water use. In the Langkloof, farmers were no longer allowed to build any new dams on their farms. Other disturbances that can be identified in the Kouga catchment include a series of extreme weather events (floods, droughts, hail) in the years 2006-2010 that have caused large-scale infrastructural and financial damage to the fruit farmers. Lastly, IAPs have expanded enormously over the last few decades and have a negative impact on water resources. Furthermore, they cause damage to irrigation infrastructure, especially in times of floods.

The fruit farmers’ responses to these social-ecological disturbances are twofold. On the farm-level, they are increasingly applying water efficient practices to save water such as localized irrigation systems (micro/drip), more efficient irrigation period planning and mulching. They are constantly looking for innovative ways to limit water use. On an institution level, on the other hand, the fruit farmers are less innovative. The fruit farmers insist on the existing forms of social organization for water management: the IBs and unofficial water schemes. The development of these institutions has created mutual dependency between water users in the same water scheme, and significant differences between the different water schemes. Literature on water management suggests that the co-evolution of water users and collectively managed infrastructure, characterised by mutual dependency, runs the danger of developing into pathological path-dependency and 'lock-in situations that block changes towards new resource management schemes (Herrfahrdt-Pähle & Pahl-Wostl, 2012; Pahl-Wostl et al., 2007). This seems to be the case in the Langkloof, where the fruit farmers insist on 'conserving' the existing social structures and irrigation infrastructure. This emphasis on the front-loop of the adaptive cycle is consistent with conventional views on ecosystem management. That is, controlling the ecosystem to keep it in a desired state (Gunderson & Holling, 2002). Literature suggests that repairing the systems to what they were before is seldom a sustainable strategy and runs the risk of increasing system vulnerability (Herrfahrdt-Pähle & Pahl-Wostl, 2012; Holling & Meffe, 1996). An exception from the attitude to 'conserve' is the fruit farmers' cooperation with other actors in the upper catchment (around Haarlem). The task-teams that are formed in response to extreme weather events can be seen as an innovative way to deal with social-ecological dynamics. Such management actions are more in line with the back-loop of the adaptive cycle: reorganization. The formation of WUAs can also be seen as reorganization. Figure 21 depicts the dynamics of the Kouga catchment SES in terms of the adaptive cycle.

