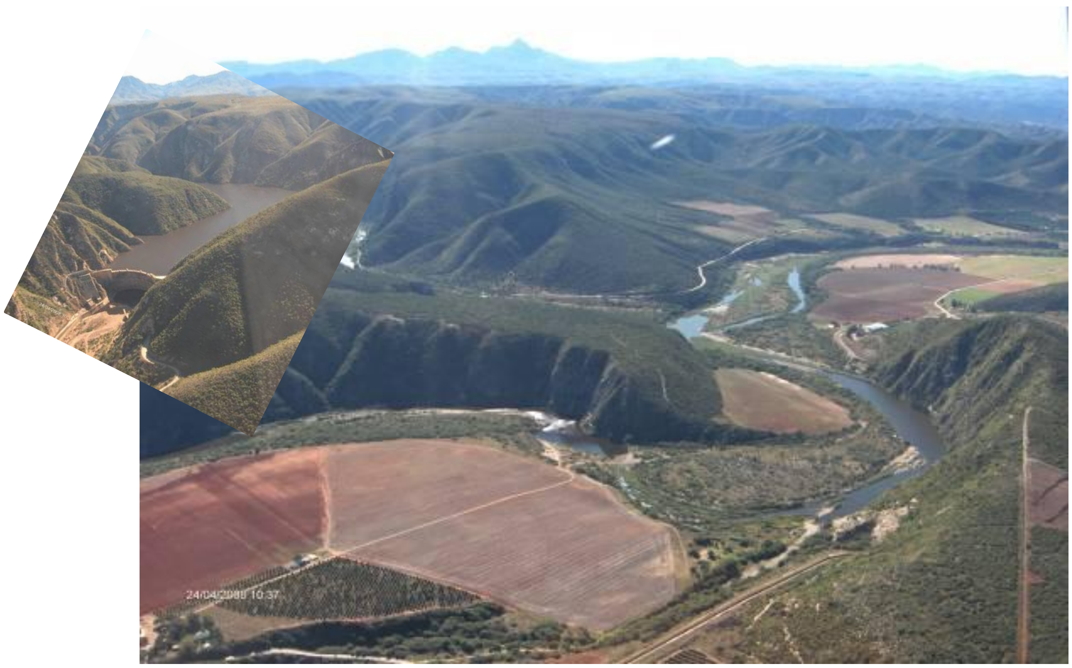
Valuing the benefits of restoring the water regulation services, in the subtropical thicket biome: *a case study in the 'Baviaanskloof-Gamtoos watershed', South-Africa*

Lennart van der Burg



October 2008

Valuing the benefits of restoring the water regulation services, in the subtropical thicket biome: *a case study in the 'Baviaanskloof-Gamtoos watershed', South-Africa*

Lennart van der Burg

Supervisors:

Dr.Rolf Groeneveld
Environmental Economics and Natural Resources Group
Rolf.groeneveld@wur.nl
Dr Dolf de Groot,
Environmental Systems Analysis group, Wageningen UR
PO Box 47, 6700 AA Wageningen, The Netherlands
Email: dolf.degroot@wur.nl

Matthew Zylstra,
Dieter van den Broeck,
EarthCollective
Email: zylstra@earthcollective.net
broeck@earthcollective.net

A thesis submitted in partial fulfillment of the degree of Master of Science at **Wageningen University,** the Netherlands.

Master thesis project assigned by the **Subtropical Thicket Restoration Programme - STRP**, South Africa.

Co-funded and supported by the **Speerpunt Ecosysteem- en Landschap Services (SELS)- WUR, Department of Water Affairs and Forestry – DWAF/Working for Water and Gamtoos Irrigation Board - GIB, South Africa.**

In collaboration with **Rhodes Restoration Research Group - R3G,** South Africa.

Facilitated by **PRESENCE** learning network and **EarthCollective**.
Front page Pictures: Kouga Dam reservoir (l) and an aerial photo of the start of the Gamtoos valley wit h the Baviaanskloof watershed in the background (r).

Citation:
van der Burg, L. 2008. Valuing the benefits of restoring the water regulation services, in the subtropical thicket biome: a case study in the 'Baviaanskloof-Gamtoos watershed', South-Africa MSc thesis. Wageningen University, The Netherlands. Commissioned by the PRESENCE learning network

Preface

The research conducted in the Gamtoos valley between March and August 2008 was part of my masters' environmental economics at Wageningen University. The great research opportunity created by EarthCollective was the main reason for the decision to come to South Africa, which I have experienced as a fantastic country. There was a unique chance to undertake research in my main field of interest, namely economics and natural resource (water) management. Therefore I would like to thank Dieter van den Broeck and Matthew Zylstra from EarthCollective for taking me on board of the research team and advising me during the entire research process. A further thanks to the diverse research team, consisting of the Wageningen master students: Eliska, Janneke Natasha and Haider, who provided the needed support and created an excellent research environment. This environment was strengthened by Gamtoos irrigation board (GIB). A special thanks to Pierre Joubert and Edwill Moore from GIB for their ongoing support, friendliness and cooperation which was crucial. I appreciate the openness of Mike Powell from Rhodes Restoration Research Group. Especially for the provided expert knowledge as well as the hospitality for the, sometimes unexpected, visits to Grahamstown. The same counts for Mat McConnachie from Rhodes University as I am grateful for his friendship.
This research was heavily reliant on the data provided by all the local stakeholders and would not have been possible without their full collaboration. I am very thankful for all the stakeholders and experts, as listed in appendix 1, for their time and invaluable input. In particular I would like to show gratitude to all the farmers in the Gamtoos valley who where patient and took time for the lengthy interviews in English or in my 'Dutch-Afrikaans'. A final thanks to my supervisors Rolf Groeneveld and Dolf de Groot from Wageningen University. Their valuable (theoretical) advice was motivating me, especially during the writing phase, to produce this final structured report.

I really enjoyed working in an interdisciplinary and international team in probably the most amazing part of South Africa. The excellent facilitation made it possible to develop a wide range of skills and through all the experience, I enlarged my worldview. I am convinced that this research and the generated knowledge will contribute to the sustainable social, environmental and economic development in South Africa.
Thanks to all of you!

Lennart

Contents thesis

Summary

This report entitled '*Valuing the benefits of restoring the water regulation services, in the subtropical thicket biome: a case study in the 'Baviaanskloof-Gamtoos watershed', South-Africa'* is initiated and facilitated by the EarthCollective[2] as part of the PRESENCE[3] network. There was a need for additional research on the valuation of the thicket ecosystem services (ES) that deliver tangible benefits and wherefore potential markets exist. This research is focusing on the water regulation services provided by the Baviaanskloof watershed, to the downstream beneficiaries in the Gamtoos valley. The Baviaanskloof is located in the Eastern Cape Province. It consists of a world heritage nature reserve (190,425ha) and additionally a large area of farmland (50,000ha). Through historically overgrazing both areas are heavily degraded which brings the need for thicket restoration. Valuing the watershed services (WS), provided by especially thicket and wetland restoration, gives insights into their relative importance for the local economy. Further on it provides the rationale for restoration from this perspective. Fresh water retention, storage and supply are the main water provisioning service where sediment supply, disturbance regulation, erosion control and water purification are the main water regulation services. The economic value of these WS can give an indication of the feasibility and potential for payment for watershed services (PWS) to finance large scale restoration in the Baviaanskloof. In this practice orientated research knowledge will be gained concerning WS and the perceived economic benefits. The main research questions formulated are:

- *What are the expected hydrological and economic benefits of restoration of the ecosystem service: water regulation?*
- W*hat possible financing mechanisms can be developed for the water regulation service?*

Through conducting an economic analysis these sub- and main questions are answered consistently per step. Summarizing; 1) stakeholder identification, 2) examining market distortions, 3) identification WS, 4) distribution benefits, 5) estimation economic values of WS, 6) indication Willingness to Pay (WTP) beneficiaries and 7) exploration financing mechanisms. A combined desk and field research is undertaken to gather both qualitative and quantitative data. Qualitative data was collected by interviewing the following main stakeholder groups: farmers upstream in the Baviaanskloof, Eastern Cape Parks Board, farmers downstream, municipalities, Gamtoos Irrigation Board (GIB) and the Department of Water Affairs and Forestry (DWAF). Additionally different 'ground managers' and expert are consulted. Through a standardized descriptive survey valuable 'on the ground' data was collected by 27 farmers in the Gamtoos valley including 6 emerging farmers. This covers 16% of the registered water users or 21% of the total agricultural water allocations. The collected monetary data is analyzed by using a number of direct and indirect valuation methods. The valuation is the major part of this thesis research.

The outcomes of this research are structured according to the State- Impacts and Responses from the developed DPSIR[4] framework. These are based on a more complex restoration model and provide logical steps in the process towards financing restoration by WS. The current degraded land in the Baviaanskloof has some severe negative ecological-, hydrological-, and economic Impacts. However, an increase in robust vegetation cover through restoration; reduces soil erosion, enhances the thicket ES and improve the valuable (soil) carbon storage. These ecological impacts are interlinked with the important hydrological impacts. Through improved infiltration and baseflow the water retention capacity of the watershed increases which reduces the storm flow and sediment yield. In this report these hydrological processes are clearly described and a number of uncertainties are stated. The main assumption made was that thicket restoration has a positive effect on the WS. There is a high level of causality, but also a number of uncertainties. Examples are the influence of the evapo-transpiration rate of thicket, the threshold and temporally

[2] EarthCollective is a network that brings together diverse groups of stakeholders to build new partnerships and synergies. It acts as a catalyst in creating, supporting and facilitating initiatives.
[3] PRESENCE stands for **P**articipatory **R**estoration of **E**cosystem **SE**rvices and **N**atural **C**apital, **E**astern Cape.
[4] DPSIR stands for **D**river - **P**ressure - **S**tate - **I**mpact - **R**esponse framework.

gradual distribution of the potential benefits of WS. The latter was seen to be important since the benefits of restoration accrue later while there are relatively high costs in the early stages.

The different positive economic impacts (benefits) are valued specifically. Starting with the potential increased water supply. This was valued by using different methods depending on, to where the water is allocated. This allocation is heavily influenced by the National Water Act. The capital and annual value of irrigation water is relatively high since the Gamtoos valley is a highly productive area. However, it can not compete to the high water value of the Nelson Mandela Metropole Municipality (NMMM), which has a rapidly increasing water demand. Nevertheless the water supply to the Gamtoos valley is over allocated and therefore additional allocations are not expected. Different expert advised that all water generated should not be allocated (to a certain extent), but used to improve the assurance of supply. The farmers in the Gamtoos valley have currently a low assurance of supply and, as the survey results reveals, a high assurance results in a number of changed management practices. These changed practices will generally result in a higher production efficiency and outcome, which stands for a substantial value. The drought damages in the Gamtoos valley were separately valued for the restriction period 2005/2006. It can be concluded that the actual damages in that period was relatively low, but the total economic loss was significant. A reduction in the duration and intensity of storm flow can provide a substantial flood damage reduction both upstream in the Baviaanskloof and downstream in the Gamtoos valley. A reduction in stormflow is expected to reduce the sediment yield, the dam sedimentation, the purification cost and extend the life span of infrastructure. These different components are valued where possible. For example: the additional purification cost at the water treatment works of the NMMM increases directly with a higher sediment yield. The secondary economic benefits of large scale restoration are expected to be substantial upstream and, when the water services will be improved, downstream as well. Most important is the direct and indirect job creation. There are some positive and negative externalities which should be taken into account in further development of PWS.

The calculated values of the main WS are incorporated in three exploratory scenarios, named: Worst, Medium and Best case. The medium scenarios depicts the assumed most likely future development with the average restoration cost and the average future benefits. The benefits included are the improved water supply; reduce flood & drought damages, reduced raw water treatment cost and carbon sequestration. The main value can be attached to carbon, and without this value restoration will not be economic viable. This report shortly addresses the WTP of farmers for the improved WS. A preliminary indication can be given that most established farmers are WTP for the 'whole package of WS', when a number of stated 'WTP criteria' are met. The emerging farmers are important beneficiaries, but will not able to pay. The municipalities were only WTP for a higher water assurance and supply, as they were not aware of the perceived benefits of other WS. It can be said that the farmers prefer GIB as implementation agency and definitely not prefer the municipalities. The combination of calculated economic values and WTP through the contingent method valuation can be used as a negotiation basis for financing mechanism, such as PWS. However the calculate values are not absolute and should be used as approximations, since there are a number of uncertainties, market imperfections, external factors and other major constraints. This report is initially intended for all the stakeholders and experts who are involved in watershed restoration. Further on it should contribute to the scientific discussion of the value of WS and the possibility for financing restoration. It is highly recommended to combine the results of this study with the ongoing PRESENCE research projects and that it will be available for related future studies. There are a number of future research possibilities recommended, such as more specific valuation studies and exploration of financing mechanisms. It is important than there is a good communication of potential costs and benefits of restoration towards the stakeholders.

1 Introduction

1.1 Background

1.1.1 Project motivation

In South Africa clean fresh water is a relatively scarce resource that is distributed unevenly, both geographically and over time (e.g. during periods of droughts), as well as socio-politically as results of apartheid. The availability of affordable water is a limiting factor for economic growth and social development (Woodworth 2006). To meet the rising water demands in South Africa, water resource managers have established a complex system of engineering supply side solutions. These included major inter-basin transfers and water pumping schemes, even over mountain ranges and across vast distances (Smakhtin et al. 2008). "Due to the increasing costs associated with supply-side measures and the limited remaining exploitable water resource potential, these solutions are becoming less viable" (Blignaut et al. 2008). It has therefore become necessary to explore other solutions to augment and conserve water supplies, such as watershed management. A watershed can be defined as "an area from which runoff from precipitation flows to a common point to join a lake, river or ocean" (Vishnudas 2006). A watershed is an independent hydrological unit and is playing a vital role in the regulating and provisioning of the present and future water supply. Although the value of water and these watershed services are debated worldwide, they are often seriously underestimated (Woodworth 2006). This undervaluing also happens in the Baviaanskloof watershed, which is the study area.

Area description and need for restoration

The Baviaanskloof watershed is located in the Western region of South-Africa's Eastern Cape Province (figure 1:1). The Baviaanskloof reserve has a rich biodiversity and is recognized as a world heritage site. Unfortunately the subtropical thicket ecosystem in the Baviaanskloof suffers from a number of pressures derived from "a range of environmental, institutional and socio-economic issues" (Boshoff 2005). At the moment only "10% of the approximate 47,000 km^2 of original thicket cover remains in its pristine state. The other land is transformed into an open Savannah-like system" according Lombard et al. (2003 cited in EarthCollective 2007). From a social, economic and ecological perspective there is a high need for restoring this ecosystem.

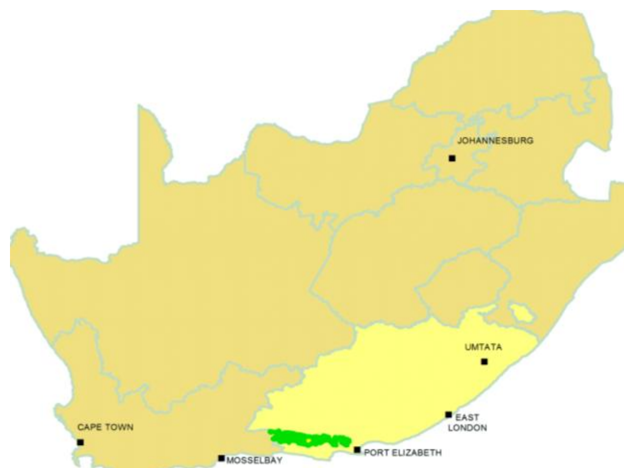


Figure 1:1 Locality map with Eastern Cape (yellow) and Baviaanskloof (green).

Need for an economic valuation study

Valuing the watershed services is needed to get insights into their importance for the local economy and the need to maintain and restore the area. The economic value of WS can give an indication of the feasibility and potential for the payment for watershed services (PWS) to finance large scale thicket restoration in the Baviaanskloof. This will create jobs to alleviate poverty, protect the water resources and prevent water shortages (Wyk et al. 2004). Restoration can be defined as: "the reparation of ecosystem processes, to as close to the original structure and function as possible" (Coetzee 2005). To make restoration in the Baviaanskloof viable on a landscape scale (i.e. thousands of hectares); there is a high need for financing mechanisms. Before these mechanisms can be put in place, the economic values of the Ecosystem Services (ES) need to be identified. Water quality and quantity are ecosystem goods and services that are under increasing demand because of the growing population and economy in the coastal regions. According to Scholes (2001 cited in Mander et al. 2007), the availability of water of acceptable quality is predicted to be the single greatest and most urgent development constraint facing South Africa. "Virtually all the surface waters are already committed for use, and water is imported from neighbouring countries". The above clarifies one of the objectives of the Baviaanskloof reserve is to "introduce PES for the provisioning of portable water to create new income streams and associated opportunities for job creation and economic growth" (Boshoff 2005). Because the Baviaanskloof reserve is located upstream of the Gamtoos River it plays an important role as a provider of clean water (Boshoff 2005). Water supply and carbon sequestration are one of the services that deliver tangible benefits as identified in the PRESENCE program. As said during the 2007 PRESENCE workshop: "We do need additional research on valuation, we should focus on those functions that deliver tangible benefits and those for which markets exist, in other words, we need to focus on the thicket's ecosystem services" (EarthCollective 2008). This discussion initiates the need for undertaking this valuation study.

Research context

This thesis research project is initiated and facilitated by the EarthCollective[5] network as part of the PRESENCE[6] project. This is a North-South collaborative initiative between various institutions such as: the Department of Water Affairs & Forestry (DWAF), Gamtoos Irrigation Board (GIB) and Wageningen University and Research centre. The research project is conducted in cooperation with GIB and the Subtropical Thicket restoration pilot Program (STRP) developed by the South African Government as part of the national Working for Woodlands and Working for Water (WfW) poverty relief program. The WfW program is mainly focused on clearing alien threes who have a high water usage. STRP is investigating options for restoring the valuable thicket biome to meet both socio-economic needs and ecological objectives (EarthCollective 2008).

Related research projects

To keep away from a 'stakeholder burnout' it must be avoided at all cost that the stakeholders are approached twice for the same matter. Good communication and planning between related projects is required and crucial to realize a proper transfer of the information in this report (including all background documents and meeting reports). This thesis research will be a complementary part of the following two related thesis-projects:

- Javed, H.A., 2008 *to investigate the institutional arrangements required to implement payment for environmental services (PES) for water in Eastern Cape, South Africa, focusing on Baviaanskloof and adjacent Cape catchments*.
- De Paoli, G., unpublished, *exploring the options for the creation of a Payment for Watershed Services Scheme in the Baviaanskloof, South Africa, WUR-LEI, ALTERRA & PRESSENCE.*

In appendix 2 the 'research approach of the transdisciplinary assessment & implementation framework' of EarthCollective is given including all relevant and related projects in a broader perspective. Additionally to these thesis-projects a major 'related project' is planned by C.AP.E. (Cape Action for People and Environment) to be commissioned probably end 2008. The terms of reference of the tender is summarized as:

To conduct a PES pilot in the Baviaanskloof Mega-reserve area of the Eastern Cape that would include; the development of a ecological/hydrological model that can be used to thoroughly investigate the potential for payments for water related services stemming from alien clearing and habitat restoration. The existing information regarding the carbon sequestration potential of thicket restoration will be incorporated into a comprehensive analysis of PES opportunities. (This includes clear indications of the nature and value of services under different scenarios as well as the costs associated with providing them)(Zijl 2008).

The CAPE desk study is mainly focused on data collection and knowledge generation with a high level of detail and in-depth modelling. The output will give a clear overview of the ES delivered at different vegetation cover and land use scenarios and the costs thereof. "The outcomes of the study will be used to interact with potential buyers and sellers services

[5] EarthCollective is a network that brings together diverse groups of stakeholders to build new partnerships and synergies. It acts as a catalyst in creating, supporting and facilitating initiatives.

[6] PRESENCE stands for **P**articipatory **R**estoration of **E**cosystem **SE**rvices and **N**atural **C**apital, **E**astern Cape

policy makers and other stakeholders/partners"(Zijl 2008). As mentioned earlier on, it is important that the mainly 'stakeholder based information' in this thesis report will be used in the CAPE study and other related future studies. Beside with the main institutions (ECPB, DWAF, GIB and NMMM) there is not any stakeholder consultation planned in (the first phase of) the CAPE study.

1.1.2 Ecosystem and watershed services

The concept of ES or natural capital is well described in the Millennium Ecosystem Assessment.

> "Ecosystem Services are the benefits that humans obtain from ecosystems. They are produced by interactions within an ecosystem and between its functions" (MA 2005).

Biodiversity, livestock keeping, landscape beauty and water availability are some ES that are under pressure (or even being lost) in the Baviaanskloof. There are opportunities for financing ES. Examples are: carbon sequestration, watershed services, nature-based tourism, and the importance of pollination that is being realized with community bee-keeping projects. Mapping and valuing of these ecosystem goods and services is often a long-term process that includes the involvement of many stakeholders. Nevertheless it is fulfilled in different levels of detail for a number of ES. Carbon sequestration is mapped in significant detail because of it expected high potential. Where some thicket species (e.g. 'Spekboom', *Portulacaria Afra*) have the unusual ability to rapidly fix carbon in semi-arid environments (3.4ton C/ha/year) (Mills et al. 2005). These exceptional regenerative abilities will add an extra value to the restoration and provision of ES. However, it should be emphasized that "the Spekboom physiology (e.g. growth and recovery rates) and distribution characteristics (e.g. geographic range, biomass and density distribution) require further understanding" (Powell et al. 2004). This is also required to get an indication of the quality and quantity of the watershed services (WS) provided by the Baviaanskloof watershed. WS can be defined as the benefits human obtain from the watershed. Most important WS are: flood control, sediment regulation, water supply, water availability and water purification. Various studies over the world are showing the importance and value of ES, including WS. There are a number of international funding streams that can conserve some of these services through global crediting. The Clean Development Mechanism for carbon sequestration, described in the Kyoto Protocol, is most well well-known. Others are, conserving biodiversity in the convention of biological diversity, the convention on combating desertification and the protection of water security (Boshoff 2005). Besides these promising instruments, there are other innovative mechanisms for PES. In all cases should the upstream service providers and the downstream service buyer benefit from watershed restoration.

1.2 Research objectives

This economic valuation study is a practice oriented research aimed at contributing towards the restoration project in the subtropical thicket biome. The expected changes in benefits that occur during the restoration of the degraded landscape in the Baviaanskloof will be described and valued. In this mainly quantitative research approach, knowledge is gained concerning watershed services and the perceived economic benefits.

1.2.1 Research problem

In order to restore and manage the watershed, financing mechanisms (such as PWS, government funding or private investments) are required. For this purpose insight needs to be gained into the monetary values of the restored water regulation services delivered by the Baviaanskloof watershed. This can be achieved by, for example, estimating the water supply value to the downstream irrigated agriculture and the drinking water supplies. The monetary values are needed to get an indication of the economic feasibility of watershed restoration and the possibility of introducing financing mechanisms.

1.2.2 Conceptual design

The described research questions will be chronologically answered in the different report chapters. In §1.3 a detailed explanation is given on how to address the research questions and which method is used. In the early stage of the research project some initial Questions were modified (Q6) where others were removed (Q7) or added (Q1 & Q2). This all to avoid overlap, keep it comprehensive and consistent with subsequent related work.

- ***What are the expected hydrological and economic benefits of restoration of the ecosystem service water regulation?***
  1. *What is the role and position of the main stakeholders involved in the in the restoration project?*
  2. *How are market distortions, such as the equity principle in the National Water Act, influencing the distribution of the watershed provisioning services?*
  3. *What is the impact of thicket restoration on the different hydrological processes, (such as base flows of rivers, sedimentation of dams and rivers, infiltration rates), and what are the expected benefits?*
  4. *How are the (economic) benefits of an improved water regulation distributed temporally and spatially?*
  5. *What are the economic benefits of restoration of the water regulating service?*

- ***What possible financing mechanisms can be developed for the water regulation service?***
  6. *Are the downstream water users (farmers and municipalities) willing to pay for the ecosystem services water regulation, which will improve through restoration upstream?*

In order to develop a better focus on the valuation the initial seventh research question, '*How can PES and CRES*[7] *mechanisms be made functional?'* was left out.

1.2.3 Scope and delineation

The main focus of this research project will be the economic valuation of the watershed services and the additional secondary economic activities. Only the direct and indirect use values will be valued. The social (e.g. equity, public involvement), ecological and political aspects will be partially included in the research as well. These aspects influence the free market trading principle with the result that optimizing the economic objective will not always be possible or the best option. It must be emphasized that the calculated values in this valuation study are intended to get a preliminary indication of the value of the provided watershed services. The study is not done to determine the *final* values that can be used as a basis for Payment for watershed services (PWS), but the *estimated* and *combined* values that can be used in the decision en negotiation process for PWS.
There is a wide range of ecosystem goods and services provided by the subtropical thicket biome, which are clearly described and valued by De la Flor (2008: 23). In this report the term 'Watershed services' (WS) will be used instead of the more general 'Ecosystem or environmental services (ES)' and to the more specific term 'water regulation services'. WS include all the water related services provided by the watershed. These services will be identified and the monetary values for downstream users will be estimated. Additional to this the gas regulation service (carbon sequestration) will be included in three scenarios. There is no sensitivity analysis conducted to determine the uncertainty of the values (parameters).
The term '(watershed) restoration' is used throughout this report and refers to both thicket (e.g. Spekboom) and wetland restoration in the Baviaanskloof (unless stated otherwise). The main focus is on thicket restoration since the research is done in collaboration with the STRP. Restoration is defined as 'the reparation of ecosystem processes, to as close to the original structure and function as possible' (Coetzee 2005).
The time span of the project was 8 months including preparation, data collection, field work & analyzing and the writing up phase, started in January 2008. The focus is only on the upstream area in the Baviaanskloof and downstream the Gamtoos valley where the

[7] Compensation and Rewards for Ecosystem Services (CRES)

economic valuation is conducted. The project can easily be enlarged to include the Langkloof (Kouga and Krom River).
These defined boundaries are necessary taking into account the different constraints, such as the limited time and the long travelling distances.

1.3 Approach

1.3.1 Analytical framework and theoretical assumptions

The framework used to conduct the economic analysis is based on the analytical issues described in *guidelines for preparing an economic analysis* (EPA 2000). The following steps are inline with the sub-research questions. The steps are undertaken in the analysis with the main focus on the valuation.

1. **Stakeholder identification**
   - Identification of the main stakeholders and the beneficiaries of the water regulation services upstream and downstream.
2. **Market distortions**
   - Examining social and environmental justice concerns in the economic analyses shortly and describe the influence on the market. Based on the National Water Act.
3. **Watershed services**
   - Identification of the main water related services provided by watershed restoration in the Baviaanskloof.
   - Establish baseline conditions to estimate the benefits of thicket restoration on the economy and environment (based on the available secondary data).
     E.g. "Does replanting degraded slopes reduce rates of water runoff, improved water retention on the landscape and ultimately water quality?" (EarthCollective 2008). Specific secondary biophysical and hydrological data will be required to develop a 'restoration model'.
4. **Benefit distribution**
   - Comparing the differences in the timing of benefits and costs. Estimate the cost of thicket restoration and identify the benefit distribution spatially and temporally by randomly interviewing downstream water users in the Gamtoos valley. An estimated monetary value will be given to these benefits at a specified time interval. The temporally benefit distribution will depend on the time spend on thicket restoration, the propagation of Spekboom and the monitoring process.
5. **Valuing watershed services**
   - Estimate the direct economic value of WS. (E.g. an increased water supply, improved water security and a reduction in erosion and sedimentation).
   - Estimate the indirect economic value of WS. (Reducing the occurrence of floods and droughts).
   - Estimate the total economic value of benefits of the combined watershed services based on three predefined scenarios (Low-Medium-High) to get an indication of the range of outcomes. Making use of preliminary calculations, assumptions, estimates, proxy market values and acknowledge the uncertainties in the calculation of the benefits.

6. **Willingness to Pay**
   - Interview and surveying the downstream water users (farmers and municipalities) to get a first impression of their WTP for restoration upstream, taking the uncertainties of the actual benefits into account.

The following seventh step *'financing mechanisms'* was not included, since the focus of the research was on the economic valuation. The activities for this logically next step are:

- Exploring the guidelines for applying PES and CRES mechanisms that can finance the restoration project in the Baviaanskloof. Thus translating and quantifying the economic value and costs-benefits of the restoration into payments and rewards mechanisms for the selected ecosystem services.

- Assessing the hydrological, economic and social changes that occur of watershed restoration.

1.3.2 Technical research design

The valuation study forms the major part of this thesis research. A combined desk and field research is undertaken to gather both qualitative and quantitative data. With the desk research various literature on valuation methods, watershed restoration projects and PES cases were analyzed. Additionally specific literature on the NWA and hydrological and socio-economic data of the area were studied. The key publications used in this document are referenced below:

- The Baviaanskloof Mega-Reserve (Boshoff 2005)
- Valuing wetlands ecosystem services (De Groot et al. 2006)
- PES in Drakensberg areas (Mander et al. 2007)
- Fish to Tsitsikamma Water Management Area (Shand et al. 2004)
- Gamtoos Pilot Project Baseline report (DWAF 2003)

Field research

Qualitative data in the research area is collected by interviewing the following main stakeholder groups: farmers upstream in the Baviaanskloof, Eastern Cape Parks Board (ECPB), farmers downstream, municipalities, Gamtoos Irrigation Board (GIB) and DWAF. Additionally ground managers of the WTW, specialist and other key informants are interviewed, listed in appendix 1. The interviews were mainly used to get qualitative, first hand information as well as expert judgments to fill in the information gaps in the literature. A standardized and structured descriptive survey is held under 27 farmers in the Gamtoos valley including 6 emerging farmers. This covers 16% of the registered water users who had 21% of the total agricultural water allocations. The survey consisted of a letter of support from GIB, the complete survey and the information of the restoration model with the main ecological, hydrological and economic impacts which can be find in appendices 3-5. The coverage is high enough to generalize some of the final findings to the entire farm population. The decision of the sample size was based on the size and variation of the population, the desired level of precision and the time available.
The farmers were selected by using a combination of non-random snowball and quota sampling methods. This means one farmer is mentioning names of a few other farmers who are then contacted taking into account that a certain amount of white and emerging farmers are covered in each production group (Maas et al. 2005). Figure 1:2 shows the upstream rivers contributing to the Kouga Dam and the further conveyance into the Gamtoos valley. The collared dots and squares are roughly visualizing the farm interview distributions per production group.

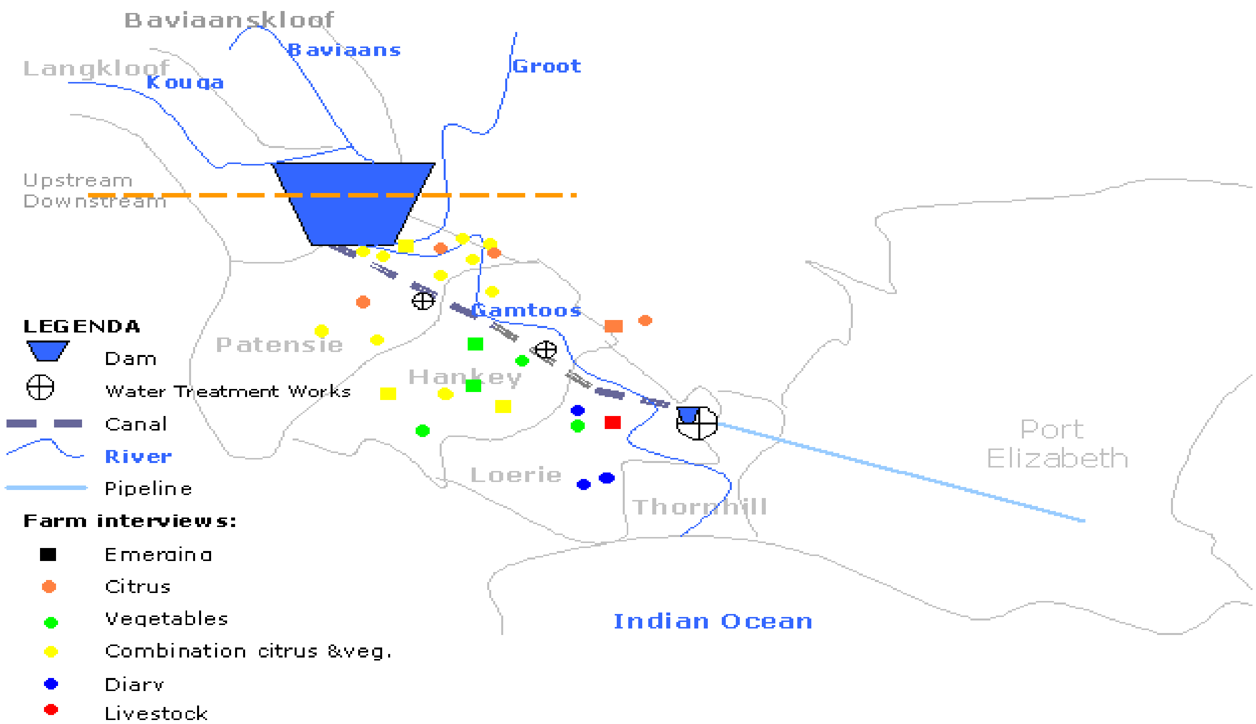


Figure 1:2 A schematic drawing of the Gamtoos valley with a geographic overview of the major futures and the farm interview distributions per production group. Based on: 'this thesis'.

It is important that the farm interviews cover each region in the Gamtoos valley (Patensie, Hankey & Loerie), where the farmers receive water from the canal. The benefits received form the WS can hereby made spatially explicit. The motivation to interview some (35%) of the emerging farmers in the area is to get an understanding of the problems and challenges they face in their production specifically and general in water resource management. The National Water Act (NWA 1998) emphasizes the importance of achieving equity in distribution and control of the water resources in a water management area (WMA) as well as efficiency, sustainability in the protection, use, development and conservation management. Observations were done during the numerous field visits into the Baviaanskloof and the Gamtoos valley. A triangulation of sources and methods is achieved by using different information sources (literature, farmers, institutes and consultants). Multiple methods (literature study, interviews, surveys and observations) are used to get information from the various data sources. The interviews and observations data are recorded in short meeting reports and field reports. Through these coded documents the source of the data can be easily recovered and re-used again. The Excel documents, in where the different (scenario) calculations are made, are accessible and easily usable.