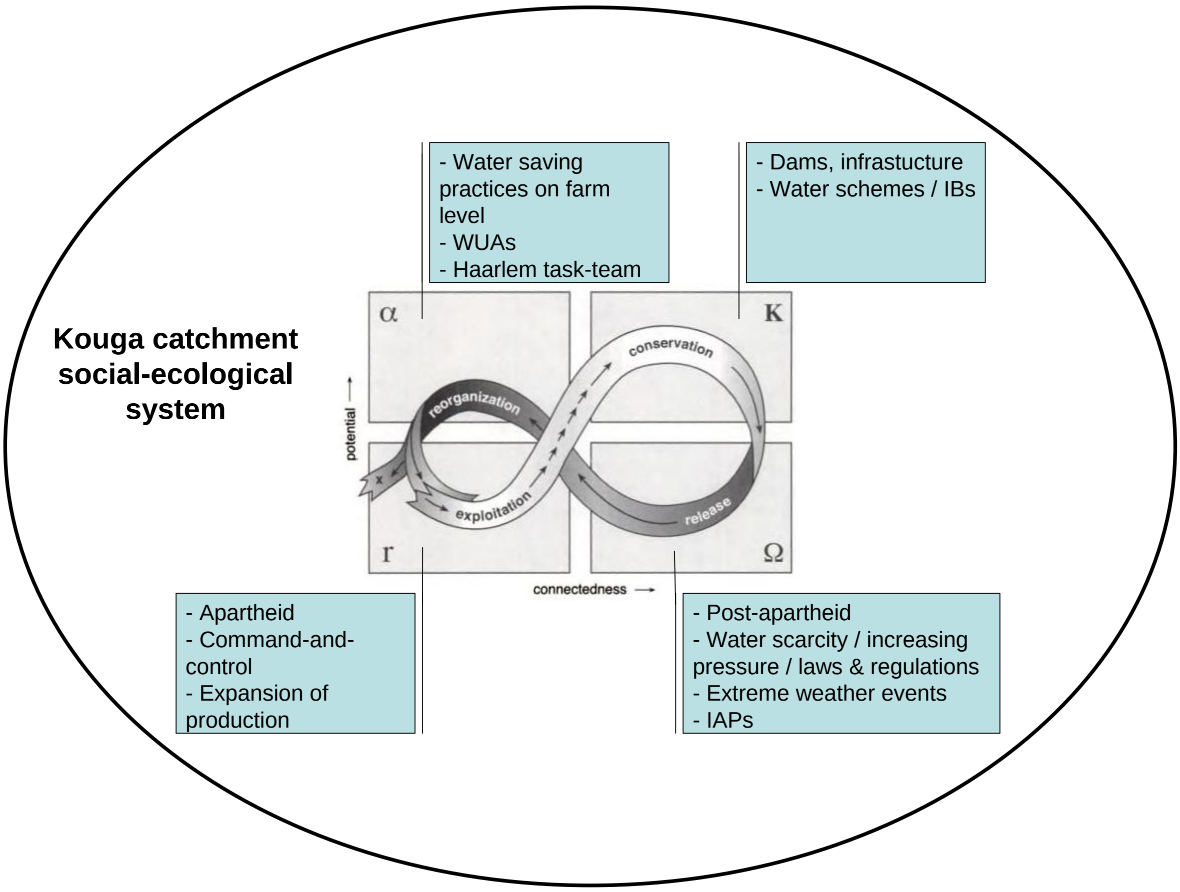

Figure 21. Dynamics in the Kouga catchment SES and fruit farmers' water management practices in terms of conservation (r and K phase) and re-organization (Ω and α phase).

The Kouga catchment as a social-ecological system: scale and boundaries

The definition of a system states that it is 'an assemblage of objects united by some form of regular interaction or interdependence' (Mele et al., 2010). On the basis of the data from this research, the question can be raised whether the Kouga catchment can be seen as a system at all. On the basis of ecological and economic data, one can agree that it can indeed be seen to function as one system. Ecologically, the Kouga catchment forms a coherent system which is demarcated from neighbouring ecological systems on the basis of watersheds: all the water from the Kouga catchment eventually ends up in the Kouga dam. Economically, the catchment is organized around fruit farming, being the main economic driver of the region.

The analysis of the Kouga catchment as a system can be taken in doubt on the basis of social and political organization. In most other studies on river catchments, the upstream-downstream competition for water is stressed: downstream water users are dependent on upstream (farming) activities and water management on catchment scale is recommended (McCartney, Lankford, & Mahoo, 2007; Stein, Ernstson, & Barron, 2011). Within the Kouga catchment, the situation is different. The water users in the Langkloof only extract water from the tributary rivers and are not connected by the main river channel. In other words, what happens upstream does not directly affect the downstream fruit farmers. This characteristic of the Kouga catchment SES is reflected in its (social) organization. On the basis of (social) organization, the catchment can be divided in a number of subsystems. These subsystems become visible through self-organization on subcatchment scale: separate water schemes for irrigation have established and developed around the Kouga tributary rivers in each subcatchment. Longstanding relationships and rules and routines have developed between water users in the same subcatchment. The water schemes are characterized by divergent development, which has created mutual dependency of water users within water schemes and significant differences between the different water schemes. With regard to water management, the historical development of water schemes plays an important role in the management decisions that the fruit farmers make. For example, the fruit farmers use the 'insurmountable differences' between the different water schemes as an argument against a WUA that covers the whole Langkloof. Other studies on catchment management have found similar results and suggest that the formation of WUAs should build on existing social structures (Stein et al., 2011). Although no upstream-downstream competition is present within the Kouga catchment, the upstream-downstream competition for water becomes apparent at a larger scale. Water demands of downstream water users in the Gamtoos Valley and NMBMM (Port Elizabeth) increase the pressure on water resources in the Kouga catchment.