Valuation methods

Different valuation methods are applied in step 6, 7 and 8 from the economic analysis. The valuation methods are based on De Groot et al. (2006), and described §2.2 in more detail. The direct and indirect use values of WS are valued, where the non-use values are only described shortly.

- *Direct use values*
  An increased water supply is valued by using the water price, rental value and economic value of water as proxies. The increased assurance of supply is valued by using the production factor method.
- *Indirect use values* (non-extractive use)
  The reduced flood and drought damages are valued by using the avoided damage costs method. With the replacement costs method a comparison is made with other (future) water

generating projects. The reduced life span of the water supply and the cost of water purification can be measured by the mitigation cost.
The calculated values are based on both qualitative data (estimations and expert judgment) and quantitative data (survey results and secondary data). The total economic value will be calculated in the different scenarios by making an estimation of the total benefit and avoided damage and the possible increase or decrease there of by restoration.

1.4 Outline report

This thesis consists of eight chapters in where the formulated research question will be answered. The literature review in chapter two gives a brief overview of the concept watershed services and describes the WS provided by the subtropical thicket biome. Further on background information is given on the economic valuation, the methods used and the constraints in the valuation process followed by a concise presentation on the National Water Act. The third chapter gives a comprehensive description on the land and water use in the upstream and downstream watershed.
Chapter four is devoted to the process of restoration, where the separate parts of the Baviaanskloof restoration model are described. The different impacts of thicket restoration are presented together with the benefit distribution. The economic benefits of restoration are valued in the fifth chapter by using a range of valuation methods. This chapter makes the economic value of the WS explicit for all the water users. These values will be combined in chapter six by using three scenarios which can form a negotiation basis for PWS. Possible financing mechanisms are explored followed by a SWOT analysis on PWS in the Baviaanskloof.
The limitations, validity and implications of results are described in chapter seven, discussion. Conclusions and recommendations for further research are given in the last chapter. Additional background material on data collection and calculation can be find in the various appendices.

2 Literature review

There are a growing number of practical reports and scientific papers on the concept of watershed services and the valuation thereof. Over fifty of these publications are analyzed and used as a starting point for this research. Throughout this report literature is used to strengthen, support or encounter some of the findings and results. In this chapter an overview of the general concepts, theories and methods on watershed services and valuation is given and, where possible, linked to the Baviaanskloof watershed.

2.1 Watershed services

2.1.1 Protection of Watershed Services

Watersheds need to be protected in order to secure the provision of high-quality and reliable quantities of water. Upstream land users implement specific natural resource management practices or activities for a financial compensation from downstream users, known as payment for watershed services (PWS). Examples of natural resources management in the Baviaanskloof can be given:

- Restoring, creating, or enhancing wetlands (e.g. removing balancing dams).
- Maintaining natural vegetation cover (e.g. subtropical thicket).
- Restoration with a focus on specific native species.
- Adopting 'sustainable' or 'best' land use management practices (e.g. sustainable farming).

These management actions will results in improved WS which would provide a whole range of benefits. Table 2:1 shows the services provide by thicket restoration in the Baviaanskloof watershed. A selection of the most important ones:

1. Creating or maintaining natural filters in the watershed to reduce water pollution and improve water quality.
2. Minimizing soil loss and sediment yield.
3. Maintaining vegetation in order to aid in regulation of water flow through the year to improve and assure the water supply.
4. Controlling for floods.

Box 2:1 Rules of thumb of land use and hydrology

The relationship between land use and hydrology is complex and is influenced by components of the physical and living environment. However some important general patterns count for each watershed:

- A good cover of intact natural vegetation guarantees moderate water use and therefore optimum stream flow under given geo-climatic conditions. It affords soil protection and therefore provides optimum regulation of seasonal flows and moderates erosion and stream sediment loads.
- Intact natural vegetation provides the assurance that the frequency of flooding and landslides will be less than prior the conversion.
- Removal or addition of vegetation initially affects annual water yield. Actual change depending on cover percentage, area, rainfall and degree of surface disturbance.
- Establishing natural vegetation on croplands or grassland is likely to *reduce* low flows when the extra water use is not off-set by improved infiltration. *Increases* in low flows require a sufficiently large improvement in infiltration after forestation. For example, to compensate for 100mm of extra water use by thicket, a 30% switch from overland flow to infiltration is needed at an annual rainfall of 350 mm/year to break even (assumption applied for thicket). This can only be expected where soils are fairly degraded at their surface and yet deep enough to store the extra infiltrated water.

Based on: (Katoomba group et al. 2007)

Monitoring
Measuring the hydrological dynamics of a watershed related to flow (quantity) are relatively difficult compared to water quality issues. There is often a lack of sufficient data on these functions (Mallory et al. 2006). However, specific water resources models such as ACRU (a multi-purpose and multi-level integrated physical-conceptual model) can be used. Data from other similar watershed can be used to learn from relationships. Extrapolating data must be done with caution cause watershed dynamics can vary greatly (Katoomba group et al. 2007). A series of "Rules of Thumb" identified in different watershed are given in box 2:1.

2.1.2 Watershed restoration case studies

Most of the recent studies on watershed services coincide with valuation of the economic impacts and if possible the introduction of additional payment instruments. These so called 'Payments for Watershed Services' (PWS) currently exist in Costa Rica, Ecuador, Bolivia, India, South Africa, Mexico, and the United States. However it is argued that the concept PWS occurs in many other places in the world, although under a different name. Two watershed restoration projects will be shortly described to get insight in the used approach and the importance of WS. There are a number of similarities with the Baviaanskloof restoration project.

Case 1: Pinacanauan watershed
Peñablanca is a protected forest reserve located in the Pinacanauan watershed, Northern Philippine. The area is recently degraded and there is a demand for watershed protection services by the different water users. Additionally, there is potential for carbon sequestration. A rapid hydrologic functions assessment was undertaken where the historical hydro-meteorological data was coupled with the land cover and land use change over 50 years time. Some results revealed:

- Increasing variability in mean annual stream flow.
- Declining trend in the dry season stream flow and an increase in wet season flow.

The declining dry season flow is generally attributed to insufficient groundwater recharge during the wet season which in turn can be the result of the following non-mutually exclusive factors:

1. A reduction in rainfall during the wet season.
2. An increase in evaporative loss.
3. A reduction in the infiltration capacity of the watershed.

The analysis of these factors revealed that the stream flow behaviour cited above is likely to be associated with the third factor. A decreased forest cover and the expansion of agriculture and grassland areas in the watershed can be seen as the cause which is consistent with the field observations and interactions with the local communities (Benhagen et al. 2006).

Case 2: New York's Catskill and Delaware River watershed
New York city had the choice of 'either devise a detailed watershed-protection plan to safeguard the water supply (estimated $1 billion) or built a filtration facility to remove impurities' (capital cost $6-10 billion and operating cost $300 million). By restoring and preserving the upstream resources the cost of filtration can be avoided. In the U.S. it is estimated that each Dollar spend on watershed protection saves $7-200 in new filtration and water treatment facilities (Richards et al. 2007). This clear financial benefit of watershed protection and restoration makes the New York's Catskill a premier example of the economic rationale for protecting and restoring natural capital (Aronson et al. 2007).

2.1.3 Watershed services provided by the subtropical thicket biome

The main provisioning and regulating services provided by the subtropical thicket in the Baviaanskloof watershed are listed in table 2:1. Trough thicket restoration the regulation services will improve and it is expected that the provisioning service improve as well. The model in figure 4:1 gives an overview of the different impacts of an improved basal cover through restoration. Additionally, the different economic instruments, institutions and interventions are described which are required for financing and maintaining the project. There is a profound link between the WS in table 2:1 and the impacts described in the figure in appendix 3 as shown in between brackets. For example the natural hazard mitigation or flood control services are directly linked to the impact of storm flow which causes the flood drought damages.

Table 2:1 Main watershed services provided by the subtropical thicket biome. Based on: (De Groot et al. 2006).

Watershed Services	Ecosystem Functions	State indicator (Impact)	Performance indicator
Water Provisioning Services			
Fresh water Retention, storage and supply	Stable precipitation or surface water inflow. Biotic and abiotic processes that influence water quality (see water purification).	Water quantity (m^3) and water quality. **(Water supply)**	Net water inflow (m^3/year) provided to downstream users. (I.e. water inflow minus water used by humans and the ecosystem.
Water Regulating services			
Natural hazard mitigation or disturbance regulation	Regulation of episodic and large environmental fluctuations on ecosystem functioning.	Water storage (buffer) capacity in m^3; ecosystem structure characteristics. **(storm flow)**	Flood control, drought recovery, refuges from pollution events.
Hydrological regimes: groundwater recharge and discharge.	Role of ecosystems (thicket) in capturing and gradual release of water.	Water storage capacity in vegetation, soil, etc., or at the surface. **(Infiltration** rate**)**	Quantity of water stored and influence of hydrological regime (e.g., irrigation).
Erosion protection or control: retention of soils	Prevention of soil loss by vegetation cover.	Vegetation cover, root-matrix, etc. **(Erosion)**	Amount of soil retained or sediment captured.
Sediment supply and regulation	Regulation of sediment supply to estuary and marine environment.	Sediment storage and concentration in the water. TSS or turbidity of runoff water. **(Sediment yield)**	Dirtiness water downstream.
Water purification Pollution control and detoxification	Role of biota and abiotic processes in removal or breakdown of organic matter, nutrients and compounds.	Water quality reports Kouga Dam. **(water quality)**	Maximum amount of waste that can be recycled or immobilized on a sustainable basis; influence on water quality.
Additional			
Gas regulation	Regulation for chemical composition of the atmosphere.	Calculation of carbon sink capacity **(Soil carbon storage)**	Carbon sequestration, oxygen and ozone production.

2.2 Economic valuation

2.2.1 Motivation for valuation

"The original motivation for environmental valuation was to enable environmental impacts, favourable or unfavourable, to be included in CBA" (Perman et al. 2003). The economic valuation has seen to be controversial since its purpose and use is not always clearly communicated to non-economists (e.g. ecologists, water resource managers and decision makers). In this valuation study the favourable impacts (benefits) of an improved water regulation services through thicket restoration will be described and valued where possible. Through three scenarios it will be compared with the management and implementation cost. It will serve as a negotiation basis for the implementation of PWS. The valuation of the socio-economic benefits of water regulation services has not been done extensively in South Africa. However, in Mander et al. (2007) the valuation of the main WS provided by the mainly grasslands and woodlands of Maloti-Drakensberg watershed in South Africa is clearly done and their approach is used in this report.
There is discrepancy over the usefulness and need of valuation studies. The monetary values placed on the environmental services are widely used to inform decision-makers of the favourable and unfavourable impacts of a project on the environment (Economist 2005). Valuation is also an important tool for decision making in balancing between competing uses, on reallocation proposals, water projects and other water policies such as resource protection which is safeguarded in the NWA. However the actual uses of the result of environmental valuations are often more 'lip service' than a real input to the (PES) decision making process at different levels. The 'quality' of the ES, the 'PES story', negotiation processes, the role of local institutions, leadership, social relations, social transformations, perceptions, bargaining power and institutional aspects are probably more important and useful inputs to the further PES design than economic valuations (Kosoy et al. 2006). Nevertheless there are a few cases where valuation studies can help to generate demand for watershed services. The (combined) value of a particular service can generate awareness and realization what can increase the demand. The calculated value of the different services should still not be confused with the actual price or 'marketable value' that can be asked for an ecosystem service (Katoomba group et al. 2007).

Nonetheless the market value of the water supply service can and should be valued quite accurately. As the fourth principle in the Dublin Statement (1992 cited in UNESCO 2006) indicated that "water has an economic value in all its competing uses and should be recognized as an economic good". Water supply is obviously a valuable ecological service which explains that many of the valuation studies done since 1997 have involved water (Economist 2005). The water needs between the different sectors must be balanced by taking the different socioeconomic and ecological aspects of the NWA (see §3.1) into account. For example, where irrigated agriculture in South Africa uses approximately 62% of the water, its contribution to the GDP is only 4%. However it provides important socioeconomic stability to rural societies, is responsible for 11% of the national employment and provides much of the country's food security (DWAF et al. 2007). To increase the water supply in Cape Town it is proven to be cheaper to restore town's watershed with agriculture to its native vegetation than to divert water from elsewhere, or to create reservoirs (Economist 2005). There are many other examples that show the heavy competition between agricultural and domestic water demand. The valuation and aggregation of the different aspects and values can, and should play an important role in the decision process.

2.2.2 Valuation methods applied

The purpose of the valuation applied was not to estimate the total economic value of the watershed services since it is difficult and not feasible in this research to estimate the non-use values which has a low 'tangibility'. The focus was mainly on the direct and indirect resource use values and as shown in figure 2:1 the option values is included as well. Estimating the economic value, where the exchange value (price of the WS) will be measured, had the priority, above the ecological (sustainability) and Scio-cultural (equity and cultural perceptions) value. Nonetheless they were included if they influenced the economic values directly (De Groot et al. 2006).

Total Economic Value				
Use values			Non-use values	
Direct Use Values	Indirect Use Values	Option Values Our future use	Existence Values	Other non-use Values
Provisioning services Water supply Water availability Water quality	**Regulating services** Natural hazard mitigation Hydrological regime Purification Erosion protection Sediment regulation	**All services** Biodiversity Conserved habitats	**Supporting services** Habitats Endangered species	

Figure 2:1 Categories of use and non-use economic values provided by a watershed (based on: Thukela ecological assets; De Groot et al. 2006; Wyk et al. 2004).

Direct market valuation

An increase in water availability leads to a higher water security and a potential increase of the water supply. There are different direct economic valuation methods available for valuing the ecosystem services, as can be seen in table 2:2.

The increase in the provisioning service 'improved water supply' from the Kouga Dam can be valued by the:

- *Water price.* Current 'set' water price for raw water in the Gamtoos valley for the different user groups. (This is not the market price since it is cost based and not determined by supply and demand).
- *Capital and rental value***.** The amount water users are WTP to obtain an extra water allocation and the short-term rental value of water.
- *Economic value of irrigation water***.** The Crop Water Productivity of the three major agricultural activities in the Gamtoos valley.

An increased water security or improved assurance of supply can be (partially) expressed in financial values by:

- *The production factor method (PFM)*. The 'improved water security' for agriculture, can be valued by the changed (future) production costs and benefits. The process of expressing the perceived benefits in financial values is complicated, because not all information is easily available. Therefore estimations are given, based on the described benefits and the market prices.

Table 2:2 Methods used to value the hydrological and economic impacts of watershed restoration.

Hydrological & economic impacts of watershed restoration		*Method*	*Description*	*§*
Direct market valuation				
(+)	Water supply	Economic crop water productivity	Economic value of water for agriculture in the Gamtoos valley	5.4.1
		Raw water pricing	Price agriculture & domestic water	5.4.2
		Capital & Rental value	Price of water rights	5.1.1
(+)	Water security	Production factor method	Production and earnings increase	5.1.2
(+) (-)	Basal cover Water use	Opportunity cost	Cost and reduced or lost profit of farmers in the Baviaanskloof	5.4.3
Indirect market valuation				
(-)	Flood and drought	Avoided damage cost	Damage or loss of production and income through flood & drought	5.2.1 5.2.3
(+) (-)	Life span water supply infrastructure & Cost of water purification / supply	Mitigation cost	Extra cost made to treat the raw water for sediment	5.2.4
(+) (-) (+)	Water supply & Dam sedimentation Water security	Replacement & substitution *cost of water*	Unit reference value, the marginal cost of thicket restoration	5.3
(+)	Financial benefit to water users	Descriptive (incl. non use values)	Economic benefits to society and secondary economic activities	5.5
	Economic instruments	Contingent valuation method	Get an indication of the WTP of the water user	4.1.4

Indirect market valuation

The reduction of flood and drought damage will be valuated by the method:

- *Avoided damage cost***.** This includes the estimated damages in the Gamtoos valley caused when the Kouga Dam was overflowing. The cost associated would not have been incurred or would be less when the 'flood control service' of the Baviaanskloof watershed was improved. Additionally the damage or loss of production and income from the water restriction when the Kouga Dam had a low yield will be estimated. A higher assurance of supply would lower these cost.

The financial value of reducing the sediment yield in the raw canal water can be quantified by the cost made to mitigate the negative effect of sediment.

- *Mitigation cost.* The extra cost made to treat the raw water with a high sediment yield at the Loerie, Hankey and Patensie water treatment works. Additionally, costs are made by the farmers to treat their drinking water and filter there irrigation water. The cost of the lost life span of the water supply infrastructure (micro-irrigation) should also be included. These are the cost of moderating the effect of the lost water purification and sediment regulation (De Groot et al. 2006).

The cost of generating one m^3 of water is expressed by DWAF through the Unit Reference value (URV) in (R/m^3). To safeguard the future of water supply there are different engineering (human made system) and watershed management projects (natural system) considered. The value of 'improved water supply' can be estimated by the cost of obtaining the water from another source (substitution cost).

- *Replacement or substitution cost***.** The relative cost (URV) of other water generating projects compared to the cost of watershed restoration to improve the water storage and supply service together with the sediment regulation service. The additional cost required to produce an additional unit of water through restoration represents the marginal cost of thicket restoration. (This value will be much too high and a combination of the other marginal benefits perceived from an improved water regulation must be found to make restoration worthwhile).

There are different economic instruments available to finance the restoration project. In order to get a first indication of the WTP of the water users the CVM was applied.

- *Contingent valuation methods (CVM).* In the survey the farmers were familiarized with the restoration project and the possible benefits perceived from an improved water regulation were explained (using visual material). After this short informative introduction the following hypothetical scenario was given:

If the project goes through and there are measurable hydrological effects, such as:

i. Improved water quality
ii. Higher water security *(improved assurance of supply)*
iii. Higher water availability / quantity
iv. Storm flow reduction

a. Are you willing to pay for (one of) these benefits of restoration?

Thus the water users (municipalities, farmers) were asked in an interview if they are WTP for specific stated watershed services. Additionally to this they were asked how much they are WTP and what criteria had to be met before paying. The motivations for their WTP often include the 'non-use values' additionally to the stated direct use values. Examples of these existence values are: *'to sustain the world heritage area', 'biodiversity'* and bequest values *'for future generation'* [quoted] (see appendices 6 and 7).

2.2.3 Valuation complexity

A common feature of all methods of economic valuation of ecosystem services is that they are founded in the theoretical principles of welfare economics. It attempts to identify circumstances under which it can be claimed that one allocation of resource (WS) is better (in some sense) than another (Perman et al. 2003). The measured demand for WS in monetary terms is the upstream willingness to accept for compensation of loss and the water user willingness to pay for a particular benefit. The revealed preference techniques: replacement cost, PFM and avoided damage cost are used in this research as described in table 2:2. These methods assume values, indirectly from people's behaviour in related substitutable markets to the WS of interest. With the stated preference techniques, based on hypothetical rather than actual behaviour, the WTP of water users is asked. Valuation based on observed behaviour is preferred to hypothetical behaviour and direct valuation is preferred to indirect (Nature Conservancy et al. 2004). As can be seen in table 2:2 several monetary valuation methods can be applied.

At a conceptual level it can be argued whether it is really possible to put values on 'priceless' and not immediately obvious or measurable WS (e.g. sediment regulation and flood control). Until present the farmers and municipalities perceive and receive these service for 'free' (at a lower standard). Where economic approaches aims to maximizing utility by using market-based incentives there is a lack of attention to other factors driving behaviour such as ethical, cultural and political norms (IIED et al. 2007); see thesis (Jansen 2008). The political context needs to be understood in order to determine a realistic value. The principles in the NWA affect or obstruct the market process. Short attention is given on how institutions and power relations affect the market process and how it will affect the values. All the values used in the report are given in Rands (R), which has a conversion factor of R8.5 to the $ and R11.8 to the € (October 03, 2008). All costs and benefits are converted to 2008 prices by using a discount rate of 8% (unless if stated otherwise). This discount rate is also used to calculate the NPV of future investments and income streams. The final economic values will be seen as inextricably linked to the environment instead of a distinct value.

2.3 National water act 1998

The national water act (NWA) forms the legal framework in this report. The values of some water provisioning services are heavily influenced by this NWA.

2.3.1 Water requirements

The previous water act of 1956 was based on the European water laws where they separated visible and invisible water. The natural flow of visible surface water could only be used when water was generated on the property itself where invisible water could be used unlimited. Water use in the 'new' National Water Act (NWA 1998) is more regulated. It specifies that "Government must ensure that water is protected, used, developed, conserved, managed and controlled in an equitable and sustainable manner for the benefit of all people". This is particularly important in South Africa, which is still facing significant inequities in access to water and the benefits from the use of water. DWAF act as custodian of the water resources and is playing the major role in distributing new and revised water allocations. The NWA states that 'water belongs to the nation and for a fair allocation licensing is required' (DWAF 2006c), with the social (equity objectives), economic and environmental externalities thereof. The NWA guarantees the water availability and security for the three water demand 'priority allocations' (to be determined):

- *Basic human needs* provide water necessary for survival (25L/person/day).
- *Ecological reserve,* represents the quality and quantity of water required to protect aquatic ecosystems.
- *International obligations*, water transfers over the South-Africa border.

These receive priority above that of agriculture and other industries. The NWA respects most of the pre-existing water rights. Farmers may continue using water until a call is made for the application of water licenses in the Water Allocation Reform (WAR) program (Nieuwoudt et al. 2004). This makes the value of water rights still existing and useful as a reference for water pricing (Hosking et al. 2002).

2.3.2 Water Allocation Reform

DWAF must promote the beneficial use of the scarce water in the best interests of all South Africans. The WAR is there to balance the protection and use of the water resources. To do so a registration and verification process is started to check if the registered water use is lawful under previous legislation and to determine the extent of Existing Lawful Use (ELU) (water rights). With this process DWAF tries to make water available to support new demands progressively over time. Where possible without the need for extensive curtailments to ELU in over allocated areas (as in the Kouga-Gamtoos watershed) (DWAF 2006b). Cutting back on ELU use is affecting the economic returns and has complex political, legal, and economic consequences. The manner in which this is needed and done is critical to sustainable development in South Africa. If the WAR program is implemented too quickly, there is the possibility of economic or environmental damage as new users struggle to establish productive and beneficial uses for the reallocated water. Conversely, if water reform takes place too slowly, the possibility of socio-political unrest and instability is increased.

An example: increasing the water availability to small-scale emerging farmers in the Gamtoos valley would not require significant reductions by the large-scale users. This supports the goal of WAR to ensure equitable access and that the rural poor realize tangible benefits from using water, which is critical to eradicating poverty and promoting growth. However, emerging users need to have the means, both financial and technical, to develop infrastructure to use the water productively. This especially when their water demand is growing in the future.

Identifying allocable water[8]

The slogan "More crops, Rands, jobs per drop of water" is used by DWAF as one of the criteria to allocate water (DWAF 2006a). To identify allocable water the following processes (among others) can be progressively followed:

1. Ending unlawful use.
2. *Watershed management, restoration and removal of invasive alien plants can increase water availability.*
3. Actively promoting water conservation and demand management.
4. Phased and progressive curtailment of existing lawful water use.
5. Lowering the assurance of supply.
6. Viable options for developing the resource (for example, construction of new impoundments.
7. Promoting water trading between ELU.
8. Curtailing ELU (DWAF 2006a).

Water user Association

The Catchment Management Agency (CMA) and the Water User Associations (WUA) are two new management agency that will be established in each catchment in South Africa in the near future, as described in chapter 7 of the NWA (1998). DWAF delegates the water resource management to catchment level where the CMA will develop a Catchment Management Strategy.

The WUA operates on regional level and exist of different water user groups. GIB will transform into a WUA in the near future, but still will continue operating the water scheme. At present GIB is a water utility company that is financially autonomous and publicly (private) owned. GIB operates the privatized government scheme since 1991.

[8] This refers to that water that can still be allocated to new licenses after meeting the requirements of the Reserve, and International Obligations.

3 Kouga-Baviaanskloof-Gamtoos watershed

3.1 Upstream area

To get an impression of the Baviaanskloof watershed this paragraph gives an overview of the geology, conservation efforts, need for restoration and water availability.

3.1.1 Kouga- Baviaanskloof watershed

The sub area Groot and Kouga-Gamtoos forms part of the Fish to Tsitsikamma water management area. The Kouga River rises in the Langkloof on the slopes of the Tsitsikamma mountain range in the western region of South Africa's Eastern Cape. The main tributary of the Kouga River is the Baviaanskloof River. It rises in the rugged mountains, flanking the narrow Baviaanskloof Valley (DWAF 2003). The uppermost rock strata of the Baviaanskloof are composed of the impure Table Mountain Sandstones and shales reaching up to 150m in thickness. The interaction between the often permeable alluvials and the underlying sandstones, quartzites and shales rock strata plays an important role in influencing where wetlands may form on the landscape. Local geology and its influence on hydrology is critical in determining wetland distribution (Gambiza et al. 2004).

The Kouga and Baviaanskloof watershed covering an area of 315,000ha. The Baviaanskloof River supplies about 35% of the water for the Kouga Dam, which nearly delivers all the water for the Gamtoos Valley irrigation area, and up to 26% of the requirements of the growing Nelson Mandela Metropole. A large part of the Baviaanskloof River, and a substantial part of the catchment of the Kouga River, fall within the existing Baviaanskloof Nature Reserve (Boshoff 2005).

Conservation in the Baviaanskloof goes back to 1923 when state-owned land in the area was proclaimed as a forest reserve and water catchment zone. Additional land purchases increased the reserve to 199,896ha currently (Boshoff 2005). The Baviaanskloof role in provisioning water and other essential ecosystem services has received greater attention the last two decades (Crane, 2006). In particular, 'eco'-tourism and game ranching is fast being recognized as attractive opportunities to support economic growth (Zylstra 2008). Further expansion of the protected area is continuing within the Baviaanskloof Mega-reserve project.

Need for thicket restoration

In the western Baviaanskloof the majority of the subtropical thicket ecosystem has been degraded by overgrazing, which is similar to other large areas in he Eastern Cape Province. The denuded land leads to loss of agricultural productivity, sheet erosion, gullies, head cuts (Kruger 2006), reduced water supply, increased water treatment costs, reduced lifespan of dams and directly and indirectly impacts on the quality of life for citizens in the region. The results of bad farming practices negate all effort put into sound catchment management by the ECPB (DWAF 2003;Joubert et al. 2000). It was found that the dry forms of subtropical thicket do not recover naturally and become trapped in a downward spiral towards desertification. Urgently, actions need to be taken to secure future livelihoods in the region. Initial studies have shown that this damage may be repaired by replanting the native vegetation. Restoration would increase the water availability in the western Baviaanskloof. This is important since water supply in the area in mainly dependent on natural processes, making the survival of the residents in the area sensitive to climate change and rain supply.

3.1.2 Water availability: western Baviaanskloof

The western part of the Baviaanskloof is populated with approximately 1,000 people. The area consist of around 20 white family owned farms who covers around 50,000ha of mainly livestock (goats, sheep, cattle and ostrich) and irrigated cropping. There is limited potential for farming and secondary activities such as tourism are growing (Crane W. 2006). Two collared communities are living in the western part of the Baviaanskloof the third is situated in the reserve.

The natural flow of water in the area finds its way down from canyons in the mountains into the wetlands. In the 1970's the farmers were encourage to built balancing dams in order to collect the water before it enters the wetlands. Nowadays these dams are interfering into the natural systems and causing a variety of problems (e.g. break after heavy storm). The farmers are by DWAF legally restricted to use more water and their ELU, however little monitoring is done. The water availability in the western Baviaanskloof is relatively stable. The last droughts were between 1987 and 1991, major flood were in 1972 and 1981 (Kruger 2006). At present the water supply in the Baviaanskloof is overused. As shown in table 3:1 the estimated water used is more than 3Million m^3 (farmers use 2.5Mm^3 and the communities 0.7Mm^3) instead of the legal 2Mm^3 (De la Flor 2008). The total volume of the farm balancing dams are over 0.5Mm^3 (J. Murray, personal communication, June 23, 2008). The water supply is the most important service for the residents of the Baviaanskloof as they could not live in the area without it. It has been evaluated as the most important issue by the communities as they mentioned 'water is everything, water is life' (De la Flor 2008).

Table 3:1 Water use upstream. Based on: (DWAF et al. 1995;DWAF 2003;Shand et al. 2004)

River	**Irrigated Area** (ha)	**Water use** (Mm^3)
Baviaanskloof	400 (2000)	3-3.2
Langkloof (Kouga)	7,610 (1995)	32
Total	8,010	35

In the Langkloof, the fertile soil in the valleys of the upper tributaries of the Kouga River catchment is intensively cultivated. Large areas of deciduous fruit orchards and a small area of pasture are grown under irrigation, using water stored in a large number of farm dams with a total storage of 32Mm^3 (DWAF 2003). The high degree of development in the Langkloof area effect the yield of Kouga Dam. It must be stated that the upstream farmers in the Langkloof and Baviaanskloof abstracting water directly form the river or groundwater cannot be curtailed by restrictions (beside natural shortage). This is an important aspect in the discussion on the current water supply and assurance of downstream water users in the Gamtoos valley.

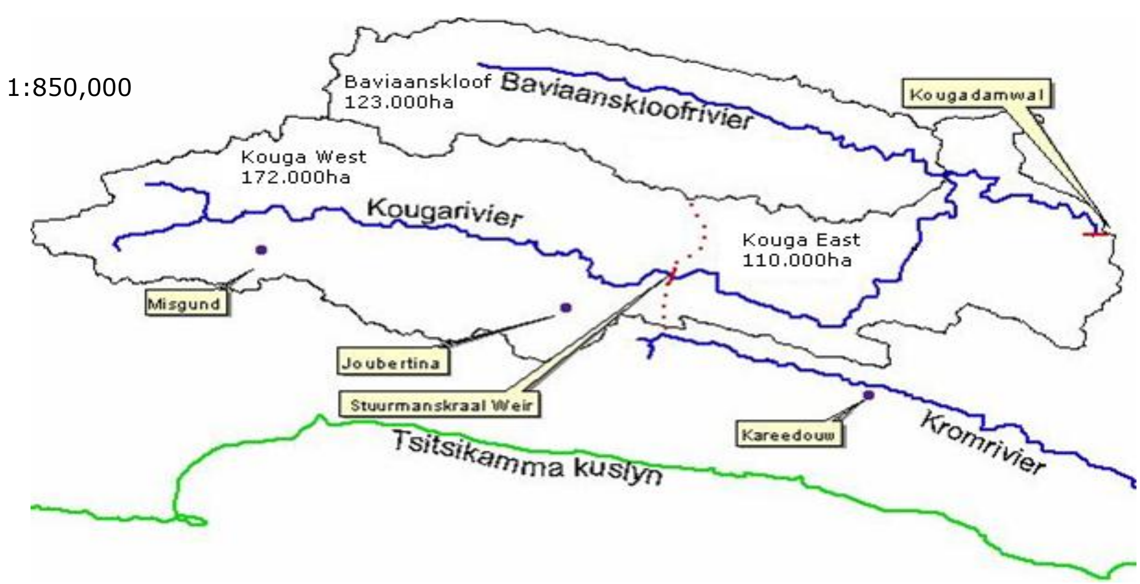


Figure 3:1 Kouga-Baviaanskloof watershed with the drainage area in hectare. Source: GIB.

3.2 Downstream area

Compared to the Baviaanskloof, agriculture in the Gamtoos valley is more developed in terms of production, cost-effectiveness and water use. Further on there are more agriculture-based jobs and foreign exchange earnings (DWAF 2003;Joubert et al. 2000). This paragraph gives an overview of the watershed, the water availability and agricultural water use.

3.2.1 Gamtoos watershed and conveyance system

Downstream of the Kouga Dam the, mostly dry, Kouga River joins the Groot River and forms the Gamtoos River, which drains the western slopes of the Elandsberg mountain range along its 90km journey to the sea (DWAF 2003). Water in the Gamtoos River is not often used for irrigation because of the high salt contents and expensive pumping cost. Additionally, permission to extract water need to be given by DWAF. Irrigation water is mainly extracted from the canal that runs from the Kouga Dam to the Loerie Dam. DWAF is owner of Kouga Dam, Loerie Dam and the main and tributary canals. GIB operates Kouga Dam and its main canal on behalf of DWAF. A small hydro power station at Kouga Dam has been decommissioned because of deterioration of the mechanical plant and severe leakage (DWAF 2003). Through the variable water outlet the hydro station is not economically feasible. Nelson Mandela Metropolis municipality (NMMM) owns and operates Loerie water treatment works (WTW) which supplies treated water to the Metro and Loerie. The small WTW in Patensie and Hankey are managed by Kouga Municipality (KM) and the raw water is supplied by GIB through the irrigation channel.

3.2.2 Water availability: Gamtoos valley

After the Kouga Dam was built (1967), water allocations (quotas) were distributed among the water users based on their irrigated area below the canal. These historically determined allocations set at 8,000 m^3/ha, cannot be exceeded. The current quantities of raw water supplied to the farmers, KM and MMM by GIB are given in table 3:2.

Table 3:2 Allocated water from the Kouga Dam (DWAF 2003).

Water user	**Quotas** (Mm^3)	**Percentage** (%)
Irrigation Gamtoos valley	59	71
NMMM	23	28
KM (Patensie & Hankey)	0.9	1
Total	**82.9**	

Not the complete 59 Mm^3/year is available for irrigation; due to canal losses of about 8.4Mm^3/year according P. Joubert (personal communication, October 10, 2008). Farmers only use 76% of their allocation. On average about 66 Mm^3/year is released from Kouga Dam. This make sense when realizing the long-term yield is 75 m^3/year (1:50) and 70 m^3/year (1:100) (Mallory 2006).

According to the WMA report (Shand et al. 2004) the Kouga-Gamtoos watershed is slightly over allocated at the moment. Severe water stress will occur when irrigation farmers in the valley will take up their full quota. According to the yield calculations there is no surplus water available at the moment, what means no new quotas can be allocated in the medium term. Applications for new water allocations in the Kouga, Baviaanskloof and Gamtoos watershed have been put on hold. Extra water can still be created through the reallocation process (§3.1) (Shand et al. 2004). Although there is a high and increasing driving pressure of demand on the water availability in the Kouga –Gamtoos watershed. The highest pressure for an increased water demand is coming from:

- *NMMM.* The population of the NMMM is expected to double within the next 12 years. Water consumption patterns have changed as the living standards of previously disadvantaged people have improved. Therefore water demand is expected to double before the population does (DWAF 2003;Joubert et al. 2000).
- *KM.* The Kouga Dam is supplying the water to Hankey and Patensie. The rapid population growth in these towns is placing an increased pressure on the water availability, resulting in temporal shortages (Kouga municipality 2007a).

- *The human and ecological reserve.* According the NWA water should be made available for alleviation of poverty, such as to agrivillages, and for resource-poor or emerging farmers (DWAF 2003). The water requirement for the ecological reserve in the Kouga, Baviaanskloof and Gamtoos Rivers is till uncertain.
- *Irrigation Gamtoos valley*. The farmers in the Gamtoos valley are completely reliant on the Kouga Dam water. There is a need for more water, especially for the dairy and citrus farmers. The area of citrus is expanding rapidly at the moment (see figure 3:2) and an increased (secure) water supply is therefore needed. However the water demand management report states: "There is a need to decrease irrigation use through higher efficiency. Beneficial and economically viable irrigation water use should be promoted" (DWAF 2003). Most of the citrus farmers are already irrigating efficient and on their 'minimum-optimal' water requirements. Where in periods of droughts they can limit there water use up to 50% in certain periods This would however reduce the fruit size and total harvest.

Figure 3:2 Increase in citrus orchards (l) and total citrus production in the Gamtoos valley (r) (based on data PPECB-PE).

3.3.3 Agricultural water use and production

GIB measures the total water use of farmers by the meters at their take-off points. To get an indication of the water use per crop in m^3/ha an estimation is made based on the design specifications of the irrigation system. (A centre pivots for annual cash crops and pastures and drip or micro sprinklers for the permanent citrus orchards). An increasing number of farmers are irrigating according a pre-set schedule instead of irrigating on experience. Water use in the Gamtoos valley is varying throughout the year. Figure 3:3 shows that it depends directly on the rainfall. Rainfall patterns vary both seasonally, annually and spatially. It generally rains throughout the year, but there is a reduction in rainfall readings from the mountains to the coast. The mean annual precipitation and mean annual runoff are 547mm/year and 255mm/year respectively. The figure clearly shows a higher water use in the summer periods, November to February. This is contradicting to the WDM baseline report (DWAF 2003), which argues that the water use in winter and summer is almost balanced. An explanation can be given by the increasing area of citrus, which use most water in summer, and decreasing of the winter crop Potatoes. Pastures would generally use the same amount of water throughout the year with a slight increase in summer.

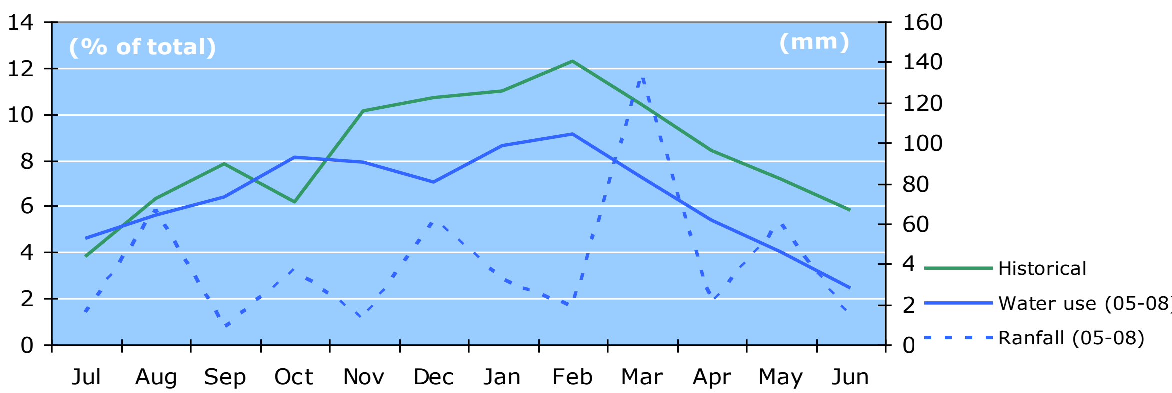


Figure 3:3 Monthly water use and rainfall in the Gamtoos valley (2005-2008). Source: GIB and DWAF Cradock.

Irrigation area
The scheduled irrigation area from the Kouga Dam is 7,420.2ha, however through efficiency (e.g. drip irrigation) more land (9,880ha) above the channel can be irrigated (DWAF 2003). The crop composition of the Gamtoos valley is given in figure 3:4. The outside circle shows the crop composition in 2003 where the data was based on expert estimates. The survey 2008 (*this thesis*), undertaken under 16% of the registered water users, is given in the inner circle. It can be seen that the area of citrus and grassland (pastures) is much large in the 2008 survey compared to the baseline study 2003. This can be partially explained through the explosive growth of citrus and pastures over the last few years. On the other hand the percentages in the 2008 survey are not extrapolated and only based on the farmers interviewed. This also explains the lower varieties in crops and thus lesser colours in the inner circle. The citrus orchards are the only significant permanent crop cultivated on an estimated area between 22-39% of the Gamtoos valley. It is mainly grown around Patensie where still another 500ha of future expansion is possible. Around 300-400 ha of citrus is possible in Hankey where at present the annual cash crops, such as potatoes, are more important (I. Griep, personal communication, May 28, 2008). In the Loerie area the main focus is on vegetable production and dairy farming (Kikuyu-Rye grassland) in the adjacent Mondplaas area. Dairy farming uses most of the water for the irrigation of their large pastures.

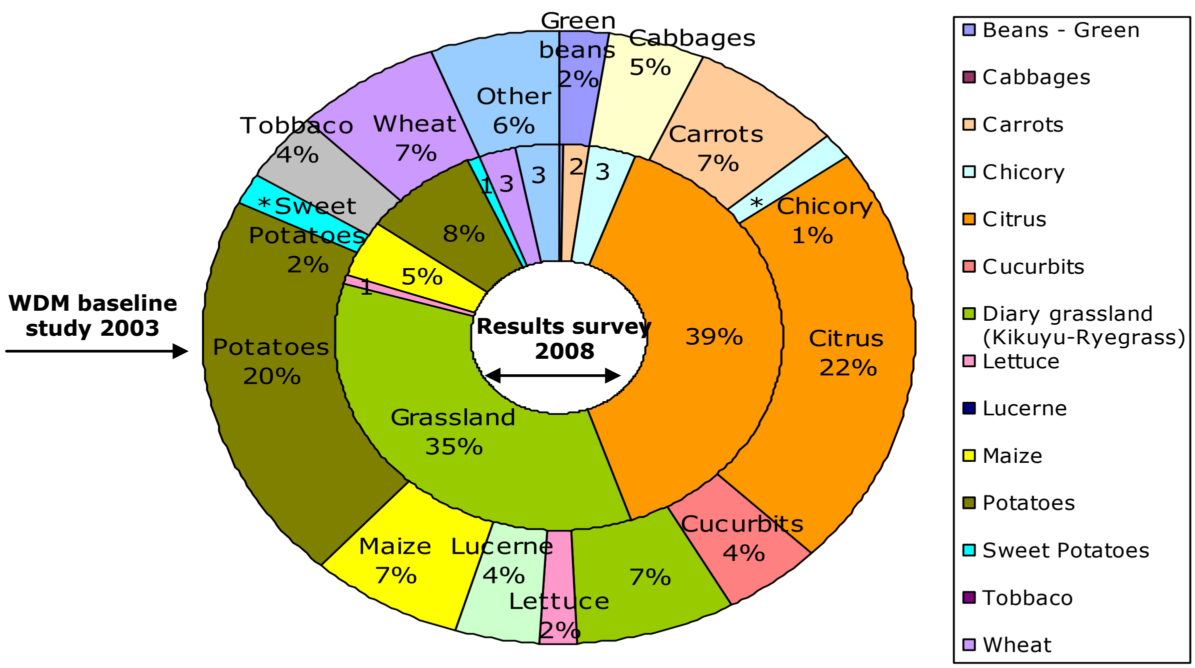


Figure 3:4 Crop composition in percentage of total irrigated land in Gamtoos valley, survey result compared with baseline study. Source: WDM Baseline study (DWAF 2003) and survey results 2008, 'this thesis'.

The subtropical climate makes the Gamtoos valley ideal for agricultural development. Agriculture is the dominant economic activity in the valley, where especially citrus is seen as the driver of the agricultural output in terms of economic value and job creation. In 2002 agriculture made up close to 20% of the overall GDP in the larger Kouga municipality region. Tourism (20%) and community services (14.9%) also delivers an important contribution. In the NMMM the major economic activities are industrial activities and manufacturing, mainly in the Port Elizabeth and Uitenhage (Kouga municipality 2007b).

Emerging farmers

In the Gamtoos valley there are around 250 farmers under which 17 'emerging or resource poor farmers', the historically disadvantage individuals (HDI). The government (financially) supports HDI to start farming. A number of problems or challenges came up during the interviews with the emerging farmers (figure 3:6).

The main issues mentioned by the established farmers are:

- *There is a low to zero production with bad production results.*
- *The emerging farmers (from outside the area) have a lack of interest, and have problems to work within a team.*
- *Lands need to be larger and better situated so they are less vulnerable for floods.*
- *Training and long-term support by mentors is required (and need to be accepted) to improve capacities.*
- *Through a shortage of good lands and enough water, the emerging farmers can not start or further increase their production.*

Figure 3:5 Emerging cattle farmer in Loerie interviewed.

Additional to these comments DWAF and GIB recognizing the following problems:

- The fact that they do not use all their water even though they have to pay for the full quota. They have not the capacity to ever use all their water which results in wastage sometimes. GIB is improving this situation by allocating their surplus water to other farmers on a yearly basis and with agreement of the emerging farmers.
- Lack of financial resources to sustain their operations.
- The size of their holdings is not economically viable (DWAF 2003).

4 Watershed restoration process

4.1 Baviaanskloof restoration model

Unsustainable agricultural development is the primary driving force in the Baviaanskloof. Forthcoming environmental pressures resulted in a change in the state of the watershed and the thicket biome. These changes have impacts on the hydrological, ecological and economic functions of the environment and on the provision and regulating services. There are a range of responses to prevent, compensate or adapt to the changes in the state of the watershed. Responses can be seen as negative driving forces since they aim to redirecting production patterns (Smeets et al. 1999). The Driver-Pressure-State-Impact-Response (DPSIR) framework in figure 4:1 is used to obtain a broader scope on the valuation of the economic impacts, and the contribution to the restoration project. The Baviaanskloof restoration model provides a more detailed understanding of the relationship between the positive and negative factors influencing the watershed services. The causal chain relations in the model are simplified, since it is far more complex in reality and not all the relationships are clearly understood. However, it is clear that, some of, the described services are particular valuable for the downstream water users. The impacts of these potentially valuable services are identified and the inter-linkages are described. The key parts of the model are used to structure the coming paragraphs. In appendix 3 the full model is given.

Watershed degradation by agriculture

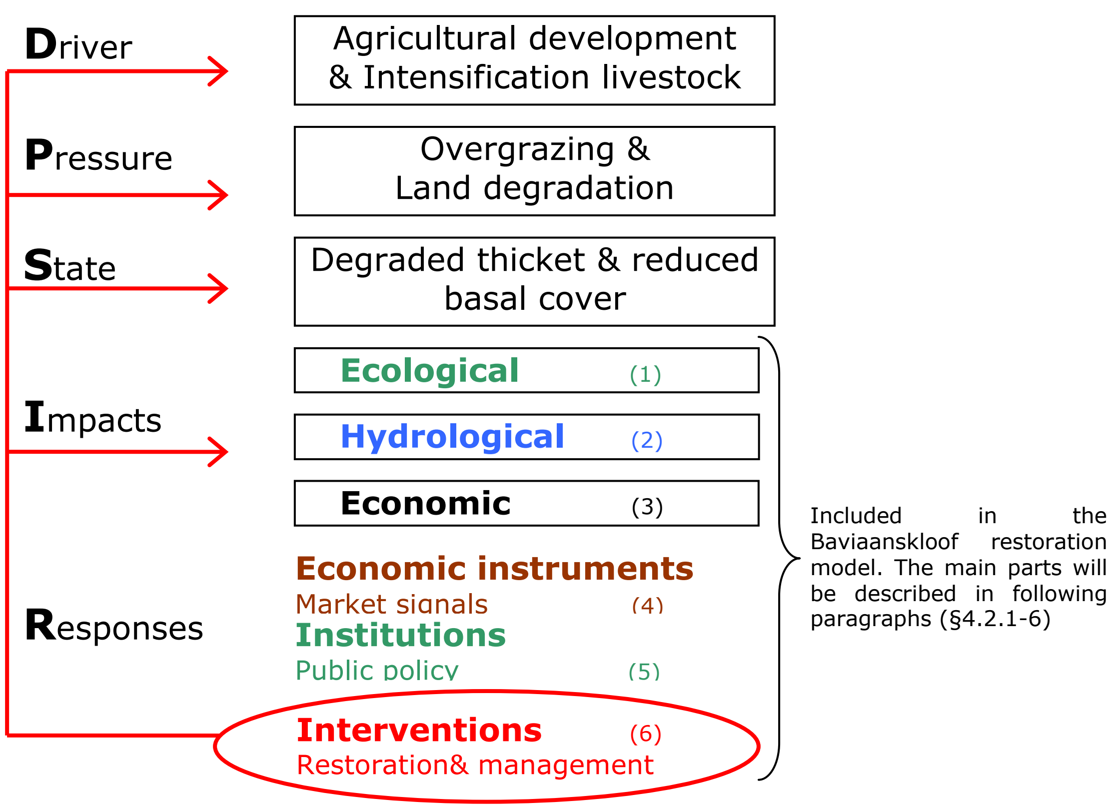


Figure 4:1 DPSIR framework, used to depict the wider context of the subtropical thicket restoration project in the Baviaanskloof watershed (based on restoration model appendix 3).

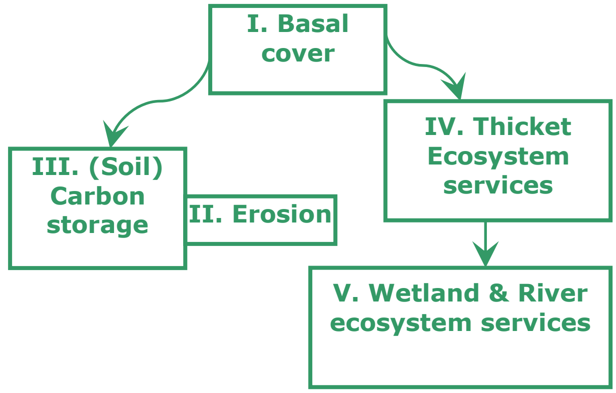


Figure 4:2 Ecological impacts

4.1.1 Ecological impacts

The ecological impacts of thicket restoration, as presented in figure 4:2, will be described in this paragraph.

Ecological impact I: Need for basal cover. Intensive pastoralism with goats transformed semiarid thicket in the Eastern Cape from a dense vegetation of tall shrubs to an open landscape dominated by ephemeral grasses and forbs. The removal of mega-herbivores contributed to the degradation as well. It is demonstrated that mainly elephants play an important role in maintaining vegetation structure. Elephants encourage coppicing in woody shrubs and promote the development of a 'skirt' around *Portulacaria Afra* plants (Lechmerre-Oertel 2003). About 800,000ha of thicket (which prior to the introduction of goats had a closed canopy and includes Spekboom) have been transformed in this manner, with only 10% remaining intact (Lechmerre-Oertel 2003). Heavy browsing by goats can transform thicket from a dense closed-canopy scrubland into an open savanna-like system with a cover of ephemeral grasses and forbs within a few decades, and possibly even within a decade. Spekboom and other succulents are susceptible to overstocking, often being completely removed from the landscape. This results in disrupted nutrient cycles, slow rates of water infiltration, poor water-use efficiency and leads to a state of desertification that is difficult to reverse (Powell et al. 2006). Broad scale thicket restoration is therefore required to restore the degraded lands and create a protective basal cover. Vegetation cover plays also an important role in determining the hillside erosion rate (Procter et al. 2007).


Figure 4:3 An erosion gully in a valley of degraded thicket

Ecological impact II: Erosion. Watershed protection through thicket restoration leads to a reduction in runoff and soil erosion (Landell-Mils et al. 2002). Good basal vegetation coverage is a key factor to control the balance between soil formation, which is extremely low in South Africa, and the soil loss. The extensive root system of the Spekboom is able to hold the soil more firmly in place and resist landslides compared to heavily disturbed watersheds. A 30 percent cover is often given as a critical threshold between erosive and non-erosive conditions, according Rowntree (2004 cited in Nortin 2008). The canopy cover of Spekboom further protects the soil surface from the raindrop impact, which causes surface sealing (capping) and splash erosion (Tainton 1999). The hillsides and steep slopes in the Baviaanskloof are especially vulnerable for erosion. The farmers in Baviaanskloof acknowledge that the formation of dongas is a fact, as can be seen on figure 4:3 (Noirtin 2008). The losses of the valuable top soil (including nutrients) are substantial and represent a considerable financial value to the upstream farmers. The reduction of erosion on degraded lands can also enhance the land value and improve its marketability (Coetzee 2005;Tainton 1999). Nevertheless the value of these economic implications will be difficult to estimate.

Ecological impact III: Carbon storage. When the thicket is full-grown the dense canopy does not only keep the thicket floor cool, but also protects the soil from the impact of heavy rain. This combination of coolness and dryness results in slow decomposition. This affects both the organic mulch on the thicket floor as well as the carbon-rich organics in the soil. Consequently, large amounts of organic carbon accumulate in the soil, improving its fertility and ability to retain moisture. Spekboom lands store about 130tons of carbon in the soil, a value equivalent to that recorded in many forest types and 10 to 50 times more than in other semi-arid ecosystems. The succulence of Spekboom combined with year-round rainfall may overcome the water-constraint in photosynthesis with as a results a higher production of biomass than normally expected on climatic grounds (Mills et al. 2005).

Figure 4:4 Fence-line contrasts between intact and degraded thicket (Boshoff 2005).

Ecological impacts IV & V: Thicket, Wetland and river ecosystem services. There are many ES provided by the thicket, wetland and river system. According De la Flor (2008), the most important ecosystem services provided in the Baviaanskloof for the communities and farmers are the:

- *Production services:* fuel wood, construction material, medicinal plants and pharmaceuticals (e.g. aloe), fodder, hunting and honey.
- *Regulation services:* pollination, water supply and regulation, carbon sequestration, soil retention and disturbance prevention.
- *Habitat services:* biodiversity and horticulture.
- *Information services:* eco-tourism.

Box 4:1 Uncertainties in the hydrological benefit of thicket restoration

A study undertaken by Lechmerre-Oertel (2003) tested the hypothesis whether "transformed succulent thicket increases runoff volume, sediment concentration of runoff, soil erosion and loss of organic matter at a patch scale (100 m^2). Runoff and water-borne sediment were measured from runoff plots established across replicated fence-line contrasts as seen in figure 4:4. Data was collected from eight extreme weather events over two years". The final results didn't show significant differences between runoff and erosion across the intact and transformed site. Each extreme weather event was unique in terms of its runoff response and the results where inconsistent. The outcome can be ascribed due to differences in the cover of ephemeral forbs and weakly perennial grasses. Additional due to complex interactions between the nature of the above-ground vegetation, soil micro-topography and land use history. (Examples: runoff tends to distribute through animal paths, loose organic matter on intact sites is measured as soil erosion and much of the topsoil in transformed sites has been lost in the past). A recommendation was made for the need for longer-term catchment size experiments to generate a predictive understanding of the effect of transformation on runoff and erosion in succulent thicket. The Baviaanskloof will be a suitable research site as enough transformed thicket is available (see figure 4:5).

Figure 4:5 Degraded thicket on hill side western Baviaanskloof.

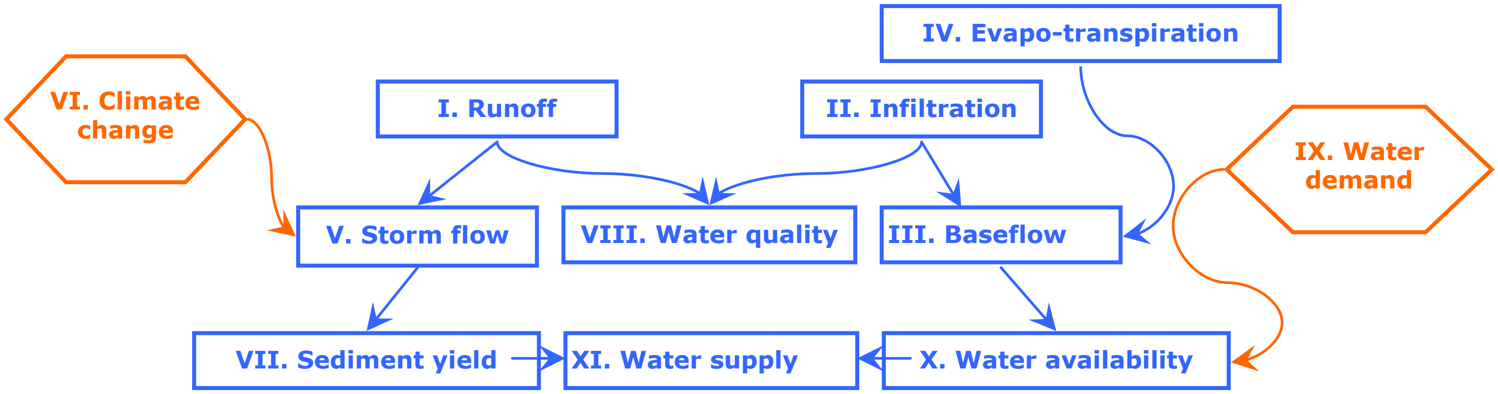


Figure 4:6 Hydrological impacts and External pressures.

4.1.2 Hydrological impacts

The different elements in figure 4:6 are supported by hydrological data and described in great detail in the coming paragraph.

Hydrological impacts I, II & III: Runoff, infiltration and baseflow. To get an indication of the impact of thicket restoration on the infiltration rate site specific data is required on e.g. rainfall patterns (intensity-depth-duration-distribution), soil types, gradient / elevation / aspect and current vegetation density. Only the latter factor can be modified by thicket restoration, which will be most effective on steep or moderate slopes with a low vegetation density. As box 4:1 indicates there is an uncertainty of the actual hydrological benefits of thicket restoration. The creation of wetlands has a much greater impact on the surface runoff reduction than thicket restoration, since it reduces runoff speed and keeps rainwater on the soil surface for as long as possible to increase infiltration (Coetzee 2005). However it is not always possible at reasonable cost. In the (mountainous) areas with a poor hydrological condition, thicket restoration is effective in reducing runoff, especially compared to pasture or range. In degraded thicket areas almost the entire litter layer is lost through run-off. The soils from degraded areas show a high level of crusting or capping (hard soil layer) because the soil is not protected against sun or the impact (kinetic energy) of falling raindrops. This decreases the infiltration capacity directly. The proportion of the landscape surface that would promote infiltration of water can decrease from 60% at an intact site to 0.6% at a degraded site (Lechmerre-Oertel 2003). If the thicket and under story cover increases the high water flows during rainfall will be reduced which improve water infiltration and soil water storage. This enhances water quality, baseflow and the overall ecosystem productivity (Lechmerre-Oertel 2003).

The pattern of runoff and soil erosion from landscapes is not uniform across all rainfall events. At the mostly small rainfall events (<10mm) or of low intensity (<10mm/day), the intact thicket canopy intercept most of the rain so it does not reach the soil surface. The water that does penetrate the canopy will infiltrate easily. During the high intensity rainfall events the umbrella nature of the canopy vegetation (of especially Spekboom) may actually shed water off the canopy towards the edge of the plant. Animals (livestock and/ or game) that browse along the edges of such vegetated clumps compact the soil and form channels that direct water around the outskirts of the vegetated patches away (personal observation). The animal path channels would allow water to be lost at a patch and landscape scale where it occurs (Lechmerre-Oertel 2003). The infiltration rate of an intact thicket site will therefore be lower during intensive rainfall but still substantial higher than on a degraded site is lower. According to H. Jansen (personal communication, April 1, 2008) the increase of baseflow will be somewhat less than the amount of water infiltrated. The restored thicket and the natural vegetation in the Baviaanskloof will take a portion of the infiltrated water through evapo-transpiration. It is expected that the total water availability will decrease in the beginning of the thicket restoration project since the evapo-transpiration is higher than the increased infiltration rate. In table 4:1 it can be seen that the mean annual runoff (MAR) from the Langkloof increased substantial (38Mm^3) most probably due to a reduction in the infiltration rate (IFR) caused by agricultural development.

Table 4:1 Hydrology of the Kouga-Baviaanskloof watershed. Based on (DWAF et al. 1995;Shand et al. 2004;Veelen van 2003).

River	**MAR** (Mm^3/a)	**Average IFR** (Mm^3/a)
Baviaanskloof	45.8	7.0
Langkloof (Kouga)	148 (1930) 186 (1998)	13.0
Total	231.8	20

Hydrological impact IV: Evapo-transpiration. Large scale Spekboom restoration can be seen as a stream flow reduction activity because it use water through evapo-transpiration ('green water') and hereby reducing the baseflow, river flow ('blue water') and the water availability. Especially when they are growing to maturity and the benefits perceived from an improved infiltration are still minor. Young regenerating plants tend to use much more water than mature and old growth plants (Perrot-Maître et al. 2001). There is no need for licensing according the (NWA 1998) part 4:36, because the restored thicket will only have a possible small negative influence on the water and the thicket is planted without a (direct) commercial purpose.

Hydrological impact V: Storm flow. Water in the Baviaanskloof arrives often in flash floods during a few months of the year, carrying a high sediment yield (Smith et al. 2000). This makes the Baviaanskloof highly susceptible to flood events. Each major flood reduces the area of arable land and reshapes the valley floor which made the land largely unsuitable for crop-based agriculture. In 1916 and 1932 floods removed almost half of the arable land in the lower Kouga River catchment (Boshoff 2005).

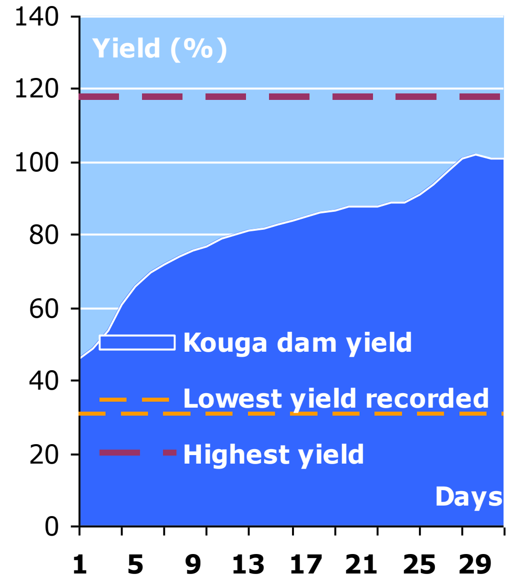


Figure 4:7 Rapid yield changes Kouga Dam March 2000 (based on data DWAF Cradock).

Figure 4:7 shows one of the most extreme and rapid yield changes that ever occurred since the records of the Kouga Dam. Within a month time the yield changed from a low (restriction) level (46%) to an overflowing dam (102%). Given the lowest yield (May 2006) and the highest yield (Nov. 2007) as reference. The development of the yield level over the last years is given in figure 4:10. It can be seen in figure 4:7 that extreme rainfall events upstream relatively easily fill up a dam to overflowing. The surface runoff from extreme rainfall events in the Baviaanskloof may reach the dam in only a few days and serious floods in the Baviaanskloof and in the Gamtoos River have occurred in the past. The Gamtoos River is known for its short duration of episodic floods, which carry heavy silt loads. Floods along the Gamtoos River rise rapidly and inundate large areas of flood plains (DWAF et al. 1993). An increased infiltration rate can decrease the peak discharge which protect the areas in the Baviaanskloof and reduces extreme runoff and erosion. Runoff from small rainfall events can be temporarily stored further down the valley in depressions, or recharge groundwater (H. Jansen, personal communication, April 1, 2008).

External pressure VI: Climate change. The storm flow events will most likely increase through the external pressure 'climate change'. The global warming scenarios are saying that the rainfall will be heavier and more intense where there will be also longer periods of drought. The high variance in water flows will increase the pressure on the natural system. Therefore there is a high need for an improved WS, such as flood control.

Hydrological impact VII: Sediment yield. A high sediment yield is one of the main water quality issues in the Eastern Cape (DWAF 1999). This stream flow sediment yield consists of the suspended load and the bed load that could come from soil erosion, erosion of the stream channels, gullies and sandbanks. The sediment yield include most likely important components such as Nitrogen and Prosperous soil which will be lost in the runoff from upstream areas (Burke et al. 2006). Although the N&P-concentrations are still relatively low to cause problems at the Kouga Dam. To get an indication of the annual sediment yield delivery, and thus soil loss, estimations are made in table 4:2 based on the measured turbidity at the raw water of Loerie WTW.

Table 4:2 Estimated total sediment deliveries to Loerie WTW in 2007.

Year	Water delivered	Total sediment	Sediment December only
2007	30 Mm^3 Loerie WTW	4,853 ton	1,387ton

The average measured turbidity (NTU) is converted to Total Suspended Solid (TSS) in Mg/L using the conversion factor of (TSS =1.26 NTU) from an other watershed based on (Lews et al. 2002). This factor and the calculated values are indicative as pattern of magnitude, but not an absolute value. Differences in watershed geology, slope and aspect, soils, discharge (m^3/s), vegetation, and land use influencing the conversion factor (Niekerk et al. 2006).
The numbers in table 4:2 are reflecting the sediment delivered to the Loerie WTW only. By extrapolating this data the total sediment yield, coming from the upstream area, will be 13,224ton. This number also includes the sediment in the runoff water coming from the downstream lands above the irrigation channel after heavy rains. However this is negligible according to GIB, but significant according Kouga municipality. The high variances in the sediment yield are influenced by different factors such as rainfall, runoff and vegetation cover (Benhagen et al. 2006). The peak in the month December is caused by a heavy flood upstream which broke some of the many sand-clay farm balancing dams. This event is the main reason for the high values. The sediment yield can vary per location especially since extreme rainfall events tend to occur over limited areas. The daily and even annual loads have a high variability. Therefore cumbersome and expensive sampling programs over long periods (5-7 years) are required to determine suspended sediment loads accurately (Rooseboom 1999). For calculating the dam sedimentation, 1.5ton sediment stands for 1m^3 of lost water storage.

Hydrological impact VIII: Water quality. The quality of the water in the Kouga Dam is good as shown in the weekly and monthly quality reports from DWAF. As Boshoff (2005: 23) argues:

> "The water supplied by the mega-reserve of the highest quality and this obviates the need for expensive treatment downstream to remove impurities. From the above, the present and future importance of the Baviaanskloof area as a sustainable source of good quality water for human, agricultural, industrial and environmental consumption downstream is obvious."

However the quality is affected by upstream farming practices (e.g. use of chlorine based fertilizers) and domestic use. (E.g. currently there are serious problems with sewage that flows into the Kouga River in the upper catchment, Langkloof. Many sewage plants of the Koukamma municipality are dysfunctional). Other water quality problems seem to occur when the Kouga Dam has low yield. Farmers in the Gamtoos valley have reported higher concentrations of manganese when dam levels have been low which can results in blockage of the micro irrigation system (DWAF 2003;Niekerk et al. 2006). The treatment cost at the Loerie WTW increases at these high manganese levels. Occasionally a low-Ph, due to floods, can cause problems downstream such as acid soil and ineffective spray chemicals. As Boshoff (2005: 28) mentioned the important purification service of the Baviaanskloof need to be sustained improved in the future (through restoration).

Hydrological impact IX: Water availability Kouga Dam. The Kouga storage dam is supplying water continuously to the Gamtoos valley and NMMM. The yield of the dam varies per month as can be seen in figure 4:9. Over a time span of 8 years it can be seen that there is a relatively low yield in autumn (April) and high in spring (August). The dam average is varying between 60-80%. Figure 4:10 put these average numbers in perspective and shows that they should be used with caution. The downstream water availability can be increased whether an overflow event can be levelled over a longer period of time what reduces the amount of water lost through overflow to the sea. An increase of infiltration reduces the runoff and inflow to the dam. The travel time of infiltrated rainwater to the Kouga Dam is much longer compared to that of runoff surface water. This difference depends very much on the location of the infiltration or runoff (i.e. distance to the dam). Far upstream in the Baviaanskloof it may take long, as there is interaction between the flowing river and the slow groundwater. Downstream in the Baviaanskloof it will be in a magnitude of weeks to a few months. The Baviaanskloof is a shallow, relatively fast reacting system as the good groundwater quality indicates little / short interaction with the environment. The infiltrated water leaves the area relatively fast. However, not that fast as the surface runoff from extreme rainfall events which may reach the dam in only a few days and serious floods can occur. The increased infiltration thus causes attenuation of peak discharges which protects the areas upstream and downstream (H. Jansen, personal communication, April 1, 2008).

External pressure X: water demand. The increased water needs by the different water users, as described in §3.3.2, places a high pressure on the water availability.

Hydrological impact XI: Water supply. Increased water availability and a reduced sediment yield (in the dam) can increase the yield and water supply from the Kouga Dam as described in figure 4:6. The supply can also be increased when the water holding capacity in the Baviaanskloof improve through thicket restoration. The storm flow peaks can be levelled off by infiltration and create a higher baseflow. The water lost through overflow can be reduced and used later on. However extreme overflows can be levelled of to a certain extent and water retained can be used only in a relative short period.