The Kouga catchment SES cannot only be divided in several subsystems on the basis of subcatchments. The system is also divided by the EC/WC provincial boundary that artificially splits the Kouga catchment in two separate administrative units, forcing the fruit farmers on different sides of the provincial boundary to operate in separate legal and political contexts. Again, social organization reflects this system characteristic: the LFA and Agri-Avontuur FA are active in the EC and WC respectively.

A SES perspective, including a scale component, has shown to be useful to visualise scale dynamics in the Kouga catchment and to show how these dynamics influence fruit farmers' water management decisions. Literature on resilience recognizes the importance of scale-dynamics (C. Folke et al., 2005; Olsson et al., 2007), system boundaries (Pahl-Wostl et al., 2007) and puts emphasis on so-called problems of fit: mismatches between scales (Cumming et al., 2006; Olsson et al., 2007). Scale mismatches occur when the scale of environmental variation and the scale of social organization in which the responsibility for management resides are aligned in such a way that one or more functions of the social-ecological system are disrupted, inefficiencies occur, and/or important components of the system are lost (Cumming et al., 2006). It is suggested that scale mismatches between ecological processes and the institutions that are responsible for managing them can contribute to a decrease in social-ecological resilience (Cumming et al., 2006).The notion of scale has shown to be important in this case-study of the Kouga catchment.

Cummings et al. (2006) suggest that social-ecological mismatches inevitably lead to problems in either the social institutions that are responsible for management or the ecological systems that are being managed. They state that fine-scale social organization cannot provide solutions for large-scale ecological problems (figure 22). It seems that this is the case in the Kouga catchment, for example with regard to IAP clearing. Problems such as the clearing of IAPs demand for a coordinated approach on catchment scale. However, the mismatch between ecological processes and social organization seems to create problems of accountability that hinder a coordinated strategy. Any adaptation which enhances a specific optimisation process of an individual subsystem at a particular scale could fail to enhance the resilience of the whole system (Rammel et al., 2007). The farmers, who are the main managers of water within the Kouga catchment, do not feel responsible for what is happening in the subcatchments that are not their own. Their main concern is what is happening in 'their own' subcatchment. At this point, it seems that problems do not arise in the institutions that are responsible for management (e.g. IBs). Rather, the problem arises in the ecological system that is being managed because management is uncoordinated on a catchment scale. This corresponds to the fruit farmers' view that 'there is enough water under normal circumstances' and that water scarcity is a 'management problem'.

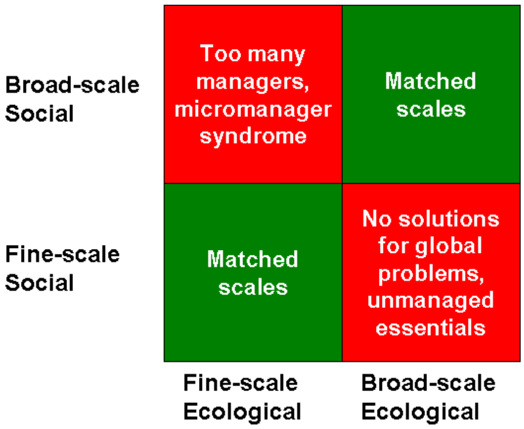

Figure 22. Mismatches in social-ecological systems (Cumming et al., 2006).

A recent addition to resilience theory brings together the notion of scale with the conceptual framework of the adaptive cycle: the panarchical perspective. Panarchies are adaptive cycles that interact across multiple scales (B. Walker et al., 2006). Theoretically, panarchy literature assumes that SESs form nested sets of adaptive cycles. Resilience of a SES at a particular focal scale ''depends on the influences from states and dynamics at scales above and below'' (B. Walker et al., 2006). In this research, a choice is made to focus on scales that can be directly influenced by fruit farmers' water management practices. A panarchical view therefore goes beyond the scope of this research. Nonetheless, it could provide additional insight on (for example) the influences of national scale politics and water policies (after the abandonment of apartheid in SA) on resilience within the Kouga catchment.