- *'To collect all the overflow water more than 3 Kouga Dams are needed'* (P. Joubert, personal communication, April 6, 2008).

An increase in the water supply possibly reduces the replacement cost, since more water is supplied at the (low) restoration cost into the current system. This cost can be compared with the other possible augmentation options, such as the construction of the Guernakop Dam in the heart of the Baviaanskloof nature reserve (§5.3) (DWAF 2003;Joubert et al. 2000).

4.1.3 Economic impacts

This paragraph will describe the different economic impacts given in figure 4:8 where in chapter 5 the impacts will be valued.

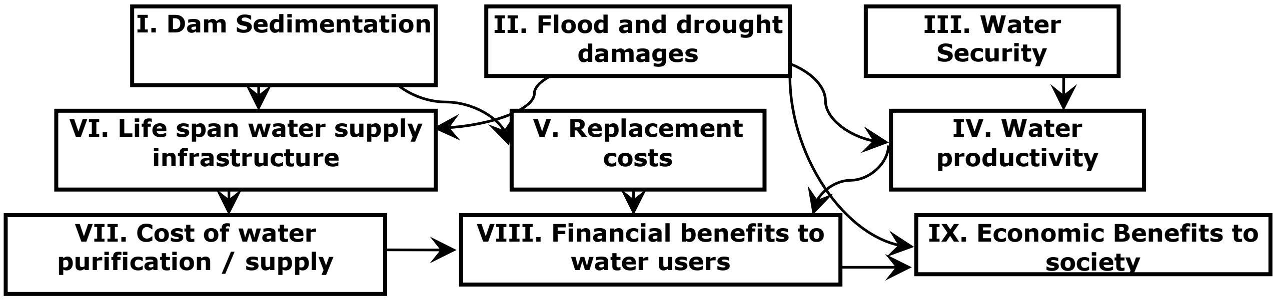


Figure 4:8 The interrelation between the economic impacts of watershed restoration.

Economic impact I: Dam sedimentation. The sediment yield of river water causes substantial sedimentation of the dams in South-Africa, including the Kouga and Loerie Dam as shown in table 4:3. This dam sedimentation results in a lower storage capacity and lower water supply. There are plans to remove the sediment out of the Loerie Dam according J. de Kock (personal communication, April 8, 2008). Estimating the dredging cost at R15/m^3 (Mander et al. 2007), the cost of this exercise will be around R9,900,000 for the full load.

Table 4:3 Siltation survey results as percentage of the net capacity of the Kouga & Loerie Dam. (Based on data: DWAF Cradock and H. Lodewijk, personal communication, September 22, 2008).

Kouga Dam Lost storage	**Net capacity** 129.72 (Mm^3)	1961	**Loerie Dam** Lost storage	**Net capacity** 3.99 (Mm^3)	1969
1.12%	128.27	1985	15.79%	3.36	1984
±3 %	125.83	2008	16.54%	3.33	2003

In general there is a large under-estimation of the extent of sediment build-up upstream of the dam reservoir (Rooseboom 1999). The Kouga Dam reservoir has a length of 30km and experts assume that, because of a lower velocity of the water, the process of sedimentation starts far before the dam wall. Thus the sediment build-up could occur from a considerable distance upstream of the dam and higher level of sedimentation is likely. The water users (should) have incentives to support restoration, to reduce the sediment yield which will keep the dam working longer.

Economic impact II: Flood and drought damages. Watershed protection can reduce the intensity and the time span of floods and drought periods, but cannot influence the recurrence of these events. The drought in 2005/2006 is clearly visible in the Kouga Dam yield in figure 4:09. During this period the farmers in the Gamtoos valley had a 25% restriction and later on 35%. This resulted in an overall lower production and a lost income. The NMMM reduced the water use by 10% through a public awareness campaign. The recurrence off droughts and floods are expected on a 5-10 year interval (between 1:05 and 1:10 year). This is not a set interval as can be seen in figure 4:10. Major floods occurred in 1981, 1996 and 2007, while in the period 1984-1992 there was very little flooding. The major overflows are causing serious damage downstream the Gamtoos valley.

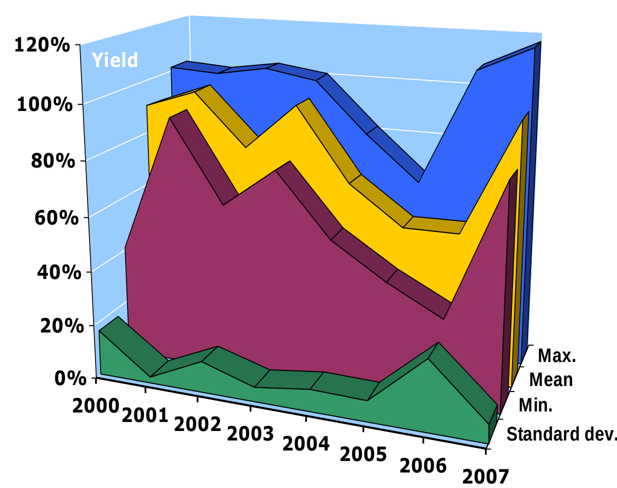


Figure 4:9 Development Kouga Dam yield average per year (2000-2008). (Based on data DWAF Cradock).

The overflow in 2007 alone was 242 Million m^3 of water; this is more than 3 times the total yearly water use of the Gamtoos valley and the NMMM combined and twice the size of the Kouga Dam.

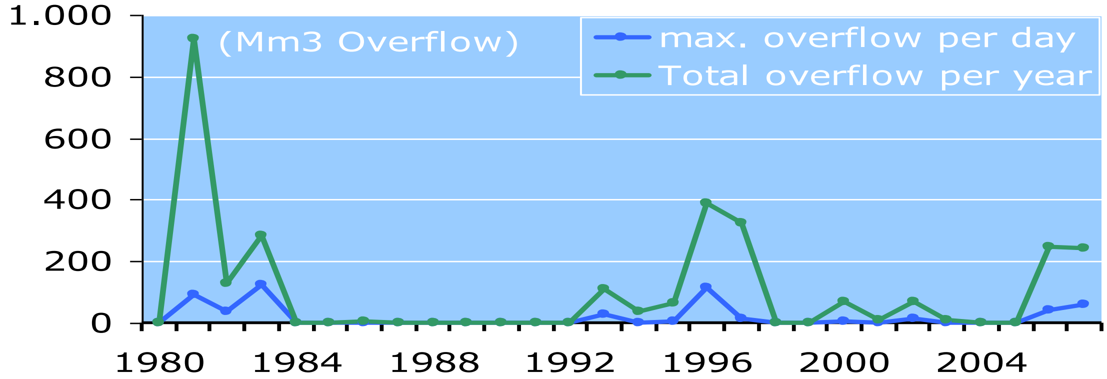


Figure 4:10 Major overflows of the Kouga Dam with a varying recurrence between 1:05 or 1:10. (Based on data DWAF Cradock).

Economic impact III: Water security. The large Kouga Dam is a buffer dam and the yield level is less sensitive to low flows in winter. The water security in the Gamtoos valley is directly related to the available yield in the Kouga Dam and indirectly to the yield in the other major dams providing the NMMM (the Churchill or Groendal Dam). Restrictions can be applied anytime but definitely when the level of the Kouga Dam is lower than 60% on March 1 or lower than 49% on September 1. DWAF decides in collaboration with the GIB and NMMM how severe the restrictions should be based on a complicated model. Restrictions will be introduced simultaneously in the whole Algoa area. The water security can be enhanced by catchment management in the Baviaanskloof as described in box4:2. In order to value the benefit of this increased water security the cost or benefit of: "the knowledge that water is not available every year and that crop failures will occur periodically" need to be estimated (Mallory et al. 2003).

Box 4:2 Baviaanskloof can enhance water supply
"The mega-reserve offers a critical opportunity to enhance the supply of potable water to agriculture and human consumers. This will be achieved by increasing water security from the Kouga Dam by including as much as possible of the catchments of the Baviaanskloof and Kouga Rivers. If the southern boundary of the existing Baviaanskloof Nature Reserve is extended to the Kouga River, around 75% of the Kouga-Baviaanskloof catchment will be under conservation management and this will permit the effective application of sound catchment management practices, thereby securing the supply of water"(Boshoff 2005).

Economic impact IV: Water productivity. Increased water security will lead to a higher water productivity, since the production losses will be lower and there will be a change towards higher value productions such as dairy or citrus, as described in §5.4.1.

Economic impact V: Replacement cost. Watershed restoration can be seen as one of the possible augmentation options for the water supply to the NMMM and the Gamtoos valley. The total cost of thicket restoration project will be compared to other water supply (engineering) options by using the Unit Reference Value.

Economic impact VI: Life span water supply infrastructure. It is expected that the sediment yield of the water in the Kouga Dam and irrigation channel have an influence of the life span of the water infrastructure. However, according to P. Joubert (personal communication, July 2, 2008), sediment does not affect the life span or maintenance cost of the irrigation channel, the pipes or the Kouga Dam. Through the high velocity in the canal, during floods or after cleaning (figure 4:11), there is hardly no sedimentation possible.

According to S. Milieux (personal communication, June 23, 2008), sedimentation can both weaken and strengthen the dam structure. The effect on the life span is thus uncertain and need to be investigated. A firm lower yield will have a positive influence on the dam life span. Less flooding can result in some minor benefits such as a reduction in debris, small damages and algae on the dam wall. Some citrus farmers in the Gamtoos valley mentioned that the high sediment yield (may) cause blockage of their micro-irrigation systems. Generally there is a low blockage potential for drippers (<50mg TSS/l) in the Gamtoos valley (Niekerk et al. 2006). After the November 2007 floods it turned to a medium to high blockage potential for drippers (>50 mg/L) for several months. Clogging in micro-irrigation systems results in ineffective usage of water and the lost of optimum yields (Niekerk et al. 2006). The life span of the water supply infrastructure can potentially be extended by the following improved services: constant water flow, reduction of overflow Kouga Dam, reduction sediment and reduction amount of debris (assumption).

Figure 4:11 Periodically canal cleaning.

Economic impact VII: Cost of water purification. The domestic water is treated in the Loerie WTW which is a relative modern facility, where the ones in Patensie and Hankey are small and outdated. All together 23.9Mm^3 raw canal water is treated for domestic usage. The quality end sediment level of the raw water is directly influencing the treatment time and cost, as described in §5.2.4.

The farmers are cleaning their irrigation water by the farm production filters. Sand, disc and screen filtration are most commonly used in the Gamtoos valley. The sediment yield of the raw water is one of factors that influence the operation and performance of these farm filters. According to some farmers at high sediment levels regular cleaning and backwashing is required. Especially the (pressure differential) screen filters clog fairly rapidly with a 'dark green' sludge on the screen. Manual cleaning (with chemicals) is needed, because backwash is not possible (Niekerk et al. 2006). The quality and sediment level of the raw water is directly influencing the amount of backwashing required. After the November floods some farmers had to clean their filters on a daily basis because filter clogging occurred within a day. The quality of the irrigation water varies both spatially (along the cannel and site branches) and temporarily (per month). It should be noted that other factors, such as (dead) algae of the irrigation canal or high manganese concentration, can play a role in the 'clogging process' which is still uncertain (J.Kruger, personal communication, May 15, 2008).

Economic impact VIII: Financial benefits to water users. The combined total benefit of the different economic impacts such as: increased water productivity and reduced purification and replacement cost. This can serve as a negotiation basis for payment for watershed services.

Economic impact IX: Economic benefits to society. The total benefits the society receives from improved Ecosystem cervices. This have positive spin offs for the secondary economic activities as described in §5.5.

4.1.4 Economic instruments

This paragraph is giving a preliminary indication if the water user is willing to pay (WTP) for the watershed service provided and whether there is a possibility for payment for carbon sequestration as described in figure 4:12.

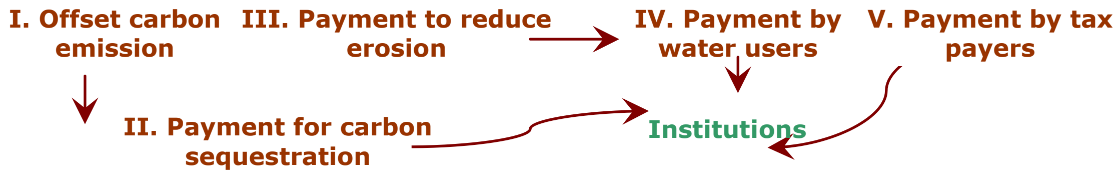


Figure 4:12 The economic instruments to finance or pay for the watershed Services (PWS).

Economic instruments I & II: Offset carbon emission and payment for carbon sequestration. Through a complicated certification procedure the restoration project is able to apply for global carbon credits that are linked to a number of potential international funding streams. However the application to small-scale afforestation/reforestation clean development mechanism of the Kyoto Protocol has failed. Nevertheless the voluntary carbon offset scheme indicates two potential alternative approaches for the forestry-based carbon sequestration. The first minimalist approach. is based on the voluntary carbon standard (VCS) only, which would be used in a single large-scale restoration. The second more individualist approach, combines use of the VCS with the Standards Climate, Community and Biodiversity Standards. This approach has the potential to deliver the environmental and social co-benefits of thicket restoration and respect the diversity of the landowners. The later requires high organisational institutional capacity. Based on Lorencová (2008), where a compressive analysis of the potential for carbon sequestration schemes and the required institutional capacities is presented. Above illustrates that there is potential for payment for carbon sequestration but the process is complicated and time consuming.

Economic instrument III: Payment to reduce erosion. Especially the NMMM, who runs the Loerie WTW, will be willing to pay for a reduction in erosion upstream since this directly relates to high sediment yield and an increase in water purification cost, as described in §5.2.4. The additional cleaning cost for farmers can be substantial during a period of high sediment yield.

Economic instruments IV: Payment by water users. There are different economic instruments available to finance restoration. Payment by the water users, who perceive benefits of the WS, is one of the proposed options (PWS). The main 'buyer groups' of these services will be the:

1. Direct buyers of water: DWAF, GIB and direct water users (farmers in the Langkloof and Baviaanskloof who receive some of the benefits).
2. Secondary buyers: KM, NMMM, farmers in the Gamtoos valley.
3. Tertiary buyers: industrial and domestic use.

According to Procter et al. (2007) there is often a limited demand from potential buyers in PWS schemes. The farmer survey in the Gamtoos valley gave different results. A total of 77% of the farmers interviewed initially indicated to be WTP for WS. Ranking the WS according to the level of importance:

- *Higher water availability* *73%*
- *Higher water security* *65%*
- *Better water quality* *58%*
- *Storm flow reduction* *50%*

Nearly all the farmers are WTP for higher water availability, while there is lesser interest in storm flow reduction. However most of the farmers did not have a preference in a specific WS as they say: *'they al come together'* or *'one cannot go without the other',* what will probably be the case.
The remaining 23%, who are not WTP, are nearly all emerging farmers who cannot pay for WS, since they have already problems to pay the standard water bill. It was not possible to ask specific questions related to their benefit of WS, because they lack the knowledge of understanding, interest and are mainly busy with their own major day to day problems (e.g.

fixing materials, work on the field, arranging transport etc.). Most of the reactions given by the farmers on the different survey questions are given in appendix 6. A bundling of some of the reactions is given below. The main reason and comments farmers had for paying or not paying for WS are:

- *To ensure that the future water supply of the Gamtoos valley is secured and of a good quality.*
- *To receive the benefits off (all) these services.*
- *Already paying (high) enough levies anyway.*
- *The water should be to good standards anyway.*
- *Restoration should happen nearby, e.g. on the slopes in the Gamtoos valley.*

It is shown that in this stage of the research project it is not feasible to estimate an amount to be paid, as the following farmers' comment proves:

- *Insights in the costs and possible benefits are needed to specify the 'WTP amount'.*

According to P. Joubert (personal communication, April 24, 2008) water users will be WTP for a higher water assurance, but he cannot say how much.

There are a range of criteria that need to be met before the farmers are WTP for the benefits of restoration. A combined selection:

- *There should be direct, visible and clear benefits with enough evidence.*
- *If there is a benefit, we must contribute to cover the restoration cost (as an investment).*
- *The price should be reasonable, affordable and profitable.*
- *Farmers should only contribute a small amount of the restoration cost, other water users (NMMM) and sectors (tourism) should pay more.*
- *Feedback is required, so I can see where I pay for.*
- *Get insights in the important project aspects such as: project size, time span, planning, financials, returns and monitoring.*
- *The project should be well managed and implemented.*

These criteria are mostly in line with the following general 'buyer's criteria' for PWS given in literature (Katoomba group et al. 2007):

- Include in the processes of negotiation.
- Provide a basis of trust.
- Clear hydrological rationale.
- Proof of the perceived benefits.
- Reliable service delivery.

The criteria given by the farmers are *not absolute* and should be interpreted and used as a guideline. Most of the farmers indicated that they are WTP even trough there may be weak scientific evidence.

- *If you don not do restoration, we can be stuffed. Get the original status back. Must be a priority, because water is our most limited resource we need for development.*

The statement of a farmer underlines that watershed restoration is important and potentially seen as a limited factor for future development, as schematically visualized in figure 4:13. This is in line with other PWS experience where full scientific knowledge is not required and the 'dialogue' is more important (Perrot-Maître 2006). However the whole 'package' of farm criteria need to be included in the PWS scheme and maximized where possible. Opportunities of PWS in Baviaanskloof are given in § 5.3.2.

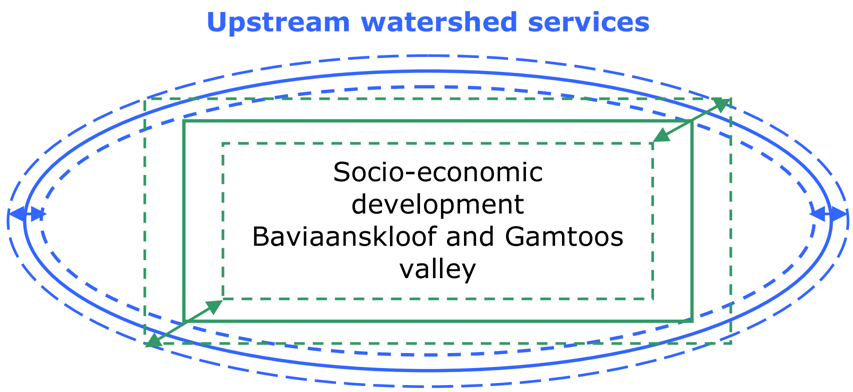


Figure 4:13 Social and economic development seen as wholly depended on the growth of the upstream watershed services provided. Based on: (Mallory et al. 2006):7.

Economic instrument V: Payment by tax payers. The wide range of economic benefits to the society, as described in §5.5, justify that some government money can be used for the implementation of PWS to finance thicket restoration.

4.1.5 Institutions

One or more institutions will be required to implement and manage the restoration project as presented in figure 4:14.

Figure 4:14 Required institutional arrangements.

Institution I: Service supply agency. Upstream landowners (farmers and communities) in the Baviaanskloof and Langkloof are supplying the actual current WS together with ECPB. Where the land in the Baviaanskloof nature reserve is already protected through its conservation status, the land in Langkloof and Baviaanskloof is still under pressure of agriculture. A service supply agency is needed to protect and improve the services provided by the watershed. ECPB and or the Baviaanskloof farmers union can be responsible for this role since they are already the main WS suppliers at present.

Institution II: PWS implementing and facilitating agent. The implementing agent is responsible for negotiating with the different stakeholders and establishing of contracts with regarding payments for the watershed services (Mander et al. 2007). "The facilitation agent is to assure the watershed is protected and sufficient managed by the upstream landholders. Specific watershed management activities need to be established and monitored. The downstream beneficiaries need to return the set payments" (Perrot-Maître et al. 2001).

To set up a PWS an institution is needed as responsible party for the implementation and facilitation. DWAF (CMA), ECPB, GIB (WUA), NMM-, Kouga-, Cacadu-, Baviaanskloof Municipality, WfW (STRP) or NGO's are the first established institutions that can be recognized as potential parties to fulfil this role. A broad analysis on the capacities of these institutions and possible arrangements is required to find a suitable implementing agent. A full study on the institutional capacity and development of PES in the Baviaanskloof is done by Javed, H.A. (in press.).

Preferred institution farmers (survey outcomes)

An important factor is that the water users downstream have trust in the implementing and facilitation agent. In figure 4:15 it can be clearly seen that the farmers in the Gamtoos valley prefer GIB and not prefer the municipality.

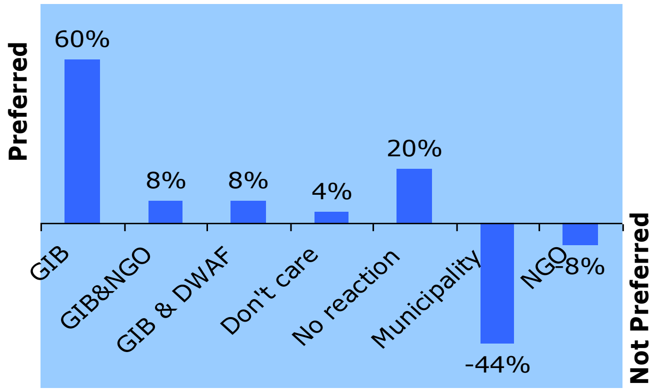


Figure 4:15 Preferred institutions, by the Gamtoos valley farmers (#25), to facilitate the payment and implementation of the restoration project (survey results).

The motivation for the different (combination) of institutions can be summarized as:

- **GIB:** *they are familiar, trustful, transparent, efficient, experienced (through WfW) and a good implementation agency.*
- **GIB & NGO**: *a balanced cooperation where GIB is focused on water and financial aspects and the NGO (as subcontractor) on the interest of nature*.
- **DWAF & GIB**: *DWAF, supported by GIB for the implementation, since they are close by.*
- **Don't care**: *if they equipped and cheap it is ok.*
- **No reaction:** most emerging farmers did not or could not answer the questions due to a language barrier, lack of knowledge or lack of interest.
- **NOT municipality:** *since they do not have the capacity (experience, skills, materials, time), are not trusted, cost effective and can not operate a long term project (sustainable). They don't steal the money, but they eat it!*
- **NOT NGO:** *are not effective and are limited in their implementation by the men in charge.*

The unmodified reactions by the farmers on the different institutions are given in appendix 7. In the motivation of the farmers it can be seen that trust is an important factor. This is shown in various PES studies worldwide. The farmers in the Gamtoos valley have a clear distrust in the municipality. This distrust is often based on their or others (bad) experience which seems to give the municipality as well as the NGO a deprived imago. The ECPB was not mentioned by farmers since they are not familiar with them. Farmers prefer GIB as the implementing agency because they have shown their skills. Making use of existing institutions that have proven skills and experience (e.g. GIB) is the most (cost-) effective way and heavy investment in capacity can be avoided. At present, GIB is implementing, on behalf of DWAF, 17 working for water (WfW) poverty relief programs including the most important one the STRP. GIB works according the WfW policies, where they employ contractors who form a team of poor people to do the rehabilitation work. In total 65 contractors and 1,000 people were employed in the WfW program (2007).

Monitoring of the proxies

At present there is no (clear) baseline established for the WS provided by the Baviaanskloof. The initial status of the watershed need to be identified or estimated before a change in (improved) WS over time can be monitored (Katoomba group et al. 2007). Accurately measuring of WS is extremely difficult and costly, because of the complicated ecological relationships. The contribution of a hectare thicket to the infiltration rate and baseflow increase depends on various factors as shown in §4.1.2. The intangibility of these WS gives the need for developing (simple and straightforward) indicators to measure and monitor the WS, which is an essential element of PWS (Meijerink 2007). These indicators are relatively coarse estimates or 'proxies'. Most PWS schemes rely on observable proxies, such as actions or outcomes (e.g., the amount of thicket cover). Developing appropriate proxies requires an understanding of how activities (e.g. thicket restoration) relates to watershed functions (e.g. surface water inflow) and, ultimately, to watershed services (e.g. fresh water supply) (Jack et al. 2008), as described in appendix 3.

The use of the proxies can be illustrated with two opposite examples:

1. The world famous PES program in Costa Rica uses a simple proxy: "whether a parcel is forested or not. The proxy does not take into account variation in the levels of ecosystem services that forested plots provide due to the number and type of trees present, proximity to surface and to ground water, or slope" (Alpizar et al. 2007).
2. In Drakensberg, South Africa a detailed ecology-hydrology-economic model was developed which made all the costs and benefits of the PES program spatially and temporally explicit. The final PWS will be based on either "the management undertaken, the results of that management activities (e.g. hectares restored) and the quantity of service delivered (the least used and often most difficult to measure). It is likely that in this payment system, a combination of the all three measures will be required, with the management effort, basal cover and hydrological benefits being measures in the short, medium and long term respectively" (Mander et al. 2007).

4.1.6 Interventions required

Implementing thicket and wetland restoration coincide with a number of management activities as figure 4:16 illustrates.

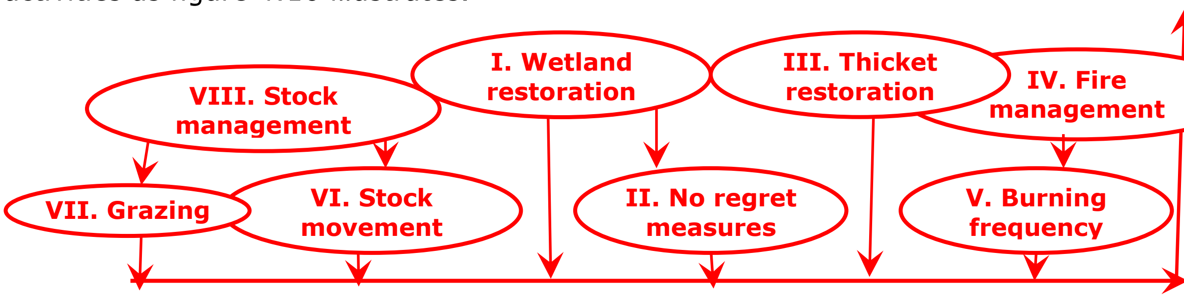


Figure 4:16 Implementation and management activities required.

Interventions I & II: Wetland restoration and no regret measures. Wetland restoration will include 'no regret measures', such as the removal of the balancing dams in the Baviaanskloof with as final result the facing out of irrigation. The wetlands should be created in areas where they can intercept, store and slowly release the surface runoff after storm events (H. Jansen, personal communication, September 24, 2008). A study is undertaken by Paoli, G (2008) to explore how the different measures can be financed and implemented. Most of the farmers in the Baviaanskloof are interested in restoration. Through progress presentation at their regular communal meetings updates of this research and the overall project were given. It is import that a substantial part of the restoration area is outside the Baviaanskloof reserve and higher up in the watershed on the western side.

Intervention III: Thicket restoration. Thicket restoration in the Baviaanskloof should happen preferably in degraded areas on the hillsides where the hydrological impacts are expected to be highest. The Baviaanskloof River is a typical fast flowing flood river as it arises above 1,100m and ends in the Kouga Dam at 150m above sea level over a distance of 110km. Figure 4:17 shows the higher range 'low-hanging-fruit' areas where the management interventions have the biggest response. The criteria to identify these areas are:

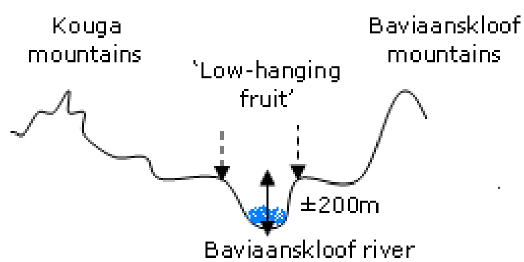


Figure 4:17 Schematic cross section of Baviaanskloof nature reserve. Based on: J. Buckle (personal communication, June 25, 2008).

- Volume, additional baseflow (m^3).
- Area intensity, additional (M^3/ha).
- Relative importance, additional baseflow of MAR (%) (Mander et al. 2007).

Selection can be based on modelling or estimates. The total area in the Baviaanskloof and BNR where restoration is possible still needs to be determined. Variables are the current size and state of the vegetation cover and the possible suitable areas (based on: geology, soils, slope angle and aspect).

Interventions III–VIII: Diverse management activities. As revealed by De la Flor (2008: 92) there is a high need for stock management in the Western Baviaanskloof to control the grazing intensity and stock movement. The grazing capacity of the field was estimated to vary from 18 to 40ha/ LSU[9] (valleys and low hills to rocky and steep areas) and average estimated on 30ha/LSU. Currently the livestock density is much higher 20.2ha/LSU (wildlife excluded) on an estimated grazing area of 25,102ha. This demonstrates that current stocking levels are not sustainable and leads to degraded areas of thicket. This is underlining the need for proper stock management as intervention as part of the thicket restoration project. Further agri-environmental support is needed to improve farm practices in other areas. Fire management and burning frequency is needed to prevent the uncontrolled fires and increase the carbon storage. However this tool is not needed for untransformed full grown thicket which is not fire prone (Tainton 1999).

4.2 Benefit distribution

The benefits are made temporally and spatially explicit where possible. The downstream water users in the Gamtoos are randomly interviewed spread out over the area as can be seen in figure 1:2. An estimated (monetary) value is given to these benefits at a specified time interval. This is needed to get a first impression of the distributional effects of the costs and benefits of watershed restoration.

4.2.1 Spatially

Some WS are delivered at different intensities upstream and downstream where others have an equal intensity to all beneficiaries. The upstream benefits of restoration of degraded thicket are site specific. The farmers will perceive local and small scale benefits on their land such as an improved infiltration, reduction in runoff and less erosion. Through the well designed water conveyance system in the Gamtoos valley all the water users perceive a benefit of an increased water security, reduced drought period and intensity, improved water quality and reduced sediment yield. However the level of economic benefits varies between the different usages. For example, Loerie WTW perceive high benefit of a reduction in sediment yield as described in §5.2.4. An increase in water supply, if any, will at first not be available for the water users, as discussed in §5.1.1. The benefit of a reduction in overflow period and intensity is mainly for the farmers near the Kouga Dam and along the Gamtoos River. Especially the emerging farmers with low lands along the river are affected by the overflow. This all indicate that benefits of WS are only perceived at a local level, i.e. in the Baviaanskloof and in the Gamtoos valley. The opposite is the case with carbon sequestration. As §4.1.4 indicates, the main benefits of carbon storage in thicket will be perceived on a global level. However the financial transfer delivers important (individual) benefits to the service provider.

4.2.2 Temporally

The temporally benefit distribution will depend on the time spend on negotiation, implementation, restoration, propagation, the growth of Spekboom and the monitoring process. The estimated time horizon of thicket restoration is 40 year, since at that stage the restored thicket will be full grown and the possible maximum WS can be delivered. It is most likely that a certain threshold need to be passed, estimated ±15 years, before a change in WS becomes visible (Pagiola 2004). This is illustrated by following two examples based on the Katoomba group et al. (2007):

- Thicket restoration does not re-create the conditions of old-growth (thicket) forest within the lifespan of most programs designed to restore hydrological conditions. Through evapo-

[9] The amount of hectares that one Large Stock Unit (a 450kg animal gaining 500g a day) needs to graze sustainable.

transpiration it is possible that the initial response to thicket restoration is negative for downstream water users. This if the amount of water taken up offsets the benefits to the stability of the watershed.

- Thicket restoration is unlikely to reduce flooding risk to the same degree as the former old-growth (thicket) forest because recovery of degraded soils often takes several decades and the impacts on drainage infrastructure (animal paths, dirt roads) are initially not undone by tree planting. Additionally most of soil is already washed away which slows the down the thicket growth.

The farmers in the Gamtoos valley underlined that their benefits will be gradual over time. Most of the estimated benefits of an assured water supply were spread over a 1-10year period (see appendix 6). However, some farmers mentioned that the benefits will be intergenerational distributed. The information on these short-, medium- and long-term direct and indirect benefits and opportunities is important in the decision-making processes. This gives the rationale to invest in WS and to see if or when the project become beneficial (Perrot-Maître 2006).

Financial returns

The actual payments may take a long time to materialize since, the services delivered by restoration need to be to some agreed standard before collecting payments is possible (Gutman 2003). Some monitoring results on the hydrological data (e.g. water supply and security) or estimates are required before downstream water users are willing or obligated to pay for WS. It can take more than a decade before the described WS will be delivered. Different payment mechanisms (e.g. user fees, §6.3.1) can solve this problem by prepayment. A good example is the working for water (WfW) program. Till so far there are no financial returns based directly on the WS. The program is funded mostly by DWAF and by a small water charge. The extra water generated through the restoration and the WfW program (alien clearing) is not allocated, since hydrological data of the improved Kouga Dam yield is required (Pagiola 2004). Thus at present the water users (farmers) are paying the small WRM charge towards WfW, with as 'only' result an increased assurance of supply (P. Joubert, personal communication, May 28, 2008).

5 Valuing Watershed services

The watershed services described in the previous chapter provides the necessary background to perform the economic valuation of these services.

5.1 Direct economic benefit water users

5.1.1 Increased water supply

The value of an increased water supply can be expressed by the annual rental or the capital value of water rights. This value is additional to the regular water prices and reflects the price that the water user is WTP for a long- or short-term increased water supply.

Water rights

An allocation or water right of 1ha means that you are allowed to irrigate 800mm which comes to a total of 8,000m^3 and can be used on an even larger area. Buying water rights is a long-term investment. In general the water rights in the Gamtoos valley are linked to a piece of land and can only be sold as one. However, mostly when a farmer has excess water rights or decides to stop farming; he keeps the land while selling the (excess) water rights. Therefore after a difficult approval process of DWAF (as discussed later) water rights can be sold separate from the land. The buyer can expect that the extra rights will be capitalized into a higher land value.

Table 5:1 The present and future demand for water rights by farmers in the Gamtoos valley. The given answers to the survey question (see appendix 6 for full results).