The promise of Actor Network Theory

As described above, the SES perspective contributes by providing a 'helicopter view' and allows for description of the Kouga catchment as a system. It uncovers the arena in which the fruit farmers can move/act to manage for social-ecological resilience. However, this perspective in itself has little explanatory value. An article by Folke (2006) provides a clue on how to explain processes in SESs. The article states that 'a complex adaptive system consists of heterogeneous collections of individual actors that interact locally, and evolve in their genetics, behaviours, or spatial distribution based on the outcome of these interactions' (Carl Folke, 2006). In other words, explanations are to be found in the interactions between actors, and the outcomes of these interactions. This view is supported by other literature on NRM and ecosystem management, which calls for analysis of (social) networks (Bodin, Crona, & Ernstson, 2005; Davidson-Hunt, 2006; Janssen et al., 2006; Prell et al., 2009).

A network perspective can add explanatory value to the SES perspective. Empirical evidence from this study suggests that a Social Network Analysis (with a sole focus on social actors, that is, human beings) will not be sufficient to explain the dynamics in the Kouga catchment. It is found that, besides social actors, non-human entities play an important role in the fruit farmers' networks. Especially the role of ecological features of the landscape (tributary rivers, subcatchments) and the role of irrigation infrastructure (dams, pipelines, etc.) in the fruit farmers' networks cannot be neglected, because they play a major role in the management decisions that the fruit farmers make. Actor Network Theory (ANT) offers an analytic lens that recognises both human and non-human entities as actors that have agency (Law, 1992). ANT is used to describe the process in which 'heterogeneous elements' are woven together and assembled into reality (Young et al., 2010).

Theoretically, the combined perspectives of SES and ANT can be defended. The position of ANT, which analyses human and non-human entities in the same conceptual and terminological framework (Law, 1992) is alligneable with the position of authors of SESs, who claim that the delineation between social and natural systems is artificial and arbitrary (Berkes et al., 2003). Furthermore, ANT accounts for uncertainty and surprise, as it recognizes emerging properties, which change actor-networks and consequently change outcomes of actor-networks (Steins, 2001).

This research tries to uncover how fruit farmers manage for social-ecological resilience. With ANT, (water) management practices can be analyzed as network effects/outcomes. An ANT analysis can explicate the process (interaction between heterogeneous actors) that leads to these effects/outcomes, because the object of ANT analysis is the process of and tactics of translation: through which mechanisms or intermediaries do interactions between actors in a network lead to outcomes? The descriptive strength of SESs provides a large body of background information to explain dynamics of interaction between actors. That is, it enables to uncover relevant actors in ecosystem management that potentially shape/change actor-networks. It informs the researcher about the inclusion/exclusion issue: which actors (not) to include in the research (McLean & Hassard, 2004). ANT could complement SES studies by explicating how actors express agency.

This study shows that the ecological features of the landscape (subcatchments/tributary rivers) shape the formation of actor-networks (IBs and informal water schemes) around collectively managed irrigation systems. Such outcomes change the SES (e.g. a dam is placed in the tributary river and actors are connected through pipelines). This changes the relationships between actors (e.g. the water users in the same IB are collectively responsible for the maintenance of infrastructure and have therefore become mutually dependent). This new 'state' of the SES again frames interactions among actors and the process of translation (e.g. actors in IBs are reluctant to cooperate in a bigger WUA, because of differences between IBs). This example describes a feedback mechanism. A fruit farmer states that *'the dam is here because of the Irrigation Board, and the Irrigation board is here because of the dam'*. Therefore, it can be argued that the fruit farmers' practices (outcomes of interactions) can be seen as new emerging properties (actors) in the SES that in their turn can influence the process of translation (figure 23),