Do you buy or sell part of your water rights?	**Nr. Responses**[1] respectively ha/R	**Range** (..-...) **Amount** (ha)[2]	**Price** (1,000R/ha)
Yes, buy	*4/2*	*10-100*	*14-17*
Yes, sell	*2/2*	*20-25*	*20-55*[3]
No, but I am willing to buy	*15/12*	*3-80*	*10-30*
No	*2*		
Total average	*21/16*	*21.7*	*23.4*
Short term renting	*2*	*1-24*	
Long-term average	*6*	*30-200*	

[1] Some farmers gave only the amount of water rights (ha) they bought or want to by and not the price (R).
[2] One hectare stands for a water allocation / right to use 8,000m^3 per year on an unspecified area.
[3] This relative high number includes land as well.

Farmers in the Gamtoos valley are willing to buy water rights between R10,000 and R30,000 with a total average of R23,400 as given in table 5:1. The capital value of water corresponds than with 2.93 R/m^3, the price for permanent water trades. Some short-term, but mostly long-term renting is taking place in the Gamtoos valley. Long-term renting is mainly done by the dairy farmers because they have a high need for more water and are limited by DWAF to actually buy the water. Most of the farmers (54%) are interested in an increase in their water supply. This amount varies from 3ha to 100ha with a total average of 21.7ha. The main reasons, given by the farmers, to buy or sell water rights are:

- *Can put more (un-cleared) land under irrigation and thus increase (citrus) production.*
- *Increase land price / value.*
- *Have extra water available for drought periods, so increased security.*
- *Willing to sell the surplus water so don not have to pay the full amount.*

In 2003, Kouga municipality tried to buy water rights from farmers to secure the future water supply to Patensie and Hankey. The transaction did not succeed since there were no rights available. The price paid will (initially) be according market value (E. Oosthuize, personal communication, May 09, 2008).

The price of short term rented water rights, in a normal year, is not equal to the short term rental value of water as calculated in table 5:2. This can be explained that in a normal year enough excess water is available and through the GIB pricing policy, described in §5.4.2, the farmers are keen to sell their bought surplus water at the water cost price. Generally for long-term rental a small rental price is paid. During a period of drought or restrictions, or both, surplus water is not available or only in low quantities and higher prices. The reason for short term (temporary) renting is mostly when farmers use 100% of their allocation and need more water to finish the water year (starts 1st of July).

Table 5:2 The water right trade prices or capital value of water and the rental value compared for the three major water schemes in the Eastern Cape. Based on: (Nieuwoudt et al. 2004) and survey results 2008.

Water scheme	**Capital value of water** (R/m^3)	**Rental (annual) value** (R/m^3/year)
Sundays River	0.35	0.02
Orange river (inter-basin transfer)	0.88	0.05
Kouga- Gamtoos	**2.93**	**0.23**

The rental value given in table 5:2 is about 0.23R/m^3 for the farmers in the Gamtoos valley. This amount is based on an investment of R23,400, the total average water right price, and a discount rate of 8%. The capital and rental value in the Gamtoos is up to 10 times higher than in the Sunday or Orange river scheme. This can at first be explained by the high crop water productivity and high returns (§5.4.1). Secondly, the Gamtoos water scheme is extremely well managed, since water in the canal is constantly available, it is supplied under constant pressure (2-6 bar) for irrigation and the water delivered is measured accurately and automatically. This adds an extra value to the water as additional private costs (e.g. pumping) are lower. Thirdly, as discussed above the calculated rental value does not always correspond with the actual value, depending on the varying water availability. Finally, the water resources in the valley are over-allocated resulting in a high demand and WTP. It should be understood that the willingness to buy or sell is heavily fluctuating as it is a direct response to the economic conditions (e.g. the price of the product) (Nieuwoudt et al. 2004).

Water right transfer and distribution

The possibility exists that future large-scale water trading comes up involving farmers in the Gamtoos valley, the NMMM, or to a lesser degree to Langkloof irrigators in the upper tributaries of the Kouga River, who wish to expand (DWAF 2003). These transfers will have various socio-economic implications. However, it is definitely not expected that DWAF will agree. The transfer of water rights is an unclear, complicated and long-term procedure. A correct understanding of section 27 of the NWA (1998) is required in order to submit a successful application to DWAF. In areas where water is available the primary focus of the application is to redress equity, promote economic growth, sustainable and efficient water use and job creation for every application. As the indicators for the allocation distribution are: equity (% of women & black users), efficiency & effectiveness (contribution to GDP/m^3 & employment/m3) and sustainability (%reserve requirements met) (Swarts et al. 2008). At present in the Gamtoos valley there are 25 out-standing water transfer which covers over 200ha. The transfers are mainly from vegetables to dairy or citrus; from dairy to dairy or between mixed citrus & vegetable farmers. Three of the handled applications were denied by DWAF, for not entirely complying towards section 27 NWA. If more applications are delayed, legal challenges are bound to arise (A. Murray, personal communication, June 27, 2008). A DWAF representative stated:

- *No water rights will be sold between white farmers, 'emerging farmers' will get the preference.*

Nevertheless if it is possible to increase the future water supply from the Kouga Dam, according to the yield-reliability curve of the dam (Mallory et al. 2003), the water value as calculated in §5.4 should be used as the 'efficiency & effectiveness' indicator. This can than be used in the decision making process of prioritizing which sectors should be given the preference in water allocation.

5.1.2 Increased assurance of supply

The estimated value of the benefits of an improved water security will be described mainly based on the farm survey results.

Restriction rules specific to each user

The assurance of supply differs per sector as can be seen in table 5:3. A greater but not absolute assurance is given to the users who will have a high economic cost and therefore not the resilience to withstand a reduced assurances of supply (DWAF 2006a). The percentages in the table are the targeted assurance of supply based on theoretical modelling and used to help decision making. A simplified calculation example:

Table 5:3 Typically priority classification system, target assurance of supply (Mallory 2005).

High	(strategic & Industrial)	99.5%
Medium	(urban)	99%
Low	(irrigation)	95%

> *With a drought recurrence level of 1:05 and a stable restriction level in the drought year of 25% of the allocation, the assurance of supply for e.g. irrigation will be: 0.8*100 + 0.2*75 = 95%.*

However none of these numbers are pre-set. The recurrence and intensity of drought is varying as well as the different restriction levels, as can be seen in table 5:4. Restrictions can be announced in the middle of the year. The possibility therefore exist that farmers already used 50% of their water in the first half year, what means that they only have 20% left if their total allocation is reduced with 30%. To determine the *actual real* assurance a long period of stable operation is required. At present it is debatable whether the theoretic assurance is correct (DWAF 2008b). The maximum restriction that the farmers in the Gamtoos valley have experienced in the past is 80%. According GIB this might be "too severe for the emerging farmers reliant on cash crops" and requested a maximum restriction of 70%. This will be considered in the '*Algoa Reconciliation Strategy study'* (2010) (Water for Africa 2006). Important to note is that in a regular year GIB does not use their full allocation. According to Water for Africa (2007:5) "it has been assumed that they will never utilize their full allocation because the assurance of supply is to low", as shown in table 5:4.

Higher water assurance increases water supply

Higher water availability in the Kouga Dam will lead to a higher level of assurance to the water users. Water delivered with a higher assurance is more valuable, since more water is supplied with a higher security. The rationale of restoration is that it possibly shortens the time span and intensity of drought, which will result in a lower period and level of restrictions in the future as estimated in table 5:4. For calculation of the future water supply a 10% reduction on the curtailment levels and the duration is assumed. This will improve the assurance of supply to GIB with 5%. Both GIB and the NMMM are interested in the increased water supply since revenue on water sales increases, where fixed cost stay constant. The restrictions for NMMM are applied in 3 levels if needed. Starting with increasing the public awareness (figure 5:1.), followed by an increase in the water tariffs for domestic users and later on for industrial users (Water for Africa 2006).

Figure 5:1 Increase the public awareness.

Table 5:4 Restoration may increase the future assurance of supply due to a lower period, and level of restriction.

Sector	Assurance of supply/ security[1] %		Allocation[3] Mm³/a	Total water supplied Mm³/a	Extra water supplied Mm³/a	Extra Value[4] 1.000R/a
Irrigation (GIB)	**Current**[2]	73.4	59	43.3	2.98	536.7
Irrigation (GIB)	**Future**	78.5	59	46.3		
NMMM (urban)	**Current**[2]	97.8	23	22.5	0.10	52.1
NMMM (urban)	**Future**	98.2	23	22.6		

[1] The product of the average restriction levels (1-3) combined with the frequency of the different restriction levels (% of time). These frequency levels are based on the different recurrence intervals, 1:10, 1:50, 1:100 and 1:200, as used in (Water for Africa 2007).
[2] The current assurance of supply is based on the 'acceptable restriction levels for the GIB' or on the 'Proposed restriction levels for the NMMM' (Water for Africa 2007).
[3] Based on the registered full allocation(DWAF 2003).
[4] Based on §4.5.2 raw water prices.

Estimated benefits to agriculture

At first the relation between an improved water security and the potential effect or response on the production system need to be determined. The current security levels definitely effect the production in the Gamtoos valley, what often resulted in an averting behaviour. Through the farmer survey an insight is gained of how farmers are affected by the water security and how they would change their management practices given the hypothetical water security of 90% (table 5:5 and 5:6). This definition of security was for the purpose of the interview simplified as: a drought and restrictions recurrence of 1:10year where the level of restriction was not taking into account initially.

Table 5:5 Overview of the importance of a secured agricultural water supply from the Kouga Dam (Survey results, #26, appendices 6 and 7).

Percentage of farmers who are-	Yes	No
completely reliant on water form the Kouga Dam	*81%*	*19%*
limited by the current water security of 80%	*65%*	35%
perceiving additional benefit with a 90% water security	*73%*	27%
changing their management practices at 90% security	*58%*	42%

Percentages are influenced by emerging farmers; none of them were interested in water security.

Some farmers using occasionally river water which is often of a bad quality. However nearly all farmers are reliant on the canal water supply. Most are limited by this supply and a higher assurance brings a range of additional benefits, a selection:

- *More security is needed otherwise there will be more restrictions in the future.*
- *Can use all my water and there is no need to save 20% of my allocation.*
- *Lower restriction levels (<50%) will benefit my production.*

Table 5:6 An increased water security from 80 to 90%, would result in a number of changed farm management practises.

Changed management practices	%	#	Given field examples and motivations
Increase citrus production (quantity) & quality	31	8	*Increase tonnage production, fruit size and reducing squeezing on the citrus skin. Maximize return.*
Increase (citrus) production area	15	4	*Clear extra (flat) land for production It should increase through security Irrigate remaining field 80ha +30ha for dairy*
Utilize all 'citrus surplus land' for planting cash crops on yearly basis	15	4	*Utilize labour and fixed cost better Cash crops such as potatoes or maize*
Reduce risk management cost	12	3	*Less varieties will be more efficient Now: 'I don't put my eggs in one basket'*
Plant high yielding cash crops and citrus varieties which has a high input cost (involve more risk)	12	3	*Plant different citrus cultivars that produce more fruit, bigger size, less squeezing and in different period Plant cash crops e.g. carrots, cauliflower, potatoes.*
Change to Dairy farming	12	3	*More milk cattle Over the long-term start dairy farming*
Possibility to get a long-term and stable contract with (vegetable) warehouses	12	3	*A long-term contract with Mc Cain or wholesalers will increase prices (±20%). At present deliver on a yearly 'sub-contract' due to unstable production If you can provide every year you built a relationship. If not buyers go to somewhere else.*
Increase efficiency	8	2	*Increase (water) efficiency*
No need to buy more allocation	8	2	*Won't by any more water rights when there won't be anymore severe restrictions.*
Change and optimize crop rotation	4	1	*Improve planning & pattern*
Long-term production planning	4	1	*Easier more long-term planning, especially required for citrus (not really for vegetables)*
Invest in new (risky) agronomic practices (equipment)	4	1	*We will have a better outlook for the future, so it will be safer to invest in new equipment*
Increase in land value	4	1	
Secondary impacts	4	1	*'Sleep better, living longer, less stress & smoking'*
No changes			
Stabilize production	8	2	*No changes, but production will be more stable.*
Not planning for restrictions	8	2	*Always plan(t) for maximum production*
Literature and expert judgment			
Change input & material use			
Different water use planning			
Optimize the dosage of irrigation			
Switch to more water efficient crops			
Sell or long-term rental of the surplus water rights retained for restrictions			
Turn crop land into 100% citrus land, if possible (I. Griep, personal communication, May 28, 2008)			
More stable production and employment (P. Joubert, personal communication, March 26, 2008)			

At present, the general strategy of the farmers is to plant low value crops which they could use as a water reserve in times of drought or they retain surplus water rights for drought years (DWAF 2003). The use of this strategy will lower when the changed management goes through. There are some important remarks to these outcomes:

- *Changing management practices and strategies are based on a combination of different factor. Water is an important one and the importance increases when restrictions are coming up, more effective to start up water saving programs.*
- *Must be 'a fact' that there is a higher water security before changing practices.*

- *Farmers deal with future challenges when they arise. Clear incentives are needed, before they will innovate to change any of their farming practices as described. A higher assurance can give them the ability to change their management practices and increase the output according to P. Dempsey (personal communication, April 18, 2008).*

The farmers are aware of the drought recurrence and the possibility of restriction, but most of them were not familiar with the concept water security since GIB does not use it in their communication towards farmers. However, GIB places a high value on the 'assured yield of the Kouga Dam' what is directly related to a high water assurance. According to P. Joubert (personal communication, March 26, 2008) 'any additional inflow into the Kouga Dam will improve the assured yield of the dam and it will not be wise to increase water allocations'. GIB prefers the Kouga Dam to have a maximum 100% yield where the farmers prefer *81% (σ12),* motivated by:
- *A high dam yield gives you a (feeling of) water security.*
- *Extra space in the dam should be reserved (in certain months) to catch the rainfall and reduce and slow down the flooding.*

Difference water security per sector
Dairy farmers are, to a certain extent, flexible and can deal with a lower water security, since they can easily by dry feeding. Vegetable farmers are vulnerable since they can lose their annual crops planted before restrictions come in. The citrus are dealing with long-term investments and need to be certain of a constant availability, especially during the fruit set period to obtain optimum growth (Swart et al. 2007). An increase in the water security is needed especially in the citrus where the capital value invested in the perennial orchards is high (around 50,000 R/ha/a). Important fact to remember is that a (citrus) farmer uses only about 75% of his allocation, where others using the full allocation. The latter will be therefore much more affected by restrictions than others. The elasticity of the water input demand for agriculture in the Gamtoos valley, as an intensive user, is therefore varying heavily.

Estimated benefits to NMMM
The domestic and industrial water users of NMMM are, at a smaller amount, affected by water shortage from time to time as table 5:4 shows. However, the NMMM is mainly interested in a higher water allocation and less in a higher assurance of supply. There are no management plans in place and no extra value is attached to a higher assurance according S. Furgusson and J. de Kock (personal communication, April 8, 2008). Hereby it can be assumed that they are content with current assurance levels which is not inline with the elasticity of the water demand calculated by Conradie (2002 cited in Nieuwoudt et al. 2004). The estimated water price elasticity demand of the NMMM was -0.47. The demand is inelastic as the absolute value is lower than 1. This means that they places a high value on water assurance, but little value on more than what it already uses, similar as in the case in box 5:1. This price elasticity is even more doubtful since the water needs per user is increasing rapidly in the NMMM as discussed in §3.3.2.

Box 5:1 Case Western USA where high water assurance has high financial value.
In the USA the urban sector attaches a high value to assurance of water supply. In Western USA cities such as Denver buy senior water rights (with a high certainty of supply) from farmers and then rent the surplus water back to farmers at low prices. The low estimates of the price elasticity of demand for urban water support this phenomenon that urban users attach / require a high value to assurance and a low value to additional water according Mirrilees et al. (1994 cited in Nieuwoudt et al. 2004).

In order to increase the overall assurance of supply and probably increase the water supply to NMMM there are preliminary plans to reduce the allocation to GIB with 25% (Veelen van 2003). GIB and the farmers will not be in favour of these plans, since they use this surplus water in times of droughts for their own assurance. A possibility is to use parts of the strategy described in box 5:1. A new pricing system can be proposed where the farmers pay per m^3 water used, which promote further efficiency more than the current, basic rate. However a safe minimum of revenues to GIB need to be secured during periods where farmers are using less due to high rainfall / low temperatures. This can be achieved to sell or rent the variable surplus water to the NMMM who can use it to increase their water supply and the overall assurance. Water from the orange river can be used to balance this partly variable water supplied to the NMMM. According to P. Duplicit (personal communication, May 22, 2008) is the NMMM potentially interested in a (partially) flexible allocation.

Valuation

It was not feasible in this study to 'translate' the changed farm management practices into economic terms, which was initial aim. With the Production factor method it is possible, however due to the heterogeneity of the production processes and uncertainty of the impact of the management action on the production it is complicated. Large amount of data and time is required to do this exercise. An estimate can be made by multiplying the quantity change in production with the market price. The economic benefit of a long-term production will be difficult to quantify, since no specific action are given.

5.2 Indirect economic benefit water users

5.2.1 Flood damages Baviaanskloof

Most parts in the Baviaanskloof are unsuitable for crop-based agriculture because of the high incidence (1:10) of major floods. The floods reducing the area of arable land and reshapes the valley floor (Boshoff 2005). Usually each major flood accompanies with damages to infrastructure (roads, causeways and telephone lines) and farmlands. The total damage of previous floods in the Baviaanskloof has never been recovered and valued. The following general information can be used to get an indication of the cost scale:

- A severe flood (1:50) in November 2007 damaged the infrastructure for R1.6M, figure 5:2.
- After every flood the causeways need to be cleaned to remove the blocking debris (1000R / causeway).

Figure 5:2 Rehabilitation project of flood damage infrastructure in Baviaanskloof.

The potential financial benefit of an improved flood control service through restoration in the Baviaanskloof can be measured by e.g.:

- The reduction in maintenance of a gravel road nearby a restoration site. Many roads in the Baviaanskloof and in Langkloof (especially nearby rivers) are affected by flooding. The length of the roads potentially affected by flooding can be calculated by using a detailed road network map. Through a desktop study combined with monitoring plots the financial value can be estimated. Using that a dirt roads is getting graded 4 times a year (aim) at 1,800 R/km. A reduction in runoff can directly reduce the amount of grading per year M. Kijzer (personal communication, July 22, 2008).

5.2.2 Flood damages Gamtoos valley

The Gamtoos River has a history of periodic floods and water shortages. "In the past 120 years the river flooded its banks on seven occasions, causing extensive damage and loss of life"(DWAF 2003). At present floods still exist in the Gamtoos valley and are caused by a number of sources, as stated by farmers:

- *Floods are caused by a combination of different factors: inflow Indian Ocean at high tide, inflow from the Groot, Klein and Gamtoos River, overflow Kouga and Loerie Dam and rainfall in the valley.*

Figure 5:3 Overflowing of the Kouga Dam fills up the river(banks) directly (GIB 2008).

Watershed restoration will decrease the overflow intensity of the Kouga Dam, as in figure 5:3, and hereby reducing the Gamtoos River inflow. In the survey 2008 a table was given to the farmers with the Kouga Dam overflow dates of the last 10years. The results in table 5:7 shows that in total 65% of the respondents perceive 'any kind of cost (damage)' from overflow. Most damages were during the heavy flood in 2007. Before 2003 it was difficult for farmers to estimate the exact year of damage, since they do not keep farm records.

Table 5:7 Percentage farmers with damage from overflow. Based on data DWAF Cradock and 'own thesis'(#26).

Year	Respondents with damage	Overflow days Kouga Dam
Total	65%	
2007	56 %	107
2006	15%	92
2003	4%	32
1996	22%	?
1983	12 %	?
1981	4%	?
1971	22%	?

The farmers estimated the economic damages perceived during the 2007 overflow. The damage was given directly in Rands if possible and recorded or if not it was given in lost area (ha) or lost production (ton). From this the damage can be calculated based on lost profit and the cost already made. In table 5:8 it can be seen that emerging farmers have relatively high damages of land overflow. This can be explained by the simple fact that they own the lower lands near the river which are more susceptible for flooding. To prevent overestimates by farmers a description of the damages was given if possible, for further calculation. Nonetheless some damages stayed unvalued since there was a shortage of detailed information. The total valued damages of the 26 respondent's counts over R2million. The damage extrapolated for the whole Gamtoos valley, based on the survey coverage, comes up to R10million. This number has a high level of uncertainty as there is a high variance in the vulnerability of farmers for flooding. Nevertheless is gives a good indication of the economic impacts of floods damage in the valley.

Table 5:8 Estimated combined (economic) damages farmers perceived by the Kouga Dam overflow in 2007. Based on 'own thesis'.

Damage	Cost (1000R)		Description
	Established farmers (#)	Emerging farmers (#)	
Land erosion	Unvalued		*Erosion damages, (grading) required*
Broken fences	20 (2)		
Land overflow & flooding of the low lands	1,379 (7)		*Lost (ton) chicories(10), maize(30), potatoes (15)* *Lost (ha) broccoli (4), carrots (4)* *2ha land destroyed to unusable.* *Damage to irrigation lines*
		625.5 (4)	*Lost plant material, investment cost & harvest* *Lost carrot & cabbage* *2ha of carrots lost at 2 years*
	Unvalued		*5ha of carrots* *5ha citrus flooded, less quality, more marks, less production. Know at the end of the year.* *Extra spraying required for citrus* *Orchard under water through overflow*
		Unvalued	*Damage occurs often*
Private road	40 (2)		*Repair works holes*
Public road closed	1.4		*Extra fuel through using back road* *2ton couldn't transported cause closed bridge*
	Unvalued		*Loss in quality (lower price) of tomatoes, Citrus and Potatoes because transport to pack house (with freezer) was delayed.* *Road inaccessible for 12h, 1 week 1h extra drive* Farmers dirt road Kouga Dam damaged
Total	**1,440.2** (10)	**625.5** (4)	**= 2,065.7** (14)

The Kouga municipality is affected by the periodically overflow as they have damages to the infrastructure and bridges are closed (figure 5:4). There are no specific reports available of the economic damages in the area around the Gamtoos River, since the rehabilitation cost are relatively low and not separately budgeted. The province is responsible for the main infrastructure and provides money to Kouga municipality or to Cacadu district municipality to maintain the roads in the entire management area. Therefore the municipality is not directly responsible for dealing with the flood damages.

Figure 5:4 Gamtoos River dangerous in flood.

5.2.3 Drought damages

In the most recent drought period (2005/2006) the farmers in the Gamtoos valley were suffering from restrictions with damage and a lost income as result. There are a number of general strategies farmers are using in dealing with a shortage in water availability, such as:

- *Planting a smaller area with less or no rotational crops with a high water use, thereby ensuring that the permanent crops have sufficient water to survive.*
- *Irrigate citrus according normal irrigation pattern, slightly less or much less according the reduction in water availability and hope for rain or available surplus water (I. Griep, personal communication, May 28, 2008).*

In the survey 2008 it was asked whether farmers experiencing 'any kind of damage or benefit' during the last period of water restrictions. From the total respondents, 42% was affected by restrictions where 54% had no damage. The latter can be explained by a range of factors, a selection:

- *Enough surplus allocation left that time, 'good' timing restrictions (summer most damages) not on full production (young citrus threes) or saved by the rain.*

The farmers affected by restrictions specified their damages and where possible estimated the economic value, as in table 5:9.

Table 5:9 A summarised specification and valuation of the damages farmers perceive from last restrictions. Source 'this thesis'.

Period and restriction	**Specification Cost /benefit** (#)		**Estimated valued Damage *1,000R**
	Not Valued	**Valued**	**Total**
2005 /2006 (July-June) **25%**	*30ha no chicory planted Fuel cost for pumping river water,(3 times normal water price) Smaller citrus fruit size resulted in lower prices or dumping.*	*209.5ha not planted with cash crops e.g. maize or potatoes* (5) *Different veggies planted (lower value & water use)*	*3,069*
		Irrigated less land, so dry feed had to be bought (2).	*1,111*
		Rented extra water rights	*24*
2006 **35%** (July-August)		*4ha not planted Extra cost dry cattle feed*	*80 178*
	No Benefits	**Benefits**	***4,462***
2005/2006	*Only Gamtoos valley restricted, to small to influence the market prices 75% of citrus is exported, no change in market price Already fixed vegetable prices*	*Avg. 22,5% higher potatoes prices* (2). *80% higher vegetable prices*	
1991	*Big loss whole valley, only 20/30% planted*		

As can be seen in the table the damages of not utilizing the land is actually a missed revenue or, where valued, a lost profit and partly uncovered fixed cost. This is still a considerable loss since the fixed cost need are now spread over a smaller area and often some investments for the unplanted area are already made. The damage in the dairy farming is the net extra cost of buying dry feeds where the avoided cost of less water and energy use is subtracted. The damage caused by the lower production is difficult to quantify since the farmers do not have always clear record keeping. The emerging farmers are not really suffering from *small* restrictions since they are not in full production and have often a surplus of water. Most citrus farmers ensure that they have enough surplus water for their citrus and leave their remaining land unused.

- *Citrus has never suffered much as result of restrictions. Most citrus farmers also plant cash crops. In times of restrictions they plant fewer cash crops, according P. Joubert, personal communication, March 20, 2008)*

The benefits perceived from a period of drought and restrictions are mainly in the form of increase vegetable crop prices. This depends heavily on whether the droughts are regional or national, since the Gamtoos valley is relatively small to influence the market price. Further it varies per farmer whether he delivers on a contract basis or on the open market.

5.2.4 Mitigation cost

Life span water supply infrastructure

As shortly discussed in §4.1.3 a reduced sediment load and constant water supply may has an effect of the life span of the water supply infrastructure (Joubert et al. 2000). If the life span of the infrastructure in the Gamtoos valley is extended, benefits will arise directly for DWAF and indirectly for the water users. In table 5:10 an indication of the financial benefit, perceived of a 10% longer life span, is illustrated. The main reason for undertaking this exercise is the fact that watershed restoration extends the life span of water supply infrastructure is often mentioned, but not often a financial value is attached. By calculating the changes in the annual depreciation charge (ADC) the potential financial benefit to DWAF and to the water users is made explicit.

Table 5:10 Calculation of the annual depreciation charges with a 10% assumed extended lifespan of the dam & canal. Based on data: (DWAF 2003;DWAF 2007b;DWAF 2008a), NMMM water bill March 2008 and (Coetzee 2008).

2008/2009 charges[1]	**Replacement value**[2] (1000R)	**Expected useful life** (years)	**Total ADC** (1000R)	**ADC**[3] (cR/m^3)	
				Domestic & industry	**Irrigation**
Current ADC	456,966.2	45	2,174.6	2.73	2.56
ADC +10% lifespan		50	1,976.9	2.48	2.33

[1] Depreciable portion: 10% dams, 40% canal and 40% weirs.
[2] Replacement value on 31 March 2000. Based on the Kouga Dam, weirs and different assets of the canal (incl. tunnel and siphons).
[3] Based on the weighted average allocation 97% on D&I for 23Mm^3 and 91% on IRR for 59.6Mm^3.

The ADC is the loss in functional performance and real term value of existing water resource infrastructure (DWAF 2007a). The ADC can be calculated by the:
Replacement value (weighted average) depreciable portion (%) / expected useful life*.

The depreciable portion and useful (financial) life over which the asset will be depreciated are subject to revision when the next engineering revaluation of assets is due (DWAF 2007a). As the table shows an extended life span of the dam will reduce the depreciation charge for both Domestic as irrigation. The current ADC does not correspond with the actual charged ADC at present since this calculation is specifically made for the Gamtoos valley. DWAF makes a combined ADC which include the infrastructure in the Krom River resulting in an ADC for Domestic of (5.00 cR/m^3) and irrigation (4.68 cR/m^3). However the positive effect on the charge will be unchanged.
Nevertheless there are a number of 'market imperfections' which does effect the positive charge change. At first, the ADC for irrigation is capped at (1.44 cR/m^3), which is much lower than the ADC from DWAF and the one as calculated in table 5:10. Since irrigated agriculture is not paying the full charge, as it is subsidized, it will not be affected by the lowering charge which can result form an increased life span. Additionally, these DWAF tariff calculations are based on the national pricing policy, which is not directly aligned with business practices, such as restoration. The revenue collected by the ADC is used for rehabilitation to extend the lifespan of the infrastructure. 'Since not the full ADC is collected it will be unlikely that the user get any benefit of the extended lifespan'(Coetzee 2008).

Life span farm irrigation
A high sediment load in the raw canal water does not affect the life span of central pivot and dragline irrigation systems. However, it does affect the drip and micro- irrigation systems of citrus according the farm survey appendix 6. High sediment loads can cause clogging of the drip irrigation which will reduce the expected life span (at present >20year). Additionally, the life span of the pumps may be decrease by the 'sand washing' (J.Kruger, personal communication, May 15, 2008). The extra cost hereof is unknown. The cleaning intensity of the irrigation system increase and, as a result, the cost as well. Table 5:11 shows a cost increase of R1.5Milion. However, the remark must be made that a high sediment yield will only occur during and after a period of floods (1:05) in the upstream watershed.

Table 5:11 Assumed increase of cleaning cost of micro- and drip irrigation during periods of high sediment yield.

Sediment yield	**Intensity** (times/year)	**Cleaning cost** (R/ha)	**Total Cost Gamtoos valley**[1] (R)
Normal	1	300	675,000
High	3		2,025,000[2]

[1] Based on 2,250ha of citrus with drip irrigation (DWAF 2003).
[2] It is unknown whether all farmers applying this cleaning and with which intensity.

Cost of water purification
A high sediment yield in the canal water increase the water treatment cost of the Loerie WTW as shown in figure 5:5b. The relation between the floods of the Kouga Dam and the turbidity of the raw input water at the Loerie WTW is made visual in figures 5:5a and 5:5b. There is obviously a delay in response of the increased turbidity after a flood and the increase treatment cost. The chemical treatment cost vary largely from 0.13 (R/m3) in November 2007 to 0.34 in January 2008. Per month this refers to 260,000R and 680,000R respectively, based on an average treated amount of 2Mm^3. All these values should be seen in perspective since the November 2007 flood was an extreme 1:50 year flood. Nevertheless a small flood in April resulted in an increase of the turbidity and treatment cost.

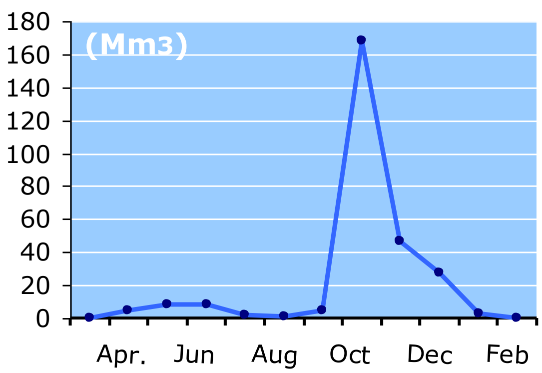


Figure 5:5a Total overflow of the Kouga Dam (2007/2008). Based on data DWAF Cradock.

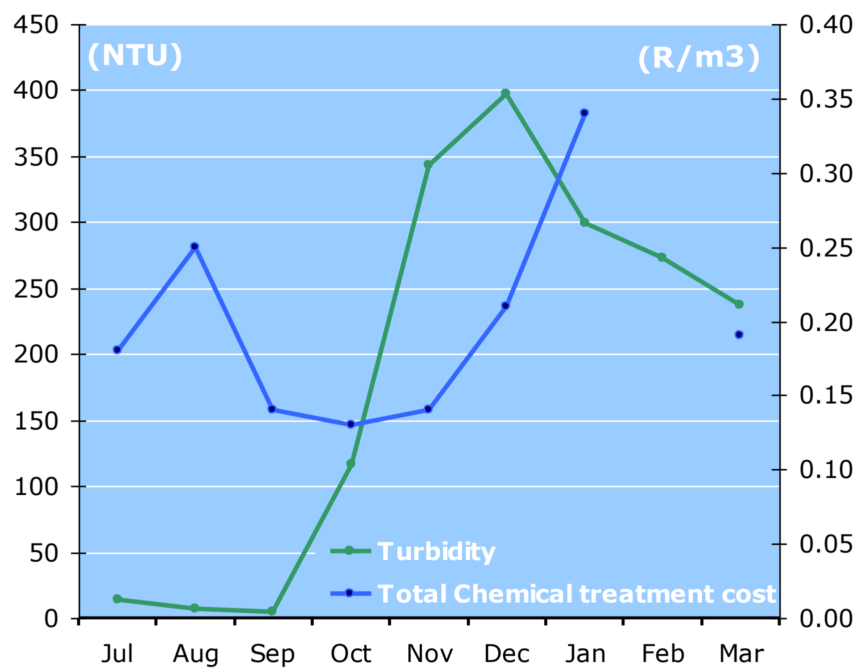


Figure 5:5b Chemical treatment cost increases indirectly with turbidity raw water at Loerie WTW (2007/2008). Based on data Loerie WTW. (Turbidity is the monthly average of the raw snap and raw comp. samples. Chemicals are e.g. coagulation chemicals $AL_2(SO_4)_3$). All chemical costs are converted to 2008 market prices to make comparison possible. The extra cost of the longer treatment process (through the use of higher doses is not included).

Hankey and Patensie water treatment works
The Hankey and Patensie WTW combined are much smaller then the Loerie WTW (0.9Mm^3 to 23Mm^3 treated water). No figures were available at the WTW that is managed by the Kouga municipality (KM), since it is an old fashion facility with minimum of reporting and measuring. Nonetheless, the same increase of cost is expected as at the Loerie WTW as they receive the same water from the irrigation canal.
An onsite interview with the WTW foreman and with the technical manager of KM, made the following visible:

- *More sediment in the water since flooding November 2007.*
- *Sediment in retention basins increased since December2007 from 6 to 7 ton per 2 weeks. Resulting in an increased transportation cost* [Hankey].
- *The sand used in the sand filtration normally gets replaced every 2 years, now they are considering replacing it after half a year already, because of the dirt* [Hankey].
- *Chlorine added increased from 300 – 500 (µg/l) cause of complaints drink water users.*
- *Health problems occur (e.g. stomach problems) cause of bad treated water, especially when river water is used due to the yearly irrigation channel cleaning* [Hankey].
- *Sediment in retention basins increased. Removal every 2 weeks instead of every month. Estimated sediment amount 180m^3 (total size 484 m^3)* [Patensie].
- Extra chlorine added to remove the dirt and to get water 'white' or clean [Patensie] (A. Mbeki, personal communication, April 8, 2008).