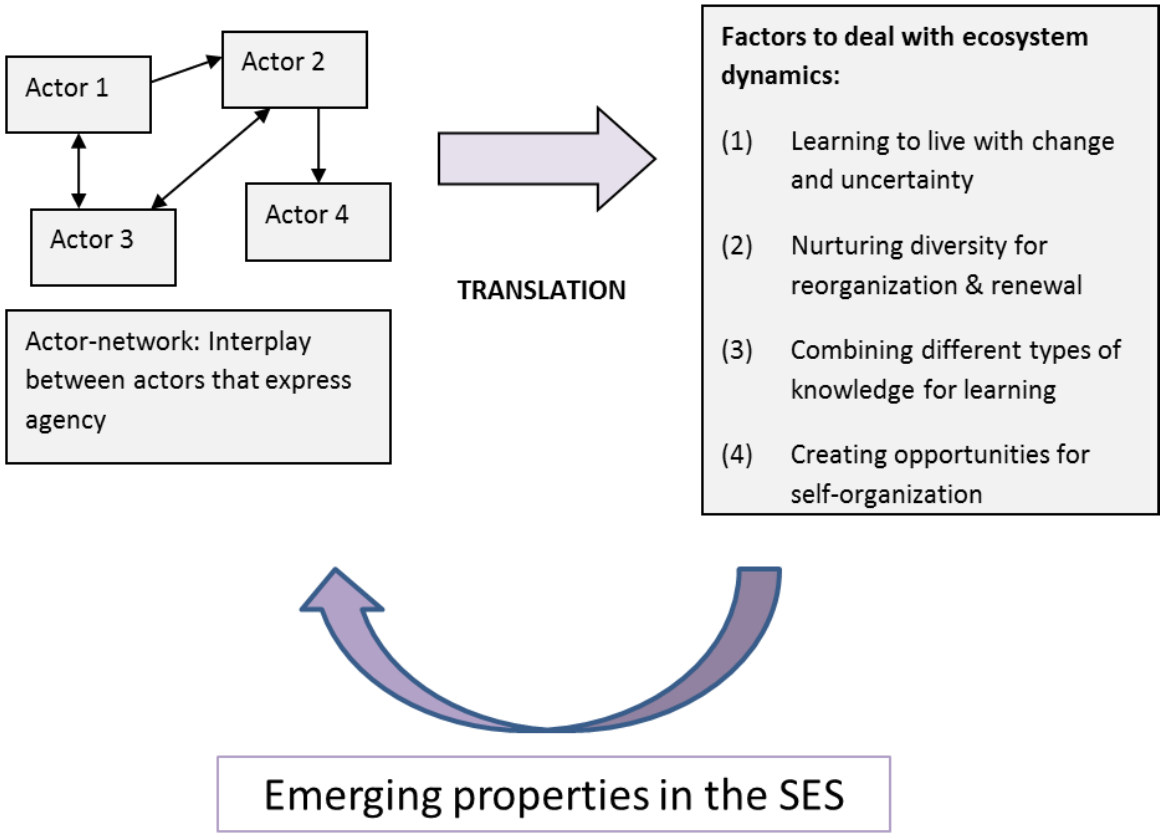

Figure 23. Actor-networks and translation in social-ecological systems.

8.2 Limitations to the research

- Broad spectrum. System perspectives take a 'helicopter view' and recognizes the importance of dynamics/interactions between components of the system (Mele et al., 2010). This creates problems to perform in-depth analyses on specific issues within the system. This research focuses specifically on fruit farmers' water management. Nevertheless, the scope of the study is still very broad. Although this constrains in-depth analysis, it is valuable in the initial stages of the Living Lands project 'Mobilizing civil society to support living landscapes in the Kouga catchment' because it provides essential basic information of the Kouga catchment SES. Such information will hopefully inspire/inform follow-up research.

- Lack of explanatory power. As explained above, the descriptive power of a system perspective goes hand in hand with a lack of explanatory power. An ANT perspective is suggested to add explanatory value to a SES perspective, as it focuses on uncovering how interactions between actors in a system lead to outcomes (Law, 1992).

- Focus on fruit farmers. White commercial fruit farmers are the biggest landowners in the Langkloof. With the objective to contribute to the formation of 'living landscapes', a choice was made to focus on fruit farmers. Although fruit farmers own most of the land, they are only a small minority compared to the total amount of inhabitants of the Kouga catchment. One could criticize this research for being undemocratic, because of its' focus on relatively powerful actors in the SES. Especially in the context of SA, where apartheid is still well-alive in the memory of the people. The readers of this thesis should keep in mind that the results of this research are mostly based on interviews with white commercial farmers.

9. Conclusion

Managing for resilience in the Kouga catchment

The fruit farmers of the Kouga catchment SES are operating in a rapidly changing environment. Especially the management of water resources has become a major challenge in the light of national water scarcity of SA. Fruit farmers' water management practices in the Kouga catchment are framed by a changing legal environment (post-apartheid), increasing downstream water demands, increasing prices of water and electricity, unpredictable extreme weather events and the presence of high water consuming IAPs. Resilience is 'the capacity to absorb disturbance and re-organize while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks'. Managing for social-ecological resilience enhances the likelihood of sustaining desirable pathways for development in changing environments where the future is unpredictable and surprise is likely (B. Walker et al., 2004). In the case of the Langkloof, this means keeping the area viable for fruit farming, which is the main economic activity in the area and employs the majority of people.

The fruit farmers recognise the challenges that are mentioned above and realise that they have to adapt their practices in order to keep their farms economically viable. Resilience theory argues that this can be achieved by conservation (front loop adaptive cycle) and/or re-organization (back-loop adaptive cycle) in the face of change (Gunderson & Holling, 2002). Here, the fruit farmers are in a bilaterate, Janus-like position. On individual farm level, the farmers are re-organizing in terms of irrigation management and water conserving practices. On institutional level, on the other hand, the focus is on conservation.

Reorganization on farm level

Drought experiences and financial pressures (increasing prices of water and electricity) have moved farmers to shift towards more efficient, localized irrigation systems such as drip and micro irrigation. Almost 100% of commercial fruit orchards is now under localized irrigation. In addition, irrigation scheduling is done in such a way that the water is used most efficient (e.g. irrigation during night, short irrigation cycles, no irrigation during strong winds). Through their interaction with irrigation consultants and by reading magazines, the fruit farmers are constantly exposed to the newest techniques to improve their practices. Mulching is currently practiced on a small scale, but the farmers are interested in ways to make mulching economically interesting. In general, they are looking for ways to make the clearing of IAPs economically rewarding. In response to flood experiences, the farmers clear their lands (especially around water infrastructure) of IAPs themselves. This is mainly to prevent infrastructural damage after floods and to save water.

Conservation on institutional level

On an institutional level, focus is on conservation. The main institutions, the IBs and FAs, are mainly concerned with conserving and restoring the fruit farming industry in the Langkloof. In terms of water management, this means protecting, sustaining and repairing the extensive irrigation works that cover the area. Water management in the Kouga catchment is to a large extent framed by the ecological characteristics of the catchment and historical patters of social interaction that have developed as a result of these ecological features. This development pattern has created path-dependency that blocks change. On an institutional level, fruit farmers' water management is characterized by conservation of old rules and routines that have developed in the different water schemes (IBs). Strong (working) relationships have developed between actors in the same water scheme. In terms of water management, fruit farmers are orientated towards conserving the collectively managed water infrastructure in 'their' subcatchment. This vision conflicts with management operations on catchment scale, such as the WfW programme. With some exceptions, the fruit farmers reject the idea of an overarching WUA to manage the water resources in the Kouga catchment on a larger scale. Institutional changes are made difficult by the problematic relationship of the fruit farmers with government bodies, which blocks successful cooperation between both actors. The role of UnIEP in the upper catchment shows that a bridging organization can play a major role in overcoming such problems. FAs represent a form of self-organization that crosses subcatchment boundaries. However, the FAs are predominantly seen as a mechanism to combine forces and 'raise the farmer's voice' in order to mobilize resources (e.g. disaster funds to repair infrastructure, IAP clearing). Again, focus is put on conserving conventional fruit farming: bringing back the system to a desired state.