Farm production filters
The water quality and sediment levels of the raw water are directly influencing the performance and the capacity of the farm filters. After the November 2007 floods farmers had to clean their filters regularly varying from twice a week to 'at the top' once an hour to prevent clogging. The intensity cleaning decrease after 4-5 months after the flood as the sediment level lowered. The main extra cleaning cost for screen filters are:

- Manual cost (time consuming) e.g. 1h/day for 4 months = 6*30.5*4 = R732.
- Chemical cost (NH_2OH-HCL) 400R per bottle, 3 bottles per year = R1,200.

The cleaning of the sand and disk filters goes by backwashing which (often) results in a water loss. This loss varies from 28m^3 for sand filters and 4.4m^3 for disc filters per 1,000m^3 of filtered water with high sediment levels.

- A total cost estimation given by some farmers varies between 6-10.000R including operational cost, loss off life span and the increase of spray chemicals needed since, some, react with dissolved particles.

The estimated cost is much higher than the combined calculated value as more factors are included, e.g. the reduced life span as calculated in table 5:11. It is argued by Niekerk et al. (2006:7) that most farmers have the wrong type of filters and are therefore less effective.

Crop damage
The damages of a high sediment yield seem to affect some of the emerging farmers quite heavily. Two emerging farmers mentioned that they could not sell there cabbage crops, since the sediment got trapped insight the crop witch can causes rotting and makes is un-saleable. The cost of the damage crops was estimated at R36,000, based on 18,000 lost crops.

Rural drink water treatment
The rural farmers and communities who are not getting drink water from the WTW had to invest recently, or are thinking to invest, in small household water purification systems since the sediment yield in the water increased (±R15,000). Beside this direct cost other damages are perceived such as clogging geysers, washing problems and health problems (of farm workers) of drinking dirty water.

5.3 Replacement costs

The water supply services of the Baviaanskloof watershed can be partially replaced or substituted by human-made engineering systems. By calculating the current cost of supplying the water for the different augmentation options, the least expensive alternative can be selected from an economic objective. The sociological and ecological objectives should, however take in consideration as well. There should also be made a difference between a water-generating and a storage project. An additional dam in a river, that already feeds a metropolitan area, can be seen as a storage project, where a new dam in an unutilized river or watershed restoration projects can be seen as water-generating. The latter case is gaining additional base and river inflow what still brings the requirement of extra storage (Pretorius et al., 1998).

Three different water supply projects to the NMMM are compared by using the Unit Reference Values (URV). The URV is used since it is one of the key indicators in deciding the economic feasibility of a water supply project for DWAF. The URV is the present value of all costs (PVC), divided by the present value of all benefits (PVB) that incurs over the economic life span of the project (Mander et al. 2007). This can be written down as:

$$URV(R/m^3) = \frac{PVC(Rands)}{PVB(m^3)} \quad (1) \qquad BCR = \frac{PVB}{PVC} = \frac{1}{URV} \quad (2)$$

Equation 2 shows that the URV is a reversed benefit cost ratio (BCR), which is used in economics. The effective, present day URV can be used to estimate the relative unit cost of water, by calculating the discounted cost divided by the discounted water supply. This value should only be used for comparing the different water supply alternatives in the same region, since the actual values of an m^3 water vary heavily in the different areas and the accepted cost per m^3 will differ as well. In addition the URV is heavily depended on the consistency of counting all the different cost and benefits that occur over the set life span of the project, which is be debatable too.

5.3.1 Watershed restoration cost

Conservation and restoration in the Kouga-Baviaanskloof watershed would postpone the necessity of building the proposed Guernakop Dam in the Kouga River. "The Kouga Dam's life span would be extended, more water would be made available over a longer period, water security would be increased in the Gamtoos area, to a lower cost" according (Joubert et al. 2000;Smith et al. 2000). However the latter has not been proven. An indication can be given by calculating the URV of thicket restoration and comparing this with URV of other water supply or storage options. The cost of restoring a degraded area with planting Spekboom varies depending on the biophysical conditions and accessibility. In general two cost scenarios can be given according to M. McConnachie (personal communication, July 18, 2008):

- *Business as usual,* current technology (crowbar and manual labour): ±R4,500 /ha.
- *Mechanization,* includes extra capital and consumable costs (drilling): <R2,000/ ha.

Additional to these cost there are additional start-up and follow-up costs, such as:

- *Implementation, facilitation and transaction cost.*
- *Opportunity cost* associated with forgone land uses upstream.
- *Replanting:* estimated cost 50% initial planting (mortality varies from 5-100%)
- *Operation and management cost,* fire and stock management.

The range of the different cost and benefit are given in §6.1 scenario analysis.

With the thicket restoration project more water can be generated by an increase in baseflow, reduction in dam sedimentation and increase assurance of supply. There are no additional costs for water storage in the Kouga Dam since excess capacity can be generated by increasing the allocation and reducing the buffer volume. Most of the further infrastructure (canal and WTW) already exists and has the capacity to accommodate extra supplies of water generated in this catchment area (Veelen van 2003). Thus the marginal cost for the water generated, refers only to the stated cost above, since the cost of the dam and canal are already covered (Pretorius et al., 1998).

Table 5:12 The URV of thicket restoration compared with other engineering options to supply treated water to the NMMM. Based on (DWAF et al. 1996;Veelen van 2003) and own estimates.

Supply augmentation options [1]	**Incremental firm yield** (Mm^3)	**PVC** (R million)	**PVB** (Mm^3)[5]	**URV** (R/m^3)
ORDP	12.8 [(2)]	661	3,574.0	0.18
Guernakop Dam	25.6 [(3)]	724	6,932.0	0.10
Watershed restoration	0.1 [(4)]	133	0.3	481.70

1 Based on a 40 year time span and 8% discount rate.
2 Based on one extra WTW unit at Nooitgedacht, additional yield possible.
3 Based on a dam capacity of $200Mm^3$ (DWAF et al. 1996).
4 Based on the improved water supply of the Baviaanskloof nature reserve and the western side (Best case scenario in §6.1).
5 Total water demand met over a period of 40year, assuming that supply is not larger than the demand.

5.3.2 Augmentation options

There are a number of augmentation option described in the water master plan 2005-2020 (NMMM 2006) and in the Algoa pre-feasibility study (Veelen van 2003) that are needed to generate additional water to satisfy the demand the NMMM. The main future water supply options are:

1. *Orange River Development Project (ORDP);* increase transfers of Orange river water and develop required additional treatment and infrastructure at Nooitgedacht WTW, which is costly.
2. *Guernakop Dam;* increase the necessary storage and transfer of water to the Kouga Dam, which has a much lower storage capacity (80% of MAR) than normally applied for optimal utilization of river runoff (e.g. Churchill dam has 200% MAR) (Hosking et al. 2002). The dam will be sited in the hearth of BNR which causes severe environmental and social constraints. Most of the existing water transfer infrastructure of the Algoa system can be used.

Beside these two augmentation option there are already three options planned and partly implemented to secure the (NMMM) water supply until 2016. Namely: water demand management, upgrading the bulk water supply system and making treated effluent water available. Other available water sources are the desalination of sea water, reducing the Gamtoos canal losses and reducing the supply to the farmers in the Gamtoos valley.
Two available water supply sources, also recommended by Van Veelen (2003), coincide with the watershed restoration.

3. *Baviaanskloof watershed restoration;* the improved water supply by thicket restoration ($0.011Mm^3/a$) can be further increased with (1) the ongoing alien clearing in the WfW project ($3Mm^3/a$) and (2) the phasing out of irrigation in the Baviaanskloof which would be in line with the conservation efforts ($2Mm^3/a$) (DWAF 2003).

As table 5:12 shows there are considerable differences in the yield of the three complementary options. The additional yield of watershed restoration is low since it is assumed that there will be no extra water in the first 15 years, as described in §6.1. This results in a much lower PVB and a much higher URV. It can be said that watershed restoration is not economic feasible from a water supply perspective in the short-term and other augmentation options are needed. However, it is likely that the firm yield of watershed restoration will be higher over a longer time span. Additionally, the PVC can lower significantly when the value of the other watershed services are included.

5.4 Water Value

Water in the Gamtoos valley is used directly as a consumption good, mainly in NMMM and Kouga municipality or indirectly as a factor of production in agriculture, forestry, or industry. The water values are significantly different among sectors and between and within geographic areas (Nieuwoudt et al. 2004). The economic crop water productivity (cwp) gives an indication of the economic value.

5.4.1 Crop water productivity

If through the restoration project more water becomes available DWAF makes the decision, according to the NWA, how to allocate the extra water (§3.2.1). To find the most economic efficient way of distributing future available water, under agriculture, the economic cwp can be used as an indicator. The economic cwp is the net production value (direct benefits) per unit of water consumed (R/m^3) (Soppe et al. 2006). Where the bio-physical cwp is used to determine the actual yield production in Kilogram per m^3 (water footprint) and is thus not related to the often varying market prices. GIB is encouraging farmers in the Gamtoos valley to change their crops to water-efficient agro-types, higher-yielding varieties, ones with lower water needs, or those with higher economic returns per unit of water consumed (DWAF 2003).

- **South Africa cwp**

The economic value of water, varies largely between the different South Africa sectors. Where agriculture adds 1.5R, industry R157.4, mining R39.5 and eco-tourism R44.4 per m^3 water according Conningarth Consultants (2001 cited in Nieuwoudt et al. 2004). Internationally and also in South Africa the economic value of water for industrial and urban use is much higher than the economic value of water for irrigation and forestry use (Mosaka et al. 2007). This can be explained by the high output and low water use in the industry sector. In general the production is based on many other factors, and not on water only. The marginal contribution of water in industry is therefore expected to be much lower than the 157.4 R/m^3 (Nieuwoudt et al. 2004).

- **Langkloof and Baviaanskloof cwp**

The cwp in the upstream areas is not been calculated. In the Langkloof the cwp will be expected to be reasonably with large areas of deciduous fruit orchards and a small area of pasture under irrigation livestock, mostly for the European market. The cwp in the Baviaanskloof is expected to be low. The 20 farmers have mainly livestock (goats, sheep, cattle and ostrich) and irrigated cropping.

Water is available from the Kouga or Baviaanskloof River, several side streams, natural fountains and wells. The water is stored in the many farm dams. The upstream water users have thus constantly water available, at a low price (1.5cR/m^3) and their use is not measured or controlled (Zijl 2008). Therefore it is expected that they have a lower incentive to use their water efficient (assumption).

- **Gamtoos valley cwp**

The economic and bio-physical cwp downstream in the Gamtoos valley is calculated for the three main agricultural land uses, as given in table 5:13, and is based on the information provided by the different farmers, advisors and citrus trade organizations. It can be calculated by multiplying the gross yield produced with the market price of that product minus the total production costs (fixed and variable).

Calculation example citrus (Soppe et al. 2006):
Market price of *1.87*R/kg; total production cost is *43,600*R/ha/year.
The net production value for citrus V_c (R/ha) = market price * Y_c – total cost.
Y_c is citrus yield (kg/ha)
Actual water consumption equals *7,000*m^3/ha, the economic cwp is 7.12R/m^3.

Table 5:13 The bio-physical and economic crop water productivity compared over the three main agricultural land uses in the Gamtoos valley, 2007 (standard deviation (σ) in brackets). Based on (Soppe et al. 2006) and 'own thesis'.

Main land use	**Water requirement** (m^3/ha)	**Gross yield production** (kg or L /ha)	**Net production value** (R/ha)	**Bio-physical cwp** (kg/m^3)	**Economic cwp** (R/m^3)
Citrus	7,000	50,000	49,817	7.14 (2.21)	7.12 (3.35)
Potatoes	4,110	32,800	17,160	8.0 (2.54)	4.2 (0.71)
Pasture (dairy)	6,000	16,692	33,814	2.78 (1.00)	5.64 (1.56)

In the table it can be seen that citrus has the highest contribution per m^3, economic cwp, closely followed by dairy. The Gamtoos valley has a relative high value crops since the economic cwp is much higher than the average of agriculture in South Africa (1.5R/m^3). The bio-physical cwp is highest at the potatoes followed by citrus. While interpreting these numbers some important aspects need to be taken into account:

- There is a large difference in production, water use and cost between the representative farmers with the same crop as this is influenced by various factors (management, soil type, rainfall). The relative high standard deviation in the cwp columns in the table makes the high difference visible.
- The market price of citrus is varying heavily. Between 2004 and 2007 the price more than doubled (0.88- 1.87) and it is expected that it will rise further in 2008 (2.43).
- The calculation for dairy is based on a 100% in house food production, so no extra dry food is bought (this only happens during dry years or periods of restriction).
- The value of the different citrus varieties can varies heavily e.g. Cambria (R4.2).
- The high difference between the bio-physical and economic cwp of the 3 land uses shows that the market price plays an important role.

Based on the given numbers in the table 5:13 it can be seen that citrus producers as a group are able, in an open market, to bid water away from the potatoes and most probably also from the other vegetables producers. There are example cases where citrus farmers are buying land in Loerie, with a water allocation. The rationale is that they can transfer the water and have than enough assured water available to expand their citrus land in Patensie (P. Dempsey, personal communication, April 18, 2008).

5.4.2 Water pricing

The tariff for irrigation water is R1,297/ha or 0.21R/m^3 for the first 6,000 m^3/ha of the allocation. The tariff for the balance of the allocation (2,000m^3) is 0.10R/m^3. Both numbers includes the two DWAF levies; Water Resource Management (WRM) and the Annual Depreciation Charge (ADC), charged per m^3. All levies included, a farmer pays R1,457 for 8,000m^3 of water (0.18 R/m^3). Is should be remarked that the first 75% of the allocation is the basic rate which need to be paid to GIB even if it the water is not used (1,122R/ha, excl. DWAF levies). However the farmers are allowed to sell water within a water year to other farmers. The rates levied by GIB are to cover the cost of the Operation and Maintenance (O&M) of the conveyance system, including the Kouga Dam (tax excl.) (P. Joubert, personal communication, March 20, 2008).

A comment of a farmer on the pricing strategy of GIB:

- *There is no encouragement to save water. Water above the 75% basic rate is nearly free (0.10R/m^3), specially compared to the total amount.*

The total cost of producing 1ha of citrus, potatoes or dairy is varying between 25,000 and 80,000 (R/ha). With the maximum water cost of 1,457 (R/ha), it contributes between 1.8 and 5.8% to the total production cost.
The price farmers are paying for raw-water is substantially less (approximately 0.18R/m^3) than what urban consumers in NMMM pay (0.53R/m^3). The latter users and taxpayers clearly subsidize agriculture. NMMM pays higher WRM, ADC, O&M and Return on Assets charges to DWAF for the operation and redemption of capital. The NMMM and the Kouga municipality are responsible for supplying the treated water in the Gamtoos valley. Their water price is increasing annually up to 20%, based on the cost of supply.

5.4.3 Opportunity cost

Opportunity costs are the costs and the reduced or lost profit to the landowners in the Baviaanskloof of making the needed resource management changes for the restoration project. This will include (but is not limited to):

- The forgone net profits from on-farm activities for the needed land-use changes of planting thicket on production lands (Kosoy et al. 2006).
- The lost production due to lowering the water use.
- The loss in agricultural output incurred by changes in farming systems, such as a lower grazing intensity to sustain the thicket cover.
- The investment and learning costs to switch (completely) to e.g. tourism.

The highest opportunity cost is expected for the 20 farmers in the Baviaanskloof, since they have a large area under production compared to the communities.
The Eastern Cape parks board don not have a real opportunity cost as the area is determined for conservation and thicket restoration will increase the conservation value.

The total opportunity cost can be determined by establishing the Willingness to Accept (WTA). This value can be compared to the willingness to pay value of the downstream water users for the different watershed services. This value will be further investigated by Paoli, G., unpublished, *Payment for hydrological services in the Baviaanskloof.*

Figure 5:6 presents the total cost of water schematically. The economic externalities are the cost imposed upon others due to the consumption of water by specific actors e.g. emerging farmers. The environmental externalities are described in §5.5.2. The full cost should correspond with the combined value (e.g. economic-, secondary-, social-, intrinsic value) in order to be sustainable in use.

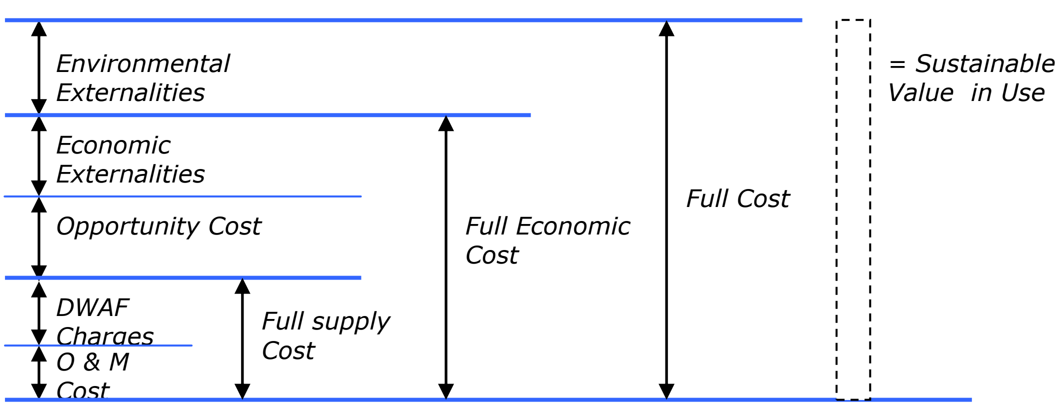


Figure 5:6 Combined total cost of water supply. Based on the *general principles of cost for water*, (Al-Hebshi et al. 2006).

5.5 Secondary benefits

The improved watershed services in the Baviaanskloof and the Gamtoos valley will lead to a number of secondary and indirect economic impacts. Examples are an increase in: conservation value, job opportunities, economic activities and GDP in the region (Joubert et al. 2000). The economic activities will develop as a positive spin-off for the increased agriculture downstream and the increased tourism upstream. These secondary benefits can be seen as important since they can provide strong arguments which support restoration and conservation. Additional, the secondary economic benefits can generate government support and funding through payment by tax payers.

5.5.1 Benefits of restoration upstream

Large scale thicket restoration in the Baviaanskloof will contribute to the local rural, and regional economy in the form of spending, employment and social upliftment. Large scale restoration will create many, high value short term jobs (±100 jobs for 2-4 years, as estimated in the medium scenario in §6.1). Spekboom planting is labour intensive as can be seen in figure 5:7. Additionally, more long-term (10-15 years) labour based jobs, comes available for the needed management activities upstream, as described in §4.1.6. Casual jobs in the provincial and private sector (tourism) can be create in the Baviaanskloof and the nearby regions of Willowmore and Uniondale (DWAF 2003;Joubert et al. 2000). The creation of employment is very important for the local rural communities in the Baviaanskloof valley. The unemployment rate is estimated between 60-80% (Lorencová 2008).

Figure 5:7 Labor intensive Spekboom planting in BNR.

The restored area of thicket will provide a range of valuable services in the future. At present, the total gross annual value (GAV) of the thicket services in western Baviaanskloof is estimated by De la Flor (2008:81) and amounts R7,666,541. The value per hectare is relatively low (R153ha/year) due to low population density (0.02) of inhabitants per ha. The GAV is the combined value of the provisioning services (fuel wood, construction, medicinal plants, fodder, and honey), regulation service (pollination) and information services (recreation and eco-tourism). Fodder production and tourism are the most important. The GAV per year for communities is R280,000 and for the farmers R7,400,000. These valuation results demonstrate that even partially degraded thicket provides valuable services to local stakeholders. It is expected that through restoration most of these values increases.

5.5.2 Benefits downstream

The benefits of restoration will have a positive effect on the economies downstream as secondary economic activities will be created. The whole range of improved watershed services can increase the agricultural production which has many forward and backward linkages with other sectors. A production increase will have ripple effects through the economy as direct and indirect jobs are generated (Nieuwoudt et al. 2004). These benefits will be mainly for the 20,000 people living in the Gamtoos valley and who are dependent on 'water related production' (Kouga municipality 2007b). An improved water quality (e.g. less sediment) has direct benefits on people's health. This especially for the farm workers who are drinking the untreated water directly from the canal, which can cause health problems. According to A. Mbeki (personal communication, April 8, 2008) even water from the Hankey WTW can cause health problems. Water is still dirty thus many people by sealed bottles or treats the water themselves.

Positive and negative externalities

There are some watershed services associated with thicket restoration where the beneficiaries are not expected to compensate for. Examples are some regulating services (erosion control, flood control, water purification), the supporting services and the cultural services (e.g. recreation). The non-excludability and non-rivalry of these, pure public, services results in positive externalities to the user as it directly affect their utility. The formation of these markets is undermined since beneficiaries of the services have no incentive to pay suppliers. This 'free-riding' is compensated by the payments for other good and services, such as: water supply, carbon sequestration or a 'package of services'. Landell-Mils et al. (2002:8) argue that "the failure of markets to materialize for positive externalities has serious repercussions for welfare". This is not completely true since the positive externalities increases the secondary economic benefits of restoration in the area (which enhance welfare). Additional to these direct and indirect values, restoration enhance a number of non-use values, which are more or less consciously experienced in the social, psychological, spiritual or cultural field.

Discussing the 'free-riding', it can be argued that the upstream landholders are responsible for reducing the created negative environmental externalities (Kosoy et al. 2006). By applying sustainable farming practices upstream, the negative externalities will be reduced where with active restoration positive externalities can be created. The improved watershed services can also result in some negative externalities. When the land upstream is reserved for restoration it is expected that the remaining land will be used more intensively for production with the reversed effect (Zijl 2008;Zilberman et al. 2003).

Downstream the possibility exists that there will be an increase in land clearing to create more production land in the Gamtoos valley. When there is more water available (with a higher assurance), farmers will consider starting land clearing when needed. The survey 2008 indicates that at least *189ha* of natural field is 'suitable' for (citrus) production, as farmers are saying:

- *Can put more (un-cleared) land under irrigation and thus increase (citrus) production.*
- *Increase land in production (through clearing) and improve efficiency.*

Figure 5.8 illustrates the already intensive citrus production on the 'flat lands' in and around Patensie.

A long-term monitoring and surveying project is required to get a better indication of the potential of these secondary economic benefits and other positive and negative subsequent economic effects (e.g. changes in prices through demand and supply). The outcome can be compared with similar situations elsewhere before the economic, or welfare value of the society can be estimated (Joubert et al. 2000).

Figure 5:8 Intensive agricultural production in the Gamtoos valley.

6 Negotiation basis for PWS

6.1 Scenario analysis

The benefits of restoration will arise in the long-term, (as explained in §4.2.2) and the perceived level is still uncertain. Because the scarcity of data and the large number of non quantifiable factors the establishing of exploratory scenarios will be helpful to explore the financial feasibility of restoration (Leemans 2007). In order to make estimates of some of the potential future benefits of restoration, three preliminary scenarios are developed. These include scenarios where degraded land is restored to varying degrees over time. The different levels of restoration are being used to estimate the economic benefits of the improved ES water regulation and carbon sequestration. The scenarios will show the required restoration efforts over time and the minimum and maximum economic benefits. The available hydrological data and broad indicators of value are extrapolated and used to develop some baseline parameters which approximate the initial current situation. This all is based on various literature sources and the farmers' survey (appendices 6 & 7). The judgments and estimations of the experts interviewed are included to complete the baseline numbers. Combined with the interlinked variable groups the three scenarios are formulated:

- *Worst case scenario*, with little area restored, against highest cost and lowest benefit.
- *Medium scenario,* most plausible scenario with medium area, cost and benefit.
- *Best case scenario,* with much area restored, against lowest cost and highest benefit.

6.1.1 Scenario elements

- Time horizon of 40 year with 2010 as base year.
- Costs and benefits in the future have a lower net present value (NPV), with a positive discount rate of 8%, used in the medium scenario.
- Geographic coverage is the Baviaanskloof nature reserve (BNR) managed by the ECPB and the private farm land in western Baviaanskloof (a combination is preferred).
- The major change is the transformation of degraded land into intact thicket.
- Uncertainties in the current hydrological state are influencing the outcome of the scenarios within the given range.
- The storyline, the most important aspects of the scenario, is the complex interplay between the different level of hydrological and economic impacts (Leemans 2007).

In table 6:1 the different level of costs and benefits (impacts) are given for a specified area restored in the BNR or in western Baviaanskloof. All this data combined will be used in table 6:2 where the economic feasibility of restoration is calculated. In column reference of table 6:1, it can be seen that the calculated values from the valuation study in chapter 5 are used as a main input for the scenarios. However a number of assumptions and estimates are made. Giving the overall key assumptions:

- Beside carbon sequestration all benefits of improved WS will arrive after the 15 year threshold.
- The provided WS will stay constant over time after the threshold. This assumption is made since there is no data available about WS development. However it is unlikely to be constant and the expectation is that the WS will improve over time.
- For simplification purposes some important interaction between the different WS are neglected. The most important variables, the specific assumptions and uncertainties will be concisely described according the number given in the table. The benefits will be described in more detail, since this was the main focus of the research done.

B **Hydrological and economic impacts of restoration (benefits).** Thicket restoration upstream in the Baviaanskloof will results in improved WS (hydrological impact), which has a number of economic impacts for the water users. As the numbers in the table indicated (A1-C7) there is a heavy interlinkages between the different WS.

Table 6:1 Economic feasibility scenarios of the total costs and potential benefits of thicket restoration in the Baviaanskloof watershed (based on: (Mander et al. 2007b).

				Farmland western side	Nature reserve	Explanation & Reference
A. Area restored	**Scenarios**	**Parameters**	**Unit**	**Outcome**		
A1. Baviaanskloof watershed		**Variables**	ha	**190,425**	**50,000**	(Boshoff 2008:6); (Crane W. 2006)
Total area restored (%)	Worst	0.5%	ha	952.1	250.0	Assumption
Total area restored (%)	Medium	2.0%	ha	3,808.5	1,000.0	Assumption & (Lorencová 2008):67
Total area restored (%)	Best	4.0%	ha	7,617.0	2,000.0	Assumption
A2. Total Kouga-Baviaanskloof watershed	**A1/A2**	**405,000**	ha			
Total watershed restored (%)	Worst		%	0.24%	0.06%	
Total watershed restored (%)	Medium		%	0.94%	0.25%	
Total watershed restored (%)	Best		%	1.88%	0.49%	
A3. Average percentage of land restored per ha	**A1*A3**					
Percentage land restored	Worst	60%	ha	571.3	150.0	Assumption
Percentage land restored	Medium	80%	ha	3,046.8	800.0	Assumption & mander et. al. 2007
Percentage land restored	Best	100%	ha	7,617.0	2,000.0	Assumption
B2. Hydrological & Economic impacts (BENEFIT)						
B1. Improved Baseflow	**B1*A3**	**56.91**	m3/ha/y			Current baseflow
Evapo-transpiration loss through planted thicket		15%	m3/y			Assumption
Min.	Worst	10%	m3/y	-1,625.6	-426.8	Assumption & mander et. al. 2007:35
Avg.	Medium	20%	m3/y	8,669.8	2,276.4	Assumption & mander et. al. 2007:35
Additional baseflow after 15 year- (Evapo-transpiration):	Best	30%	m3/y	65,023.2	17,073.2	Assumption & mander et. al. 2007:35
B2. Sedimentat yield	**B2*A3**	**0.03**	ton/y/ha			
Reduced sediment yield: Min.	Worst	10%	ton/y	1.5	0.4	Assumption
Reduced sediment yield: Avg.	Medium	30%	ton/y	24.1	6.3	Assumption
Reduced sediment yield: Max.	Best	50%	ton/y	100.4	26.4	Assumption
B3. Dam sedimentation	**B3*B2**	**1.5**	Ton/m3			Expert opinion in mander et. al. 2007:35
Additional storage capacity:Min.	Worst		m3/y	1.0	0.3	Estimates
Additional storage capacity: Avg.	Medium		m3/y	16.1	4.2	Estimates
Additional storage capacity: Max.	Best		m3/y	67.0	17.6	Estimates
Economic value of sediment:Min.	Worst	**15**	R/y	15.1	4.0	This can be estimated using the economic value of
Economic value of sediment:Avg.	Medium	**R/m3**	R/y	241.0	63.3	water or the cost of dredging estimated at R15 per
Economic value of sediment:Max.	Best		R/y	1,004.3	263.7	cubic meter (mander et. al. 2007).
B4. Improved water supply	**B1+B3**					
Additional water supply:Min.	Worst		m3/y	-1,624.6	-426.6	Estimates
Additional water supply:Avg.	Medium		m3/y	8,685.8	2,280.6	Estimates
Additional water supply:Max.	Best		m3/y	65,090.1	17,090.8	Estimates
B5. Raw water pricing						
Capital value agricultural water		**2.93**	R/m3			Table 5.2
Rental annual value agricultural water		**0.23**	R/m3/y			Table 5.2
Economic crop water productivity. Weighted average citrus, potatoes & da		**6.02**	R/m3			Table 5.13
Price of raw water (Agriculture)		**0.18**	R/m3			§ 5.4.2 Water pricing
Price of raw water (D&I)		**0.53**	R/m3			§ 5.4.2 Water pricing
Average water price		**0.36**	R/m3			§ 5.4.2 Water pricing
Replacement COST URV		**34.28**	R/m4			Table 5.12
B6. Assurance of supply (water security) IRR	**B4/Ratio**	**590,000**	m3/%			Table 5.4, Ratio developed
Improved assurance of supply IRR: Min.	Worst		%	-0.003	-0.001	Assumption
Improved assurance of supply IRR: Avg.	Medium		%	0.015	0.004	Assumption
Improved assurance of supply IRR: Max.	Best		%	0.110	0.029	Assumption
B7. Assurance of supply (water security) D&I	**B4/Ratio**	**230,000**	m3/%			Table 5.4, Ratio developed
Improved assurance of supply D&I: Min.	Worst		%	-0.007%	-0.002%	Estimates
Improved assurance of supply D&I: Average	Medium		%	0.038%	0.010%	Estimates
Improved assurance of supply D&I: Max.	Best		%	0.283%	0.074%	Estimates
Economical value of higher assurance		?	R/%	?	?	Table 5.6
B8. Raw water treatment cost	**B2/B8....**	**0.0012**	R/TSS			§ 5.2.4 Mitigation cost, Figure 5:5 & 5:6
Cost reduction: Min.	Worst	**66**	R/y	646.8	169.8	Total water use (Mm3/y). Estimates
Cost reduction: Avg.	Medium	**24**	R/y	10,348.4	2,717.2	Total water treated (Mm3/y). Estimates
Cost reduction: Max.	Best		R/y	43,118.1	11,321.6	
B9. Carbon sequestation credits (Intact thicket)	**B9*A3**					
Above and below ground Carbon seq.: Min. (tC/ha/y)	Worst	2.50	Ton C/y	1,428.2	375.0	Assumption
Above and below ground Carbon seq.: Avg. (tC/ha/y)	Medium	3.00	Ton C/y	9,140.4	2,400.0	Assumption
Above and below ground Carbon seq.: Max. (tC/ha/y)	Best	3.40	Ton C/y	25,897.8	6,800.0	(Mills et al. 2005)
C-price: Min. (R/ton C)	Worst	ZAR 99	R/y	141,122.8	37,054.7	EU alowance Over The Counter (EUA OTC) Dec
C-price: Avg. (R/ton C)	Medium	ZAR 198	R/y	1,806,371.6	474,300.0	2008 as on 05 October. 2008
C-price: Max. (R/ton C)	Best	ZAR 255	R/y	6,603,939.0	1,734,000.0	www.pointcarbon.com
B10. Flood & drought damages 2007	**A2*F+B6*D**	**1,032,850**	R/y			Table 5.8 & 5.9
Damage reduction: Min.	Worst	**Flood**	R/y	-3,714.9	-975.4	Estimates
Damage reduction: Avg.	Medium	**2,231,000**	R/y	42,556.8	11,174.2	Estimates
Damage reduction: Max.	Best	**Drought**	R/y	265,554.2	69,726.7	Estimates
B11. Created temporary employment	**B11*C1...**	**200**	Days/y			M. McConnachie (p.c.,July 18, 2008)
Created annual jobs: Min.(working days /ha)	Worst	30	Jobs/y	45.0	45.0	Assumption
Created annual jobs: Avg. (working days /ha)	Medium	40	Jobs/y	135.0	135.0	Assumption
Created annual jobs: Max. (working days /ha)	Best	60	Jobs/y	288.0	288.0	Assumption
C. Total restoration COST						
C1. Total restoration period	**C1*A3**					
Min. relative cost (12 teams) (ha/year)	Best	960	year	7.9	2.1	Estimates & M. McConnachie (p.c.,July 18, 2008)
Average cost (9 teams) (ha/year)	Medium	675	year	4.5	1.2	Estimates & M. McConnachie (p.c.,July 18, 2008)
Max. relative cost (6 teams)(ha/year)	Worst	300	year	1.9	0.5	Estimates & M. McConnachie (p.c.,July 18, 2008)
C2. Land price						
Land price		?	R/ha	0.0	0.0	Compensation through potential PES revenues
Opportunity cost		?	R/ha	0.0	0.00	Compensation through potential PES revenues
C3. Cost of restoring degraded land: planting Spekboom (Incl. labour, transport, all material, overhead)						
Min. cost: Mechanisation (drilling)	Best	2,000	R/ha	2,000.0	2,000.00	M. McConnachie (p.c.,July 18, 2008)
Avg.cost: drilling & business as usual)	Medium	3,250	R/ha	3,250.0	3,250.0	Assumption
Max.cost: Business as usual	Worst	4,500	R/ha	4,500.0	4,500.00	M. McConnachie (p.c.,July 18, 2008)
Following up cost due to mortality (upto 3-4 times)		10,000	R/ha	10,000.0	10,000.00	M. Powell (p.c., September 29, 2008)
C4. Service suppliers & PES implementation agency	**C4*C3**					
Start-up' cost I (incl. cost of valuing WSS, identifying potential buyers and part of negotiations		0%	R/ha	0.0	0.00	Assumption
Start-up' cost II (incl. cost of negotiating, establishing a contract, and implementing the agreement.		10%	R/ha	1,325.0	662.5	10% . 5% of project cost. Assumption & (Landell-Mils & Porras 2002)
C5. Overhead Cost		5%				
Operation and management of restoration		25%	R	3,644	3,478	25% of total average cost. Assumption
C6. Cost of Fire Operation and Management						
Commercial Farm Land		?	R/ha	0.0	0.00	M. Powell (p.c., September 29, 2008)
Communal Land		?	R/ha	0.0	0.00	M. Powell (p.c., September 29, 2008)
Conservation Area		?	R/ha	0.0	0.00	M. Powell (p.c., September 29, 2008)
C7. Cost of grazing operation and management						
Cost of livestock removal & maintenance (fencing)		19.3	R/ha/a	19.3	0.00	van Niekerk et al., 2007
C8. Discount rate						
Low, negative disocunt rate	Best	-2.0%				Assumption
Average discount rate	Medium	8.0%				(Veelen van 2003b); (Mander et al. 2007a)
High discount rate	Worst	12.0%				Assumption

B2&3 Sediment yield and dam sedimentation. The sediment delivery from the Kouga-Baviaanskloof watershed is unknown. A baseline number is calculated based on the extrapolated sediment yield in the canal (in 2007) and the sedimentation in the Kouga and Loerie Dam per year over the entire catchment area. This number is expected to be relative high (0.03 ton/ha/y) since the sediment yield in 2007 was above average through the floods and broken farm dams. However according Taiton (1999:17), a soil loss rate for degraded land was given between 5 and 10 ton/ha/y. The high difference can be explained by the amount of sediment that retains in the number of upstream farm dams and in the river bed, which causes damages through the lost water storage upstream. The economic value of dam sedimentation is estimated based on the dredging cost 15R/m^3. However this value is not further used, since the value of the additional storage capacity is calculated by the water price. The final value is added to the improved water supply calculations.

B4 Improved water supply. The improved yearly water supply by the additional dam storage capacity is insignificant compared to the additional infiltration rate and base flows, which can level of the storm flow periods. It is assumed that the current baseflow is equal to infiltration rate, which is not completely correct since there will be an unquantifiable loss through natural and human extraction. A change in the infiltration rate against the MAR is assumed as a result of restoration. The assumed evapo-transpiration rate of thicket can, in the low scenario, result in a negative water supply. However the exact water use pattern of thicket is unknown and need to be determined to make more accurate estimates. The assumption that an increased baseflow results directly in an increased downstream water supply is not completely valid. The Kouga system is less vulnerable for low dry whether flows in winter since in general, all runoff water can be stored in the dam and is therefore not getting lost. The main benefit is the storm flow water retained in the watershed during periods of dam overflow. This improved water supply is valued by the average price of raw water sales in the Gamtoos valley. The economic or capital value of agricultural water is not used since the actual water allocation to agriculture is unsure and dependent on political decisions in the NWA (1998). Additionally it is most likely that no extra water will be allocated and all water will be used to increase the supply assurance.

B6&7 Assurance of supply. Water saved by a reduced overflow should be used to increase the assured yield of the Kouga Dam. This improved assurance can be calculated based on the amount of water that is not supplied during restrictions. A standard rate is developed in million m^3 needed to increase the assurance, specifically for domestic or irrigated agriculture with one percent. It must be stated that there is not a one to one relationship since the assurance of supply is determined based on the long-term historical yield and the extra water supply in the dam does only shorten the period and intensity of restrictions. The benefits of a higher assurance, as described in §5.1.2, are unknown, but expected to be substantial. The value of an assured level of supply need to be estimated in Rand per percent. For agriculture this can be achieved by valuing the actual benefits of the changed management practices described in table 5:6. The benefits of an increased assurance are therefore not used in the final feasibility calculation in table 6:2. Double valuing is hereby avoided.

B8 Raw water treatment cost. A cost ratio is developed between the chemical water treatment cost at Loerie WTW and the sediment yield (TSS) of the raw water. This ratio is needed to make some initial estimates of the reduced treatment cost due to a lower sediment yield. The high standard deviation made obvious that there is a strong, but not direct relation between the sediment yield and treatment cost, as shown in figure 5:5 & 5:6. The treatment cost is dependent on a number of other water quality factors. A proper ratio need to be developed based on longer and more accurate data. The value of an increase life span of the water supply infrastructure from the farmers and from DWAF is excluded due to the high level of uncertainty.

B9 Carbon sequestration credits. Carbon payments are by far the main financing source as can be seen in table 6:2. The heavy reliance on the carbon is risky as until so far the certification process did not succeed see §4.1.4. The bundling of carbon credits with payments for the described WS has been identified in Mander et al. (2007) as most favourable option. A higher contribution of the WS will increase the financial security of thicket restoration.

B10 **Flood & drought losses and damages.** The expected benefits of restoration is shorter periods of flood (Kouga Dam overflow) and drought (restrictions) with a lower intensity. The reduced flood damage is based on the total extrapolated damages in the Gamtoos valley weighted per recurrence interval and multiplied by the percentage of restored area in the Kouga-Baviaanskloof watershed. This is equally done with the drought damage however, it is multiplied with the improved level of assurance as for agriculture. As said this only counts when no extra water is allocated. Combining both reduced damage gives the total value. The overall effect is relatively low as seen in table 6:2. An explanation is that less than one percent of the Kouga-Baviaanskloof catchment is resorted in the medium scenario for farmland.

B11 **Created temporary employment.** In order to shorten the total restoration period and minimize the total costs, the amount of employers available in the Baviaanskloof is crucial. The assumption is made that between 6 and 12 teams are available with a varying level of productivity. The duration of the employment depends on the total restoration period (see C1). It should be stated that the creation of over 100 jobs per year may not be feasible unless employers from other areas temporary immigrate, which will not be in favour as it may cause various potential social-economic problems.

C **Total restoration cost.** The potential area for thicket restoration is not accurately determined. Estimated in Lorencová (2008), the total area will vary between 3,000 and 4,000ha, as given in the medium scenario. At present, the Subtropical Thicket Restoration Program (STRP) has restored approximately 180ha of degraded thicket in the Baviaanskloof, which is not included in the scenarios. Most of the restored area was in the BNR; however some experimental plots are established on private land. The thicket restoration project is at the moment in the pilot phase, which aims to identify the best restoration practices. The management cost are relative low as no burning management is required and it is assumed that the land is permanent dedicated for restoration. However, when Spekboom is full grown it is expected that sustainable grazing, according land carrying capacities, can be introduced.

6.1.2 Final output

As described, these exploratory scenarios include a large number of non-quantifiable factors which made the final outcomes highly hypothetical. A number of general and specific assumptions are made in a simplified calculation. The three scenarios depict the range of the URV. Where scenario 'worst' is based on the relative highest cost and lowest benefits, the opposite counts for the 'Best' scenario. The 'Medium' scenario depicts the most likely future development. Only the best scenario in table 6:2 can be seen as economic feasible since the URV is lower than one. The medium scenario can be seen as possible according Mander et al. (2007), since the URV is lower than 2.5. The URV can be calculated specifically per WS; however the economic benefits of the WS are in this case to low. Looking at the medium scenario for farmland, a total cost of 2.10R is required to produce 1R of total benefits.

Table 6:2 Economic feasibility scenarios of PWS in the Baviaanskloof watershed - Summary of the key results (Mander et al. 2007b).

Variables	Scenarios	Worst	Medium	Best	Worst	Medium	Best
Total area restored	ha	952	3,809	7,617	250	1,000	2,000
Economic cost restoration	Unit *Range:*	*Max. cost*	*Avg. cost*	*Min. cost*	*Max. cost*	*Avg. cost*	*Min. cost*
Restoration cost	R/ha	19,469	18,219	16,969	18,641	17,391	16,141
Management cost	R/ha/y	19	19	19	0	0	0
Total management Cost	PVC (Million R)	0.102	0.757	8.959	0.000	0.000	0.000
Total restoration Cost		10.534	48.509	138.142	5.592	13.913	32.920
Economic benefits restoration	Unit *Range:*	*Min. benefit*	*Avg. benefit*	*Max. benefit*	*Min. benefit*	*Avg. benefit*	*Max. benefit*
Improved water suply	PVB (Million R)	-0.001	0.011	1.007	0.000	0.003	0.264
Reduced raw water treatment cost		0.001	0.038	1.880	0.000	0.010	0.494
Carbon sequestation credits		1.303	23.264	402.440	0.342	6.108	105.669
Reduced flood & drought damages		-0.006	0.155	11.577	-0.002	0.041	3.040
Feasability							
Economic unit reference value (URV)	(PVC/PVB)	8.20	2.10	0.35	16.42	2.26	0.30

6.2 Stakeholder involvement

Service suppliers: upstream land owners and water users

- *Most commercial farmers* (and other private land owners) in the Baviaanskloof are eager to participate in restoration. This mainly to identify new income streams that would improve the returns from stock farming. (Interest was shown after presenting preliminary results at their regular farmers meetings).

- *The local communities* will be interested to participate in restoration mainly for the additional jobs that will be created.

- *Eastern Cape parks Board* is interested to participate in the thicket restoration project when they get a financial compensation for their activities. They can be a potential viable, discrete seller of WS and responsible for managing activities both in and outside the reserve (Zijl 2008). If they increase their staff capacity they can play a role in monitoring the farmers in western Baviaanskloof who are willing to restore their land and interested in working with a stewardship agreement.

Service demanders: downstream water users

Broad groups of downstream water users are interested in restoration and the improved watershed services. Potential buyers of WS include:

- *DWAF* is interested in watershed restoration, but it is not their first priority since they are focusing on other major issues, such as implementation of the NWA. At present DWAF have a shortage off staff and do not have the capacity for participating.

- *GIB* (water utility company) or the future Water User Associate, will be interested to participate in, and contribute towards, watershed restoration and PES initiatives in order to learn about the less expensive supply augmentation options.

- *Established farmers* in the Gamtoos valley are the major water users and will therefore be the main beneficiaries of the improved WS. As described in §4.1.4. they are interested in the WS and WTP under certain criteria.

- *Emerging farmers* in the Gamtoos valley could not give proper response due to a lack of understanding. They definitely are beneficiaries, but do not have the financial means to contribute to payments.

- *Kouga municipality* is convinced that restoration is beneficial for the water regulation service.

- *Nelson Mandela Metropolis Municipality*(NMMM) is interested in all projects that generate extra water. However their WTP depends merely on the provided (hydrologic) evidence. A feasibility study and a stochastic analysis of the benefits of the restoration project are required to convince NMMM (and to get them involved).

6.3 Payment for Watershed Services in practice

Knowing the benefits of the WS and the economic values thereof, as presented in chapter 4 and 5, is of little use if it does not lead to real investments in restoration. The main beneficiaries of restoration §6.2 and the magnitude of the benefits they receive (§4.2) are required to capture some of the benefits and contribute to financing of conservation. Together with some financial support from a governmental department (e.g. DWAF) a public-private mechanism can be set up which involves less risks (Nature Conservancy et al. 2004).

6.3.1 Payment mechanisms

A number of categories of payment mechanisms are described in Landell-Mils et al. (2002) and in Perrot-Maître et al. (2001). Based on the data obtained from the main stakeholders four of the mechanisms can be potentially suitable for paying for watershed protection or restoration in the Baviaanskloof.

- *Intermediary-based transactions*. Intermediaries are used to control transaction costs and risks, and are most frequently set up and run by NGOs, community organizations and government agencies. In some cases independent trust funds are created.
- *Retail-based trades*. The restoration in the Baviaanskloof can be partially financed through existing consumer purchases. Through labelling or even certification consumer recognition and an additional value to the product can be generated. A concrete example is the Baviaanskloof Mega Reserve conservation area label. Especially citrus growers can create additional value for there export fruits to Europe. Plans already exist to develop a certification system and label as 'Baviaanskloof Mega Reserve citrus initiative' according P. Dempsey (personal communication, April 18, 2008).
- *User fees.* Since all the WS are interlinked an option is to sell it as 'one package' to the water users in the Gamtoos valley and NMMM. A set standard rate per sector can be imposed as a user fees to all beneficiaries (to ensure payments). The extra fees can possibly be included in the water resource management charges (WRMC), which is introduced by DWAF in 2002. This charge includes the control of invasive alien plants (WfW) as well as charges for activities such as planning and implementation, demand management and water allocation. The WRMC, levied in a specific WMA, will be based on the total cost estimates divided by the total allocation, weighted according to affordability, assurance of supply and equity (Blignaut et al. 2008). The restoration cost of upper catchments (using the most cost effective possible action) may be charged to affected water users in order to increase long-term water security. Additionally, these costs may also be supported by subsidy where available and appropriate. If there is a clear benefit of restoration for the water users it potentially will be included in the WRMC. (However the legal pricing strategy need to be amended) (Blignaut et al. 2008;DWAF 2007b;Goverment Gazette 2005).
- *Property Acquisition.* DWAF, ECPB, GIB or a private investor can buy ('low-hanging-fruit') lands in the Baviaanskloof watershed for restoration, protection and conservation. This can speed up the process of PWS because there are fewer stakeholders involved. Financing can come in through one of the above mechanisms.

Pareto efficient

To develop an economic (Pareto) efficient and realistic PWS scheme, the following conditions need to be met:

1. The compensation of upstream landholders should be at least equal to the opportunity cost of the promoted land use, associated with forgone revenue from alternative land uses, (e.g. agriculture) and the cost of the management practices over time (Landell-Mils et al. 2002).
2. The amount of the payment should be lower than the economic value of the environmental externality (Kosoy et al. 2006).
3. Money need to be available for the administration costs under the expected PWS transaction over time.

6.3.2 SWOT analysis for PWS in the Baviaanskloof

To finance thicket restoration, a PWS scheme is seen as a feasible option. However insights need to be gained in the Strengths, Weaknesses, Opportunities and Threats of PWS in order to make appropriate preliminary judgements. To achieve this, a concise SWOT analysis is conducted, based on the field experience supported and completed by related PWS literature. SWOT is a well established means of thinking critically and is here used as a tool to pinpoint the positive and negative factors of PWS in the Baviaanskloof. There are many obvious issues around PWS, therefore it is tried to focus mainly on area and field specific factors beside the obvious. In figure 6:3 the key messages of the SWOT are summarised and described later on.

Table 6:3 SWOT matrix with the summarised key issues of PWS for thicket restoration in the Baviaanskloof.

	Positive	Negative
Internal factors	**Strengths** **I.1** Low participation costs **I.2** Secure land rights **I.3** Low chances on 'free riding' **I.4** Early involvement stakeholders **I.5** General recognition of PWS **I.6** Demand WS higher than supply	**Weakness** **I.7** Initial funding required **I.8** A threshold for WS need to be met **I.9** Complex monitoring WS **I.10** Uncertainty benefits **I.11** Long negotiation process **I.12** A mechanism is needed to enforce payment
External factors	**Opportunities** **E.1** Local trust building by 'champions' **E.2** Private and public funding **E.3** Potential for poverty reduction **E.4** Open and transparent process	**Threats** **E.5** Community reservations **E.6** Neglecting community involvement **E.7** Large-scale monoculture plantations **E.8** Legislative changes **E.9** WS delivery and payment constraints

The SWOT analyse is not absolute, since there are far more sociological, ecological, economic and institutional factors that plays a role in PWS. A specified number of preliminary concrete formulated factors are given which are seen to be most important. However, the analysis is subjective since the level of importance per factor can vary heavily. The listed key strategic issues can be used as input for the further PWS objectives.

I. Internal factors

The focus of the SWOT analysis was on the current strength which should be increased and the weaknesses which should be reduced.

Strengths

I.1 A low participation cost is assumed, given that:

- A relative low number of participants are involved upstream and downstream.
- There are small amount off main landowners (ECPB & 20 farmers) and communities (3) upstream in the Baviaanskloof.
- Landowners in the Baviaanskloof hold large areas (avg. 4,200ha), therefore they are more than likely be able to and willing to commit to restoration.
- A high group homogeneity results in lower chances on conflicts.
- Lower cost of the multi-stakeholder participation process (Landell-Mils et al. 2002).
- Most farmers in Baviaanskloof, Patensie and Hankey are organized in a farmers union.

I.2 There are secure land rights in the Baviaanskloof and the property borders are clearly defined (critical for PWS schemes).

I.3 The controlled water supply downstream can minimize the 'free-riding' in consumption of the improved WS.

I.4 All the stakeholders were involved at an early stage which is positive to establish a long-term participatory process needed to identify alternative practices and a mutually acceptable set of incentives (Perrot-Maître 2006). Involvement increases the understanding of the benefits provided by watersheds and the growing threats, which may increase their WTP (Gutman 2003).

I.5 In general, no resistance is offered by the water users over the fact that they are currently used to receive watershed protection services (at a lower level) for free and they may need to pay for WS (Sikor, 2000).

I.6 The demand for the improved WS will be higher than the potential supply. The reversed happens to most current deals and markets for WS, resulting in low prices (Katoomba group et al. 2007).

Weakness

I.7 The 'start-up' cost need to be covered by some kind of initial funding until the services are delivered to the buyers (Richards et al. 2007).

I.8 A minimum area of the watershed need to be restored to exceed the 'hydrological and carbon threshold. What means that there will be a measurable change in the WS and the potential to sell carbon credits.

I.9 Measuring or monitoring this (change in) WS is required. However it is complex and proxies need to be used, as described in §4.1.5.

I.10 The high uncertainty about the level of benefits perceived, requires sufficient prove of the changed WS to some agreed standard.

I.11 The negotiation process to reach agreements on the approach, costs and compensation can be very time consuming (Déprés et al. 2005).

I.12 A financing mechanism need to come in place to enforcement payments (Gutman 2003).

E. External factors

An identification is made of the potential opportunities for PWS and the main threats are highlighted, which can possibly be turned into an opportunity.

Opportunities

E.1 Trust-building can be achieved locally based and led by a "champion", a person sympathetic to the farmers'.

E.2 If private (farmers and GIB) and public (DWAF, NMMM and KM) water users are involved, a lack of finances is not expected.

E.3 The fact that thicket restoration in the Baviaanskloof can lead directly and indirectly to poverty reduction need to be emphasized. The communities are (small) landowners and can be potential service deliverers. Additional, the poor people in the community can benefit when they are involved in the 'on ground' implementation and management. Therefore a PWS schemes is more likely to have pro-poor impacts as often is the case in PWS projects (Richards et al. 2007).

E.4 Openness and transparency in the communication towards stakeholders need to be achieved, since it will increase their cooperation and shorten the negotiation and overall process.

Threats

E.5 Effort to inform and built trust is needed to include the communities. They have significant reservations about entering into a land contract because the fear of losing the land (Brinkman et al. 2006).

E.6 The possibility exists that thicket restoration will only occur on the large farm lands, since it will be more efficient from an economic point of view. However from a social objective the smaller land-owners and communities need to be involved to ensure equity distribution.

E.7 In the restoration (design), the needs of the entire ecosystem must be taken into account. A common heard argument is that restoration projects, for e.g. carbon sequestration or watershed restoration, require a large-scale monoculture plantations known as 'Kyoto forest'. This will negatively impacts the ecology and biodiversity, thus need to be avoided at al time (Richards et al. 2007).

E.8 Legislative changes as announced in the NWA (1998) can negatively offset possible benefit of WS, as described in §5.1.1.

E.9 Sellers must never forget that payment is contingent on delivery – and delivery is contingent to payment of the agreed price (Katoomba group et al. 2007).

7 Discussion

A critical reflection is given of the research performed. The uncertainty and limitations of the used methods are described and the effect on the validity of the results and the implication of the final outcomes are discussed. Some major constraints of the methods described in §2.2.2 is placed in a wider perspective.

7.1 Limitations and uncertainty of the methods

Data availability

The availability and accessibility of data was one the main limitation in this research. A number of assumptions had to be made since there was a shortage of detailed hydrological data. Some of the available data was imperfect or not properly recorded. An example can be given for the water treatment works (WTW) in the Gamtoos valley. For the towns Hankey and Patensie no records were kept for the monthly treatment cost or quality of the raw input water. Loerie WTW had the required data of the raw water quality samples available, but only in handwriting. Digitalizing of the data was time consuming and therefore only a relative short period 2007-2008 was analyzed. The final results are still useful to serve as a first indication, but there is definitely a need for analysis over a longer time interval. This process will be easier in the future as they are upgrading Loerie WTW at the moment. The accessibility to the different DWAF reports or consultancy feasibility studies was difficult since until recently (2005) most reports were only available in hardcopy.

7.1.1 Technical research design

Most of the field data was collected by the Gamtoos valley farmers' survey, because it was expected that the farmers are one of the main beneficiaries from the improved watershed service. (The research outcomes provided substantiating evidence for this expectation). Additionally, a number of expert and stakeholder interviews were held to support and complete the data. In the end, a large amount of qualitative data (e.g. opinions) and quantitative data (e.g. production figures) was collected (see §1.3.1). During the analysis process the qualitative data was grouped, combined, generalized and concisely presented. To prevent the loss of valuable information, which definitely occurs when analyzing and aggregating data, the unmodified data is presented entirely in appendices 6 and 7. When interpreting the reactions given by the farmers' one should be aware that they sometimes answer strategically to maximize their own benefit. To improve the data validity, additional background information (e.g. production figures) was acquired to validate the given estimated values of damages and lost production. The latter was often difficult since most farmers do not keep records or make long-term management and production planning. The structured interview was simplified in order to shorten the time and to make the farmers comfortable with the questions. Additionally, background information on the benefits of restoration was given by explaining the restoration model. The way of 'framing' the interview questions and providing this supporting information has serious consequences for the interview results. In general people mostly act with 'bounded rationality' and they are often not fully informed and are limited in their computational ability (Landell-Mils et al. 2002). The farmers' response was often based on their knowledge, confidence and capacity to directly analyze the available information of the restoration project. The same counts for the identification and valuation of possible perceived future benefits. The examples given for e.g. possible flood damages were sometimes needed to illustrate the question and trigger the farmer to think further forward. In order to maintain relative objectivity of the research, care was taken to avoid influencing or steering the response of the farmers. The final outcomes of this empirical research are mainly based on the experimental data and linked later to the existing theories. By using simple words and illustrating questions with 'on the ground' examples, an effort were made to make this research understandable for the broad public i.e. all stakeholders. The academic research level was achieved by linking these examples to the theoretical concepts e.g. PES. However one must remember that the results need to be meaningful for local stakeholders. The over 'academisation' of PES can scare some initial supporters away as they say 'too complicated to be useful' (ISEE 2008). Therefore the aim was to create a balance between the scientific credibility of this research and the practical implications.

7.1.2 Theoretical assumptions

Through this research a change in awareness, perceptions and beliefs in watershed restoration was created among the different stakeholders interviewed. The important role of thicket vegetation cover in regulating the watershed services was clearly explained. A broad background study on the effect of thicket restoration was conducted, but a high level of uncertainty still remains. The main assumption made in this report was that thicket restoration in the Baviaanskloof will have a positive effect on (an the assured) water supply, sediment supply and regulation, flood control, water purification and erosion control. The occurrence and intensity of this effect is unknown and was estimated in §6.1 scenarios. The estimates are often based on short-term data and are heavily influenced by extreme events. For example, the 2007 flood resulted in an extreme increase of the sediment yield. It was also not guaranteed that the additional infiltration during flood was substantial enough to generate extra water that reaches the Kouga Dam. Because of this, some calculated values are highly hypothetical since the restoration was not in place yet and benefits need to be assumed. Clear results are needed, from e.g. the current thicket wide pilot plots, to make more accurate estimates of the economic impacts which was the goal of this thesis.

Valuation tool

This thesis used a number of different valuation methods used which has the advantage that the different watershed services can be valued in the most appropriate way. However, because of time and capacity constraints, it was not possible to carry out a comprehensive analysis since a complete separate study would be needed per valuation method. The reason for using a number of valuation methods was to get a broader indication of the estimated economic values of the different watershed services. Only the economic benefits of the watershed services are valued where this was possible or otherwise described in detail. The constraints of the different methods used in §2.2.2, are described accordingly.

a. The final values of an increased water supply, through direct market valuation, are heavily influenced by market imperfections and policy regulations which influences the free trading principle (De Groot et al. 2006), as partly described in §5.1.1 .

b. The production factor method was used to value a higher assurance of supply. Care should be taken not to double count values perceived from watershed services and not to neglect other factors. The decision of a farmer to increase the productivity was based on a wide variety of production factors, such as natural resources, processes and qualities. The increased water security was only one of the factors and it cannot account for the complete financial benefit (unless others are assumed to be indefinite). In this report, only the benefits of an improved water security to agriculture were valued by both the benefits of the changed management practices and the avoided damages from restrictions. There was a fine line between the improved water security and reduced drought period and intensity. Values were not double counted since it was not possible to make proper estimates of the value of the changed farm management practices. With more in-depth and detailed questioning of the farmers, the value of an assured supply can be determined. In the survey the concept assurance of supply was simplified by only stating the recurrence factor (1:5) and the according perceived security (80%). The level of curtailment was not taking into account initially. A major shortcoming here was that farmers may interpret the improved assurance incorrectly and that their answer does not reflect the reality / their real behaviour resulting in over- or undervaluing. More attention needs to be paid to the changed practices and the economic value thereof (see recommendations).

c. The avoided damage cost method was used to value the extra cost caused by the flooding and drought in 2007 and 2006 respectively. Additionally, the farmers in the Gamtoos valley estimated the (financial) benefit they would have when these events did not occur. It needs to be taken into account that cost of avoided damages or substitutes does not always accurately match the original benefit, it can lead to over- or under- estimates (De Groot et al. 2006). In general, a major constraint was that the values are influenced by external factors. The fact is that most damages and benefits are a combination of complex factors and cannot be valued straightforward. For example, the flooding in the Gamtoos valley was caused by a number of sources and the contribution of the Kouga Dam overflow was unknown. Therefore, to quantify the damage reduction some approximations need to be made. Generally this will be required in order to attach values to the mainly non-marketed, 'intangible' services provided by the watershed. Until now most of the watershed services such as flood protection and soil regulation are un-valued and un-marketed in the Gamtoos valley. The main reason was the fact that watershed services are non-excludable and / or non-rival[10] (Perman et al. 2003). These so called positive externalities can be seen as secondary economic benefits.

d. Calculating the replacement cost requires a large amount of data. The final Unit Reference value (URV) is heavily dependent on the consistency of counting all the different costs and benefits that occur over the set life span of the project, which can be debatable as well.

e. With the contingent valuation method (CVM) insight was gained in the willingness to pay (WTP) of farmers for restoration. There are various sources of bias in the interview techniques that can influence the data and therefore need to be taken into account when interpreting the WTP outcomes. One example is the 'strategic bias', where the respondent purposely overstates or understates their WTP out of own interests (Perman et al. 2003). The Dichotomous contingent choice model is a variety to the CVM and eliminates some of the weaknesses. Here respondents are asked if they are WTP a predetermined amount. There is some controversy whether people would actually pay the amounts they state in the interviews. I.e. their stated preference as opposed to revealed preference (De Groot et al. 2006). The contingent choice model was not used in the survey because the WTP question was to get a first indication of the possibility of introducing PES as a financing mechanism. In order to make a good estimation many respondents are needed in a CVM. Additionally with CVM you measure everything, probably also things already measured (e.g. avoided cost and existence value). These valuation methods are complementary to each other as well as overlapping and contradictory (De Groot et al. 2006).

7.2 Validity of the results

The reliability and validity of the results are discussed in a nutshell, taking the given conditions from the previous paragraph into account. Additionally, a reflection was given on the assumptions made while interpreting the findings.

- The *data validity* of the results indicates how well the data, i.e. calculated values, represents the phenomenon for where it stands for, i.e. the value of WS. In total, 16% of the registered water users in the Gamtoos valley were interviewed, after which the data was analyzed, valued and used in the scenarios. The major strength of this study was that 'on the ground' information is discussed with, and collected from the main stakeholders. Direct problems were identified and described in detail in this report.
- Discussing shortly the data validity of some economic impacts. The calculated URV in §5.3 represents the replacement cost and indirect the value of WS. It can be argued that it was idle to make a comparison with large water generating engineering projects. Nevertheless, watershed restoration can be a substantial augmentation option when the values are calculated over a longer time span or when the additional benefits generated through e.g. carbon credits are included. The value of a longer life span of the infrastructure was estimated based on an extended useful life which results in a lower cost for DWAF and thus lower water user charges. Some major assumptions were required. Firstly, that restoration indeed leads indirect to an extended life span and secondly that the national charge system

[10] Non-rival: 'The consumption of a good or service by one individual does not reduce the amount available to others' (Perman et al. 2003).

can be altered locally. Through these major constraints *this* potential benefit of restoration can stay unvalued and without additional support may be neglected as argument in the PWS negation process. The total value of watershed services could not be estimated since not all use- and non-use values are included. In general, it can be said that the validity of the valuation methods is uncertain and the outcomes should be used as approximated values.

- *Internal validity* indicates whether the final results give a true reflection of reality. This depends heavily on the quality and accuracy of the data provided by the water users, as discussed in §7.1. Additionally, the inherent subjectivity plays an important role since the goal of this research was to provide values of the water regulation services to support and motivate thicket restoration. The danger was that the values are too 'ambitious' and not realistic in the 'real' world. Additionally, the assumptions on watershed services are based on the available literature and may not correspond with the actual situation. The calculated values of an improved and assured water supply, the reduced treatment cost and the value of carbon credits may differ through market distortions, such as the National Water Act, future developments and market changes (demand and supply).
- The *external validity* indicates how far the results of this study can be generalized. As it was a case study in the Baviaanskloof the outcomes can be extrapolated, with caution, to other areas. At first the described WS provided by the thicket biome can, to a certain extent, be generalized for all natural basal vegetation cover in a watershed, such as forest or fynbos. There are a number of rules of thumbs as described in box2:1. Since the relationship and principles are similar, data can be extrapolated to other watersheds. However this should happen with caution as the dynamics of the system can vary heavily. This all does not count for the calculated values such as: raw water prices, economic crop water productivity and Unit reference values. These values are specific for a geographic area and depend on a broad range factors like production intensity, water availability, efficiency and the demand-supply relation. Additionally the comparison of values is not always possible since different measurement tools are used. For instance market trading indicates the capital value of water, which can be much less when water is abundant in the area. Therefore 'transferring' economic valuation from on site to another was proved as difficult. It cannot be said that watershed restoration projects are possible or economically feasible in general. The relation between the different ecological, hydrological and economic impacts of the restoration model. based on Mander et al. (2007), can be relevant in different areas, such as in the Kouga or Krom watershed.
- With analyzing the *sensitivity* the relative importance of the differences in the stakeholder (group) responses towards restoration can be indicated (Punch 2005). There was a clear difference in reaction between the established and emerging farmers. Where most established farmers are interested in, and WTP for improved WS, the emerging farmers had a lack of understanding and are not able to pay. There are small difference in the responses between dairy, vegetables and citrus farmers as described in appendix 7, however it was difficult to generalize these. The municipalities are reserved in their responses to be in favour of and WTP for restoration.

Scenario analysis

In the valuation, it was preferred to use marginal values, thus the value of an additional unit of benefit provided by the expected improved watershed services. However, the marginal benefits of restoration are not constant as they depend on e.g. source, location, initial conditions and Spekboom growth patterns. It was expected that there is a threshold effect which will play an important role in restoration. For example, to improve the watershed services a minimum area of land need to be restored. For simplification purposes, it was assumed that the marginal values of the watershed services, used in the scenarios, are constant. Through the outcomes of the valuation (chapter 5), the marginal values can be calculated for the different impacts in the three preliminary scenarios (table 6:1). These exploratory scenarios have a high uncertainty, but also a high causality as described in §4.1. There was uncertainty over the desirable and sustainable scale of restoration in the Baviaanskloof in order to make it feasible. The economic URV in table 6:2 was given for the total of water, sediment, carbon and storm flow. This combined economic value does not

imply 'money in the pocket'. The numbers should be used as a basis for PWS negotiation and should not be seen as the total absolute financial benefit.
According to Mucina et al. (2006) and from own calculations it can be said that thicket restoration is likely to be very labour intensive and requires long-term investments of resources. Problematic here was the comparison of the present and future values of the cost and benefits, since restoration is a long-term project with high initial costs, while benefits accrue later. The discount rate is therefore important, because the higher the rate, the smaller the future benefits and vice versa. It is a contentious issue which rate to use as it is a question of values and ethics (it discounts the interest of future generations). It depends on the long term sustainability and certainty of the resource or services to be available. There are arguments in favour of using low or even negative discount rates for restoration projects, when future benefits are likely to be high or increasing due to scarcity or uncertainty about the long-term availability (Aronson et al. 2007). These aspects need to be clarified together with the future costs (e.g. increase labour prices) and benefits of thicket restoration. In this studies three different discount rates (-2%,8% and 12%) are used for the three developed scenarios. A discount rate of 8% was used for the medium scenario, as this is the general, average used rate in the Algoa feasibility studies (Veelen van 2003) and in the Drakensberg study (Mander et al. 2007). The decision on the discount rate to be used can determine the feasibility of restoration.

7.3 Implications major outcomes

Through the economic valuation by this thesis, insight is gained in the potential value of watershed services. In the scenario analysis the value of the improved WS was estimated which results in the total financial benefits. The implications of these outcomes together with the watershed restoration process are discussed in this section in a wider context.

Results discussed in a wider scientific context
The monetary valuation done by this study and the described financing mechanisms such as PES are useful in estimating how much area is optimal and desirable to restore. There is a potential market for watershed services in the Gamtoos valley since the water users are interested and the total values are substantial. An important fact is that the different beneficiaries need to be aware of the potential value of their benefit. There is a clear role for the implementation agency to facilitate this awareness and negotiation process. A positive economic outlook lies in the employment opportunities created by restoration and maintenance. Jobs can be created in difficult mountainous areas with up to 50% unemployment. Job creation should be promoted and marketed together with the increase in water security. These two benefits of restoration are National Strategic Issues and important to create awareness and interest among the different stakeholders and government departments.