A shift towards re-organization and renewal

The recent disturbances of the SES have uncovered the vulnerability of the Langkloof as a fruit farming area. However, the wish to expand business is still present among some of the farmers. The fruit farmers have one clear solution to manage for resilience and to increase water security: more water storage capacity. This vision corresponds to conventional 'command-and-control' views of ecosystem management and a comparison can be made with the story of Easter Island (chapter 1.1). However, in the current political situation, it is highly unlikely that they will be allowed to increase water storage capacity. Therefore, the fruit farmers should shift their minds from a focus on conservation to a focus re-organization. On farm level, many practices have been introduced to manage for social-ecological resilience. On an institutional level, however, there is still a lot to gain. A bridging organization could play an important role in bringing together all the actors that are involved in water management in the Kouga catchment.

10. Recommendations

10.1 Recommendations for further research

- Include full range of actors. This research aims to contribute to the creation of 'living landscapes', as part of the Living Lands project 'mobilizing civil society to support living landscapes in the Kouga catchment' (Living Lands, 2012). For that reason, focus is put on the biggest landowners in the catchment: commercial fruit farmers. In terms of landowners, the research overlooks other farmers (e.g. sheep, cattle, vegetables). Furthermore, the research has a strong focus on white commercial farmers (although four emerging farmers were interviewed as well). The data suggest that the situation of emerging farmers significantly differs from white commercial farmers (e.g. more interaction with government). The focus on landowners also excludes people who do not own any land, which is the vast majority of inhabitants of the Kouga catchment. Most of them work as agricultural labourers. In fact, they are the ones that implement most farming practices 'on the ground'. Their voice is not heard in this research. To provide a full picture of the Kouga catchment as a social-ecological system, a more detailed understanding of all system components (all actors) is necessary. An ANT analysis, as suggested in chapter 8.2, could be useful to identify patterns of interaction between actors (both human and non-human) in the Kouga catchment SES.

- Study the farmer-government relationship. Through this research, it has become clear that the relationship between commercial fruit farmers in the Kouga catchment and the SA government has deteriorated since the 1994 regime change. Both parties are sceptical towards each other. Here, I touch upon a very sensitive research topic, namely 'trust'. A large body of literature recognizes the importance of trust in ecosystem management (Beierle & Konisky, 2000; Davenport, Leahy, Anderson, & Jakes, 2007; Hahn et al., 2006; Pretty & Ward, 2001). Distrust has been recognized as one of the biggest obstacles to effective natural resource management (Davenport et al., 2007). Although the issue of trust goes beyond the scope of this research, its relevance shows from the data. A more in-depth study is therefore recommended.

10.2 Recommendations to Living Lands

Here, I will present some recommendations to Living Lands, for the project 'mobilizing civil society to support living landscapes in the Kouga catchment'. The recommendations are based on the conclusions of this research and my personal experiences in the Kouga catchment.

- <u>Focus on subcatchments.</u> The management of water of (fruit) farmers in the Langkloof is organized on subcatchment scale: organization takes place around tributary rivers through collectively managed irrigation systems. Each subcatchment has its own social-ecological characteristics and differs from other subcatchments. Furthermore, the subcatchments are not physically linked by the Kouga river, which flows through another valley.

  An initial focus on subcatchments, as opposed to the Kouga catchment as a whole, makes the Living Lands project more manageable and allows for more personal interaction with the landowners. Problems/challenges that people on the landscape face can be framed more accurately and context-specific. In a later stage of the project, it can still be considered to work on a catchment scale.

- <u>Focus on either Eastern Cape or Western Cape</u>. The Langkloof is divided by a provincial boundary. The upper catchment (WC) is institutionally and practically very far removed from all downstream activity, and administratively in a different province (EC). This means that a completely different set of actors is involved in ecosystem management. A focus on either the EC or the WC therefore seems recommendable for practical reasons.

  Intuitively, the upper catchment (WC) seems more organized and able to act upon social-ecological change (e.g. by means of task teams). Such capacity seems less developed in the EC. In terms of creating 'living landscapes', perhaps more can be achieved in the upper catchment (WC), while the need is higher in the EC.

- <u>Efficiency of mulching.</u> Many fruit farmers indicated that they are interested in strategies to make alien clearing economically viable. In other words, to make a product out of the cut IAPs. The use of IAP mulch is suggested by some of the respondents to save costs on water, electricity and herbicides. However, others indicate that this is not economically interesting because of high transportation costs and the need for a mulching machine. A cost-benefit analysis (Hanley, Spash, & Cullen, 1993) could shed light on the economic viability of mulching in the Kouga catchment.

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Appendix 1: Personal position in the research

This research was facilitated by Living Lands, a South African NPO with the aim to conserve and restore 'living landscapes'; these are 'areas with a variety of healthy natural ecosystems and land-uses and which are home to diverse ecological, agricultural and social systems' (Living Lands, 2011). One of the main research objectives of the research is to contribute to the formation of living landscapes, as part of the Living Lands project 'mobilizing civil society to support living landscapes in the Kouga catchment'. This project is currently in its initialising phase and knowledge about the catchment is limited. To 'feed' the project, this research aims to provide a broad overview of fruit farming and water management in the Kouga catchment.

The concept of 'living landscapes' includes a social and economic component and therefore goes beyond views of conventional ecosystem management, with a sole focus on ecology (Pretty & Ward, 2001).This research focuses mainly on the social component of living landscapes: the fruit farmers, their relationships and their capacity to manage for social-ecological resilience. However, the research problem is strongly framed by ecological issues around water. Therefore, 'the social' is not seen as closed from the natural environment: a human-nature interaction is assumed. This has implications for the research approach, which takes a human-in-ecosystem perspective. Viewing the Kouga catchment as a SES allows for including the human-nature interaction in the analysis. This approach is compatible with the philosophy of Living Lands and my own philosophy as a researcher.

My personal position in the research is strongly related to the Living Lands philosophy: I care about nature, but reject the sole focus on ecology in ecosystem management. For pragmatic reasons, I believe in a holistic approach that tries to balance ecological and social interests. This also becomes apparent through my scientific background. After receiving my MSc degree in biology (specialization: ecology) I decided to move away from the natural sciences and start the social MSc Development and Rural Innovation (this thesis is written in the fulfilment of the MSc Development and Rural Innovation). The idea was to integrate insights from natural and social sciences, and to apply this in the context of landscape management. In a way, this also explains my choice for a SES perspective.

During the fieldwork, my position can be described as that of an 'outsider'. This has proven to be helpful for the research. Competition for water and legal changes in SA have made water a sensitive issue. Some farmers are suspicious when someone approaches them to ask questions about their water management. However, most farmers (not all) were very cooperative to me as an 'outsider' (a student from the Netherlands, who is not directly involved in the competition for water). Furthermore, the research was facilitated by Living Lands, which can be labelled as a 'green organization', which made me a 'greenie'. A note should therefore be made that some respondents might have provided socially desirable answers, given the sensitive nature of the topic.

The historical connectedness between the Netherlands and SA helped me to interact with the fruit farmers. Most of them have European ancestors and speak Afrikaans, which has evolved from the Dutch language. The shared history/language often functioned as an 'ice breaker' during the interviews. Over time, my Afrikaans improved, which gave the respondents the opportunity to talk in their own language, because I perfectly understood what they meant. During some interviews, questions were asked in Dutch, answered in Afrikaans and (if necessary) clarified in English. I believe that this contributed to an open and friendly atmosphere during most of the interviews.