A comparison must be made with the Maloti-Drakensberg PES study in South-Africa done by Mander et al. (2007), which was used as main reference. There are a number of similarities and differences in the watershed. In the Drakensberg watershed, one of the main benefits was the enhanced baseflow in winter months. Since there was no large dam, the system was more reliant on the additional baseflow during winter months. There was no engineering solution to capture the storm flow and to regulate the water flow. This in contrast with the Baviaanskloof watershed, where additional baseflow was less important as it was usually stored in the dam and not subject to loss. The benefit from extra water generated through restoration is therefore significantly lower in Baviaanskloof than in the Drakensberg case. This study has shown clearly that the management of upstream land uses can have noticeable influences on the hydrological impacts. Changes occur in the streamflow components baseflow and storm flow, as well as in sediment yields. In the Drakensberg study no WTP was found for storm flow reduction, because everyone benefited slightly and it was difficult to find one or more main beneficiaries, e.g. Municipalities, farmers, traffic department. Therefore, it was seen as a positive externality for downstream users. In the

Gamtoos valley, 50% of the farmers were interested in stormflow reduction which causes a considerable amount of damage. Other stakeholders, e.g. municipalities, were indifferent since they pass on the responsibility. The three main services (river baseflow, soil erosion prevention, and carbon sequestration) were estimated both in the Drakensberg study as for and in the restoration-study in the Baviaanskloof. The latter includes also the value of flood and drought damages and purification cost. Comparing the total values reveals that restoration in the Drakensberg is economically feasible (URV 0.48-0.31), where restoration in the Baviaanskloof was only feasible in the best case scenario (URV 16.42-0.30). This difference can be explained by the higher value for sediment and water. Both studies are clearly showing that the PES incomes from water sales alone are not sufficient to pay for restoration. This implies that the other services need to be included and for the Baviaanskloof state funds can be used to bridge the 'feasibility cap' (Mander et al. 2007).

Implications. This discussion leads towards the final conclusions of the research (chapter 8) where it was attempted to provide the economic rationale for restoration. Summarizing, it is important to keep in mind *what* is valued and who needs to benefit from these perceived values. Estimating the costs and benefits of WS was not always possible. Additionally the benefits were not always 'broken down' in a way that allows the separation of benefits associated with restoration. For example, the damage of flooding caused by the Kouga Dam overflow or the extra treatment cost at Loerie WTW caused by increased sediment yield. Not all information was easily available and the concept of 'watershed restoration' was generally not public knowledge.

8 Conclusions and Recommendations

Based on the original findings, conclusions are formulated in this chapter while briefly answering the research questions, followed by recommendations for further research and some practical implications.

8.1 Main conclusions

The objective of this research project was to value the economic benefits of restoration of ecosystem services, specifically water regulation, and to develop a basis for financing mechanisms to restore the subtropical thicket biome in the Baviaanskloof. Hydrological and economic information was provided to access various sources of funding to initiate a landscape-scale restoration project across the thicket biome.

What are the expected hydrological and economic benefits of restoration of the ecosystem service water regulation?

1. *What is the role and position of the main stakeholders involved in the in the restoration project?*

The primary service suppliers who should be actively involved in the actual restoration in the Baviaanskloof are the farmers, communities and the ECPB. The potential beneficiaries who could financially contribute to restoration are the farmers in the Gamtoos valley, Kouga Municipality, NMMM, DWAF and GIB. Other beneficiaries are the emerging farmers in the Gamtoos valley.

2. *How are market distortions, such as the equity principle in the national water act (NWA), influencing the distribution of the watershed provisioning services?*

The final outcome values of the provisioning services are heavily influenced by market imperfections and policy regulations (De Groot et al. 2006). Market imperfections such as legislations and trade-bans distort the market outcome, leading to misleading estimations (see example §5.2.4). According the NWA (1998), all new water allocation are initially reserved for the ecological and human reserves, as well as for the emerging farmers through the equity principle as described §5.1.1. Additionally, no extra water should be allocated to agriculture, according to DWAF and the NMMM, since the Gamtoos River is stressed and the Kouga Dam is over allocated. It can be concluded that the water value differ, depending on to where any additional water will be distributed.

3. *What is the impact of thicket restoration on the different hydrological processes, such as base flows of rivers, sedimentation of dams and rivers, infiltration rates, and what are the expected benefits?*

The DPSIR framework (figure 4:1) and the Baviaanskloof restoration model in appendix 3 depict the relationship between the ecological impacts (restoration) followed by the interrelated hydrological impacts. There is high level of causality as the interactions between the different impacts are well known. Nevertheless, there are a number of uncertainties about the intensity of change of the different model components, which can be crucial for the final outcomes. The expected benefits of an improved water regulation are increased water availability and supply, improved water quality and a reduced stormflow and sediment yield. However, the area of thicket restoration needs to be large enough in order to make a difference. Proper sites in the Baviaanskloof need to be selected to maximize the hydrological impacts as the benefit of thicket restoration are largely site-specific and the additional services provided will be hard to prove.

4 *How are the (economic) benefits of an improved water regulation distributed spatially and temporally?*

Upstream, the benefits will be local near the restoration sites, whereas downstream there is an equal distribution among the water users with a different level of economic benefits. It can be said that at present the emerging farmers are generally adversely affected through flooding, drought and sediment loads. This is partly because they do not have the equipment and knowledge to deal with these situations (in contrast to established white farmers). However, often they own the lower lands which are more susceptible to flooding. It can be concluded that the expected benefits of restoration will be definitely beneficial to them; however, they will not be able to financially contribute to restoration. A main beneficiary identified was the NMMM, which has a lower treatment cost when the sediment yield reduces. The benefits of the watershed services are perceived at a local or regional level where the shortly discussed benefits of carbon sequestration are global (see §4.1.4). From an economic and social perspective it is important to include both of these services in a future PES scheme. According to the farmers in the Gamtoos valley the benefits of restoration will be gradual over time. However for calculation purposes, it was estimated that the assumed threshold of benefits will be reached after 15 years. This has serious consequences for the financial return of the project, since future benefits will have a lower value at a positive discount rate as discussed previously. This information is needed to get a first impression of who are the main beneficiaries, where are they located, when are they expecting to perceive the benefit of which value. This data gives the rationale whether to invest in WS and to see if or when the project becomes beneficial.

5 *What are the economic benefits of restoration of the water regulating service?*

Valuing the different watershed services makes it possible to get an indication of their relative importance to the society. The main conclusions per economic impact are given below including some debatable values since they are important to trigger (future) discussions.

- A potential increase in water supply can be valued by using different methods depending on where the water is allocated. It was assumed that DWAF will finance the priority allocation to the ecological and human reserve as well as subsidises the extra water to the emerging farmers. The water price for additional irrigation (IRR) water in the Gamtoos valley is the capital value (R2.93) or the annual rental value (R0.23) together with the current water price (R0.18). The capital value for domestic & industrial (D&I) water for NMMM was not valued in this thesis. However, it was estimated to be equal or higher than IRR, with a water price of (R0.53). The economic crop water productivity (weighted avg. R6.02/m^3) can be used to express the economic value added / generated due to the increased supply. The cost of generating the additional water was compared with other existing augmentation options. It can be concluded that the water supply competitiveness of restoration projects is low with an extremely high URV (R482/m^3). The water supply in the scenarios was valued by the average water price.
- Various experts advised that the available water generated should not be allocated (to a certain extent), but used to improve the assurance of supply. Therefore, it is important to estimate the value of this higher assurance. Firstly, this was done by the extra water supplied on an average yearly basis. When assuming a 10% reduction on the curtailment levels and the duration for both IRR and D&I, the annual value of the extra water supplied is R536,700 and R52,100 respectively. Secondly, the benefits of a perceived higher assurance of supply are estimated. A range of changed management practices was given by the farmers and experts who would be introduced at a higher assurance. These changed practices will generally result in a higher production efficiency and outcome which stands for a substantial value.
- The drought damage in the Gamtoos valley was separately valued for the restriction period 2005/2006. It can be concluded that the actual damage in that period was relatively low, but the total economic loss (of profit) was significant (4,462,000 for 37% of the repondents).
- A reduction in the duration and intensity of storm flow can provide a substantial flood damage reduction both upstream in the Baviaanskloof and downstream in the Gamtoos

valley. The upstream damages are to the whole infrastructural network and local on the farm lands. From the survey it can be concluded that a number of downstream farmers are affected by the overflow of the Kouga Dam (65% of the respondents had a total damage of R2,065,700).

- A reduction in storm flow was expected to reduce the sediment yield, the dam sedimentation, the purification cost and extend the life span of infrastructure as described in the model in appendix 3. These different components are valued where possible. At first, the sedimentation in the dam can be valued by the total dredging cost which will not be feasible for the Kouga Dam, but possible for the lower Loerie Dam (R9,900,000). More realistic is to value the yearly lost storage due to sedimentation based on the estimated silt retention as was done in table 6:1. This result in an increased water storage and supply. The additional purification cost at Loerie WTW increases directly with a higher sediment yield (up to R420,000/month). It was expected that the same is true for the Hankey and Patensie WTW. Some smaller damage occurs through clogging farm filters, crop damages and health problems. It is difficult to value the extended useful life span of the water supply infrastructure. However as an indication, a coarse annual value of R200,000 was estimated which is based on an assumed 5 year longer life span.
- The secondary economic benefits of large scale restoration are expected to be substantial upstream and, when the water services will be improved, downstream as well. Most important, is the direct and indirect job creation. Additional benefits arise through the ES provided by the area restored. There are some positive and negative externalities which should be taken into account in the further development of PWS.
- The exploratory scenario analysis demonstrates that only the best case scenario was economic feasible and the medium scenario can be seen as 'possible' (URV less than 2.5). The benefits included in the scenario are the improved water supply, reduce flood & drought damages, reduced raw water treatment cost and carbon sequestration. The main value can be attached to carbon and without this value restoration will not be economic viable.

What possible financing mechanisms can be developed for the water regulation service?

- *Are the downstream water users (farmers and municipalities) willing to pay for the ecosystem services water regulation, which will improve through restoration upstream?*

Based on the survey outcomes it can be said that 77% of the farmers were willing to pay for one or more WS. A sub-division was made where most interest was for increased water supply, followed by a higher assurance, better water quality and stormflow reduction respectively. The emerging farmers are not able to pay for WS; however they are interested as far they could comprehend the concept. The municipalities were only willing to pay for a higher water assurance and supply, because they were not aware of the additional treatment costs caused by the high sediment yield and are not directly responsible for the cost of flood damages. An interesting fact is that the farmers indicated they do not require full scientific data, as they believe in the 'whole package' of benefits. Nevertheless a number of 'WTP criteria' are given which should be taken into account. It can be said that the farmers prefer GIB as implementation agency and definitely not prefer the municipalities. The combination of calculated economic values and WTP through the contingent method valuation can be used as a basis for financing mechanism, such as PWS.

8.2 Recommendations

Following from the conclusions a number of recommendations can be formulated for further research and for some required implementation actions.

8.2.1 Suggestions for further research

It is hoped that this valuation study will trigger future research, provide information for decision making, inform and create awareness for stakeholders and should kick-start the

first preliminary PWS negotiation processes and eventually watershed restoration.
Suggestions for further research:

- The outcomes of this study need to be combined with two related studies (facilitated by PRESENCE) in the Baviaanskloof on the *institutional arrangements required for PES* conducted by: Javed, H.A. and the e*xploration of PWS* conducted by*:* De Paoli, G. After completion of these studies, the information should be integrated into a joint synopsis report to obtain a better overview of all the issues and opportunities for PES.
- *Cooperation between various studies in and around the Baviaanskloof***.** The planned study of C.A.P.E.[11] and possible future studies need to be coordinated to ensure a proper knowledge transfer from this and other studies to avoid stakeholder burnout. Important lessons can be learned. For example, this study shows that farmers in the Gamtoos valley are WTP for restoration based on a basic level of knowledge, whereas the C.A.P.E tender seems to be trying to get the scientific knowledge perfect, which *may* not be required. The coordination should be a function of the decision makers from DWAF or SANBI[12] who are assigning the projects possibly combined with an external party such as EarthCollective.
- *Hydrological baseline study***.** A hydrological baseline study on the Kouga and Baviaanskloof Rivers is required to get an indication of the initial situation. This is required for monitoring the possible future benefits of restoration and to convince DWAF and GIB thereof.
- *Long-term monitoring of the hydrological impacts of restoration***.** The actual hydrological benefits of thicket restoration are uncertain and based on assumptions, expert judgment, and desktop studies. A paradox situation needs to be avoided to save the fragile image of watershed restoration (in general). Long-term field measurement on e.g. the current thicket wide plots, is therefore required to gain insight into the actual improvement of the WS. The study of Lechmerre-Oertel (2003) should be used as starting point.
- *Monitoring of the economic impacts of restoration***.** This is required to validate the assumed potential secondary economic benefits. For example: a better quantification of the number of jobs created is needed in order to 'sell' this to those who are interested herein and need to be convinced (e.g. government department or municipality).
- *Valuation upstream***.** A valuable exercise will be the estimation of economic and biophysical crop water productivity in the Baviaanskloof. This can provide the economic rationale of phasing out low productive irrigation upstream in favour of the downstream water users.
- *Detailed valuation of the assurance of supply***.** A future study to estimate the actual value of the changed farm management practices due to an increased water security is recommended. Taking the outcome of this study into account, the following aspects should be included: estimation of the possible threshold, differences between crops, economic trade-off between an increased supply or increased assurance and an overview of the different constraints.
- *Developing a sediment yield - treatment cost ratio.* In order to make valid estimations of the additional treatment cost at the WTW a proper ratio based on long-term data is required.
- *Exploration and developing of functional financing mechanisms.* The initial seventh research question 'How can PES and CRES[13] mechanisms be made functional?' was not addressed, but remains important. The calculated economic costs and benefits of restoration can be used as a basis to set up financing mechanisms. The next step is to explore the guidelines for applying PES mechanisms, arrange initial funding and set up a service 'supply chain'. There are different possible 'routes' to introduce PES. For example experimental options, such as CRES need to be explored. It is possible that landowners in the Baviaanskloof are interested in additional services (e.g. improvement of the dirt road R331) alongside financial compensation. The possibility of private investments in protection and restoration in the Baviaanskloof should be promoted. Together with financial support from the government a sustainable 'Public-Private Partnership' can be developed. These and other possibilities need to be analyzed, compared and evaluated.

[11] Cape Action for People and Environment (C.A.P.E.)
[12] South Africa national biodiversity institute (SANBI)
[13] Compensation and Rewards for Ecosystem Services (CRES)

8.2.2 Implementation actions required

This report was initially intended for all the stakeholders and experts who are involved in watershed restoration (a selection thereof is given in appendix 1). Furthermore it should contribute to the scientific discussion of the value of watershed services and the possibility for financing restoration. Briefly some practical implementation actions following from the results are given below for both decision makers and future PWS agencies.

1. **For policy makers**

- This valuation study can help to provide insight and create awareness, for policy makers at different levels, about the potential value of WS. It is important that they know how to interpret the monetary values, because they should be seen in addition to the social and ecological objectives.
- A (small) part of the watershed restoration cost can be covered by the Water Resource Management charges. In order to make this possible the water charge policy need be altered and include restoration as a specific WRM activity, similarly as done for the Working for Water program. This makes additional funding available, with low transaction costs.
- Participation and financial commitments from national and regional DWAF officers is required.
- In the discussion on financing needs, some funding need to be reserved for further research and development, training and awareness, impact and monitoring studies.
- A change towards post-modern management is advocated which is focusing on water retention-storage-drainage relation, above the current supply side solutions with technical and infrastructural options. A balanced water demand management style, with a participatory multidisciplinary approach, a focus on more long-term sustainable and societal solutions is required (Verhallen 2007).
- An additional issue is the water allocation reform process, which has some severe social-economic implications for development in the Gamtoos valley as revealed through the farm interviews. A short-term and explicit decision on this issue by DWAF is required.

2. **For PWS implementation and facilitation agency**

- Because of the high level of uncertainty an adaptive management approach is advocated. Unexpected changes, e.g. intensification of livestock and further degradation in the upstream areas in the Baviaanskloof, need to be tackled at an early stage.
- There is a need for increased public participation and dedicated education and awareness programs.
- The different stakeholders need to get a (better) understanding of the potential benefits of restoration and the watershed services. Good communication of the potential benefits and advice are essential to convince beneficiaries to pay and avoid 'free-riding'. For example, GIB is interested in a higher assurance of the water supply but does not communicate the 'concept assurance' and the perceived level of assurance properly to the farmers at present. By improving this communication farmers will be able to maximize their benefits of the potential increased assurance of supply.
- Organize to meet with all stakeholder representatives (§6.2) in order to set up further steps on the way to large scale thicket restoration. Trust-building and continuation with increasing stakeholder interest to create social capital is important for implementing a PWS scheme.
- The listed key strategic issues in the SWOT matrix can be used as input for PWS. Further development and expanding of the different ecological, hydrological and economic objectives will be required.
- Restoration should be implemented on a fixed, long-term contract basis in order to provide security of provision of WS to the beneficiaries (downstream) and the providers (farmers upstream).

List of acronyms

ADC	Annual depreciation charge
BNR	Baviaanskloof nature Reserve
C.A.P.E.	Cape Action for People and Environment
CMA	Catchment Management Agencies
CRES	Compensation and rewards for Ecosystem Services
CVM	Contingent valuation method
CWP	Crop Water Productivity
D&I	Domestic and Industry
DPSIR	Driver pressure state impact response (model)
DWAF	Department of Water Affairs and Forestry
ECPB	Eastern Cape Park Board
ELU	Existing Lawful users
GIB	Gamtoos Irrigation Board
HDI's	Historical Disadvantage Individuals
IRR	Irrigation
KM	Kouga municipality
LNV	Dutch ministry of Agriculture, Nature and Food quality
MAR	Mean Annual Runoff
NMMM	Nelson Mandela Metropolis Municipality
NWA	National Water Act, 1998 (Act 36 or 1998)
(P)ES	Payment for Ecosystem Services
(P)WS	Payment for watershed service
PVB	Present value benefit
PVC	Present value cost
SANBI	South Africa national biodiversity institute
STRP	Subtropical thicket restoration project
SWOT	Strength weakness opportunities threats (analysis)
TSS	Total suspended solids
URV	Unit Reference value
WAR	Water allocation reform
WfW	Working for Water project
WMA	Water management Agency
WRDC	Water Resource Development Charges
WRM	Water Resource Management
WTP	Willingness to pay
WTW	Water treatment works
WUA	Water User Associations

References

Al-Hebshi, M., Dellink, R., van Ierland, E. & Ruijs, A. 2006, *course economics of water*, Water and Environment Centre, Sana'a University, Yemen.

Alpizar, F. & Blackman, A. 2007, "Payments for Ecosystem Services Measurements with Impacts", *Resources* pp. 22-24.

Aronson, J., Milton, S. J., & Blignaut, J. N. 2007, *Restoring Natural Capital Science, Business and Practice*, 1 edn, Island Press, London.

Benhagen, M. E., Indab, A., Amponin, A., Cruz, R. b., Folledo, R., van Beukering, P. J. H., Brander, L., Hess, S., van Soesbergen, A., van der Leeuw, K., & de Jong, J. 2006, *Designing Payments For Watershed Protection Services Of Philippine Upland Dwellers*.

Blignaut, J. N., Marais, C., & Turpie, J. 2008, "The working for water programme: Evolution of a payments for ecosystem services mechanism that addresses both poverty and ecosystem service delivery in South Africa", *Ecological Economics*, vol. 65, pp. 789-798.

Boshoff, A. 2005, *The Baviaanskloof Mega-Reserve, an environmentally, socially and economically sustainable conservation and development initiative* 52.

Brinkman, W. & Duijl, E. European Tropical Forest Research Network, Forest, Water and Livelihoods. ETFRN 45-46, 39-42. 2006.
Ref Type: Newspaper

Burke, L. & Sugg, Z. 2006, *Hydrologic Modeling of Watersheds Discharging, Adjacent to the Mesoamerican Reef Analysis Summary*.

Coetzee, D. 2008, *RE: Annual Depreciation Charge Calculation Gamtoos valley*.

Coetzee, K. 2005, *Caring for Natural Rangelands*, University of KwaZulu-Natal Press.

Crane W. 2006, "Biodiversity conservation and land rights in South Africa: Whither the farm dwellers?", *Geoforum*, vol. 37, pp. 1035-1045.

De Groot, R. S., Stuip, M. A. M., Finlayson, C. M., & Davidson, N. 2006, *Valuing wetlands: guidance for valuing the benefits derived from wetland ecosystem services,* Ramsar Convention Secretariat, Gland, Switzerland & Secretariat of the Convention on Biological Diversity, Montreal, Canada., Technical Report No. 3/CBD.

De la Flor, T. I. 2008, *Valuation of the Goods and Services provided by the Thicket Ecosystem in the Western Baviaanskloof, South Africa,* Wageningen University and EarthCollective.

DWAF 1999, *Eastern Cape water resources situation assessment* 3018/7160.

DWAF 2003, *Water Conservation and Demand Management in the Agricultural sector: Gamtoos Pilot Project* Baseline report 2.

DWAF 2006a, *A strategy for Water Allocation reform in South Africa*.

DWAF 2006b, *DRAFT A guide to verification of water use*.

DWAF 2007a, "Establishment of a pricing strategy for water use charges in terms of section 56(1) of the national water act, 1998", *Staatskoerant*, vol. 201, no. No. 29697, p. 20.

DWAF. National water act; Establishment of a pricing strategy for water use charges in term of section 56(1) of the National Water Act, 1998. No. 36 of 1998, 1-42. 2007b.
Ref Type: Statute

DWAF 2008a, *Approved Raw Water Charges - 2008/09*, National Water Resource Infrastructure.

DWAF 2008b, "Legislation, raw water charges", *SA Irrigation*, vol. 30, no. 3, pp. 19-21.

DWAF & Chief Directorate Planning, D. S. P. 2007, *Water Situation Assessment Model A Decision Support System for Reconnaissance Level Planning Volume 1- Theoretical Guide* version 4 Interim Draft.

DWAF & City of Port Elizabeth 1993, *Algoa water resources system analysis. Instream flow requirements for the Algoa region. report no. 5 of 13.* PM 000/00/0593.

DWAF & City of Port Elizabeth 1995, *Algoa water resources system analysis. Agricultural water demand, report no. 4 of 13* PM 000/00/0493.

DWAF & City of Port Elizabeth 1996, *Algoa water resources stochastic analysis. Possible future augmentation schemes. report 3 of 7* PM 000/00/0395.

DWAF, N. W. R. P. 2006c, *Water available for allocation per Water Management Area (WMA)*.

EarthCollective. INREF Seed proposal. 1-21. 2007.
Ref Type: Serial (Book)

EarthCollective 2008, *PRESENCE Workshop: Seed phase outcomes* Patensie, South Africa and Wageningen, The Netherlands.

Economist 2005, "Are you being served?", *Economist* pp. 1-6.

EPA 2000, *Guidelines for Preparing Economic Analyses*, Office of Policy, Economics and Innovation.

Gambiza, J. & Palmer, T. 2004, *Local Environmental Action Plan Part I: Water Resources and Wetlands* Makana Municipality.

GIB. e-Newsletter. GIB 4, 1-8. 2008.
Ref Type: Electronic Citation

Goverment Gazette 2005, "Raw water pricing strategy", *Staatskoerant*, vol. no. 27732, pp. 25-27.

Gutman, P. 2003, *From Goodwill to Payments for Environmental Services, A Survey of Financing Options for Sustainable Natural Resource Management in Developing Countries*, WWF.

Hosking, S. G. & du Preez, M. 2002, "Valuing water gains in the Eastern Cape's Working for Water Programme", *Water SA*, vol. 28, no. 1, pp. 23-28.

IIED & nef 2007, *Notification of new research competition and inaugural IIED/nef Fellowship Programme. Greening Economics: New perspectives on the economics of environment and development* .

ISEE. International Society for Ecological Economics.
http://www.ecoeco.org/conference08/callforpapers.php . 2008.
Ref Type: Electronic Citation

Jack, B. K., Kousky, C., & Simsa, K. R. E. 2008, "Designing payments for ecosystem services: Lessons from previous experience with incentive-based mechanisms", *PNAS*, vol. 105, no. 28, pp. 9465-9470.

Jansen, K. 2008, *Applying socio-cultural valuation and perceived wellbeing in assessing the impacts of carbon marketing on local communities in the western Baviaanskloof, SA.*, Wageningen University and EarthCollective.

Joubert, A., Smith, B., & Neke, K. 2000, *Preliminary Assessment of the Proposed Consolidation and Expansion of the Western Sector of the Baviaanskloof Wilderness Area*.

Katoomba group, Forest trends, & Ecosystem Market place 2007, *Getting started: An introductory primer to assessing &developing payment for ecosystem service deals DRAFT FOR REVIEW & COMMENT*.

Kosoy, N., Martinez-, na1, M., Muradian, & Martinez-Alier, J. 2006, *Payments for Environmental Services in Watersheds: Insights From a Comparative Study of three Cases in Central America*.

Kouga municipality 2007a, *Integrated Development Plan 2007-2012*.

Kouga municipality 2007b, *Water service development plan*.

Kruger, P. E. J. 2006, *Notes and recommendations by the Baviaanskloof Agricultural Society for the restoration of the Baviaanskloof river system*.

Landell-Mils & Porras 2002, *Silver bullets or fool's golds,? A global review of markets for forest environmental services and their impact on the poor*.

Lechmerre-Oertel, R. G. 2003, *The effects of goat browsing on ecosystem patterns and processes in succulent thicket, South Africa*.

Leemans, R. Scenario analysis. 2007.
Ref Type: Statute

Lews, D. J., Tate, K. W., Dahlgren, R. A., & Newell, J. 2002, *Turbidity and Total Suspended Solid Concentration Dynamics in Streamflow from California Oak Woodland Watersheds* USDA Forest Service Gen. Tech. Rep., PSW-GTR-184. 2002.

Lorencová, E. 2008, *Exploring and comparing organizational institutional capacity of carbon sequestration schemes in South Africa; Case study of Baviaanskloof Subtropical Thicket restoration,* Wageningen University and EarthCollective.

MA 2005, *Millennium Ecosystem Assessment Synthesis Report*, Island Press., Washington, D.C.

Maas, L. & Verwijmeren, J. Sampling. 5. -1. 2005.
Ref Type: Unpublished Work

Mallory, S. J. L. 2005, *The modelling of water restrictions applied in complex bulk water supply systems and the application of these techniques to operationalizing the ecological Reserve*, Water for Africa (Pty) Ltd.

Mallory, S. J. L. 2006, *DRAFT Operational analysis of the Algoa system, Starting storage as on 1 July 2006* REPORT 3.

Mallory, S. J. L., Huger, D. A., & Tlou, T. 2006, *Integrated Water Resources Modelling*, Water for Africa (Pty) Ltd; Institute for Water Research, Rhodes University.

Mallory, S. J. L., Tlou, T., & Matji "Water resources modelling for the new water act ", pp. 1-12.

Mander, M., Blignaut, J., Schukze, R., Horan, M., Dickens, C., van Niekerk, K., Mavundla, K., Wilson, A., McKenzie, M., & Mahlangu, I. 2007, *Payment for Ecosystem Services: An ecosystem Services Trading model for the Mnweni/ Cathedral Peak and eastern Cape Drakensberg areas*.

Meijerink, G. 2007, *Institutional aspects of payment for environmental services (PES) schemes: the role of monitoring*.

Mills, A., Cowling, R. M., Fey, M. V., Kerley, G. I. H., Donaldson, J. S., Lechmerre-Oertel, R. G., Sigwela, A. M., Skowno, A. L., & Rundel, P. 2005, "Effects of goat pastoralism on ecosystem carbon storage in semiarid thicket, Eastern Cape, South Africa", *Austral Ecology*, vol. 30, pp. 797-804.

Mosaka, D. D., Mulling, D., Green, A. B., Downing, R., & Mapekula, P. G. 2007, *A manual for cost benefit analysis in SA with specific reference to water resource Development*, Conningarth Economist, WRC TT305-07.

Mucina, L. & Rutherford, M. C. 2006, *The vegetation of South Africa, Lesotho and Swaziland*, Trelitzia 19, Pretoria.

Nature Conservancy, World Bank, & IUCN 2004, *How much is an ecosystem worth? Assessing the economic value of conservation* .

Niekerk, A. S., Reinders, F. B., & Ascough, G. B. 2006, *Guidelines for the Selection and Use of Various Micro-Irrigation Filters with Regards to Filtering and Backwashing Efficiency*, WRC, WRC Report No. 1356/1/06.

Nieuwoudt, W. L., Backeberg, G. R., & Du Plessis, H. M. 2004, "The value of water in the South African Economy: some implications", *Agrekon*, vol. 43, no. 2, pp. 162-184.

NMMM 2006, *Water Master Plan 2005-2020* NMBM Ref: B855 ACE Ref: P1580.

Noirtin, E. 2008, *Analysis of stakeholder interactions and their involvement in thicket restoration, Western Baviaanskloof, South Africa Who is willing to restore and why?,* Wageningen University and EarthCollective.

NWA 1998, *National water act* Act No 36.

Pagiola, S. 2004, "Overview of Economic Valuation Methods," pp. 1-6.

Perman, R., Ma, Y., McGilvray, J., & Common, M. 2003, "Welfare economics and the environment; Valuing the environment," in *Natural resources and Environmental economics*, 3 edn, Pearson education Ltd, pp. 105-161;- 399-443.

Perrot-Maître, D. 2006, *The Vittel payments for ecosystem services: a "perfect" PES case?*, International Institute for Environment and Development, londen UK.

Perrot-Maître, D. & Davis, p. 2001, *Case Studies of Markets and Innovative Financial Mechanisms for Water Services from Forests*, Forest trends; katoomba Group.

Powell, M., Marais, C., & Mills, A. 2006, *Carbon sequestration and restoration: challenges and opportunities in subtropical thicket*.

Powell, M., Skowno, A., Mills, A., & Knowles, T. "Providing a context for the rehabilitation of subtropical thicket,", pp. 1-12.

Procter, W., Comerfoord, E., & Dodds, S. H. 2007, *Motivating Change in the Catchment*.

Punch, K. F. 2005, "Introduction to social research, Quantitave and qualitative approaches," second edn, Sage, London, pp. 14-117.

Richards, m. & Jenkins, m. 2007, "Potential and Challenges of Payments for Ecosystem Services from Tropical Forests", *Forestry Briefings Series*, vol. 16, pp. 5-15.

Rooseboom, A. 1999, *The extraction of water from sediment streams in South Africa*, University of Stellenbosch, WRC report: 691 /2/02.

Shand, N. & Umvoto Africa 2004, *Fish to Tsitsikamma Water Management Area: Tsitsikamma to Coega Internal Strategic Perspective*, Directorate National Water Resources Planning, South Africa, P WMA 15/000/00/0304.

Smakhtin, V., Ashton, P. J., Batchelor, A., Meyer, R., Maree, J. P., Murray, M., Barta, B., Bauer, N., Terblanche, D., & Olivier, J. 2. 2008, "Unconventional water supply options in South Africa: possible solutions or intractable problems?", *Water International*, vol. 26, pp. 314-334.

Smeets, A. & Weterings, R. 1999, *Environmental indicators: typology and overview*, European Environmental Agency, Copenhagen, Denmark, Technical report 25.

Smith, R. B. T. & Clark, D. 2000, *Baviaanskloof testament to Irony. Preliminairy report on data collection trip into the less accessible western Kouga mountains.*

Soppe, R., Hellegers, P., Perry, C., Boon, D., Bastiaanssen, W., de Wit, M., & Pelgrum, H. 2006, *Combining Remote Sensing and Economic Analysis to Assess Water Productivity A demonstration project in the Inkomati Basin* .

Swart, J. & Avenant, E. 2007, "The need for a holistic water management system, Blyde river irrigation district", *SA Irrigation*, vol. 29, no. 2, pp. 10-12.

Swarts, A., Quibell, G., & Mahlangu, S. 2008, *Integrated Monitoring of Water Allocation Reform*, Cape town Theme society.

Tainton, N. 1999, *Veld management in South Africa*, University of Natal press.

UNESCO 2006, *Water a shared responsibility The United Nations World Water Development Report*.

Veelen van, M. 2003, *Algoa water supply - Pre-feasibility study, main report*, BKS ACRES, PM000/00/2602.

Verhallen, A. Policy development for integrated water management. 2007. HWM 21306 Lectures C7 and 8 September 12th 2006.
Ref Type: Slide

Vishnudas, S. 2006, *Sustainable watershed management: Illusion or reality? - A case of Kerala state in India,* Delft university of technology.

Water for Africa 2006, *DRAFT operational analysis of the Algoa system* 3.

Water for Africa 2007, *Algoa system manual operational analysis, monitoring and communication report* .

Woodworth, P. 2006, "Working for Water in South Africa Saving the World on a Single Budget?", *World policy Journal* pp. 31-42.

Wyk, N. J., Pienaar, H., Huggins, G., Mulling, D., & Mander, M. "Contribution of economic valuation as a decision making tool in reserve determining processes: Thukrla river case study", in *SASAQs* , pp. 9-11,20.

Zijl, H. SANBI tender PES Pilot project BMR EC. 2008.
Ref Type: Unpublished Work

Zilberman, D., Lipper, L., & McCarthy, N. 2003, *When are payments for environmental services beneficial to the poor?*

Zylstra, M. PRESENCE in the Baviaanskloof: An Ecosystem Approach for Subtropical Thicket Conservation And Restoration (Eastern Cape, South Africa). In: Lessons learned from applying the Ecosystem Approach (working title). PRESENCE. IUCN Commission on Ecosystem Management. 4-7. 2008.
Ref Type: In Press

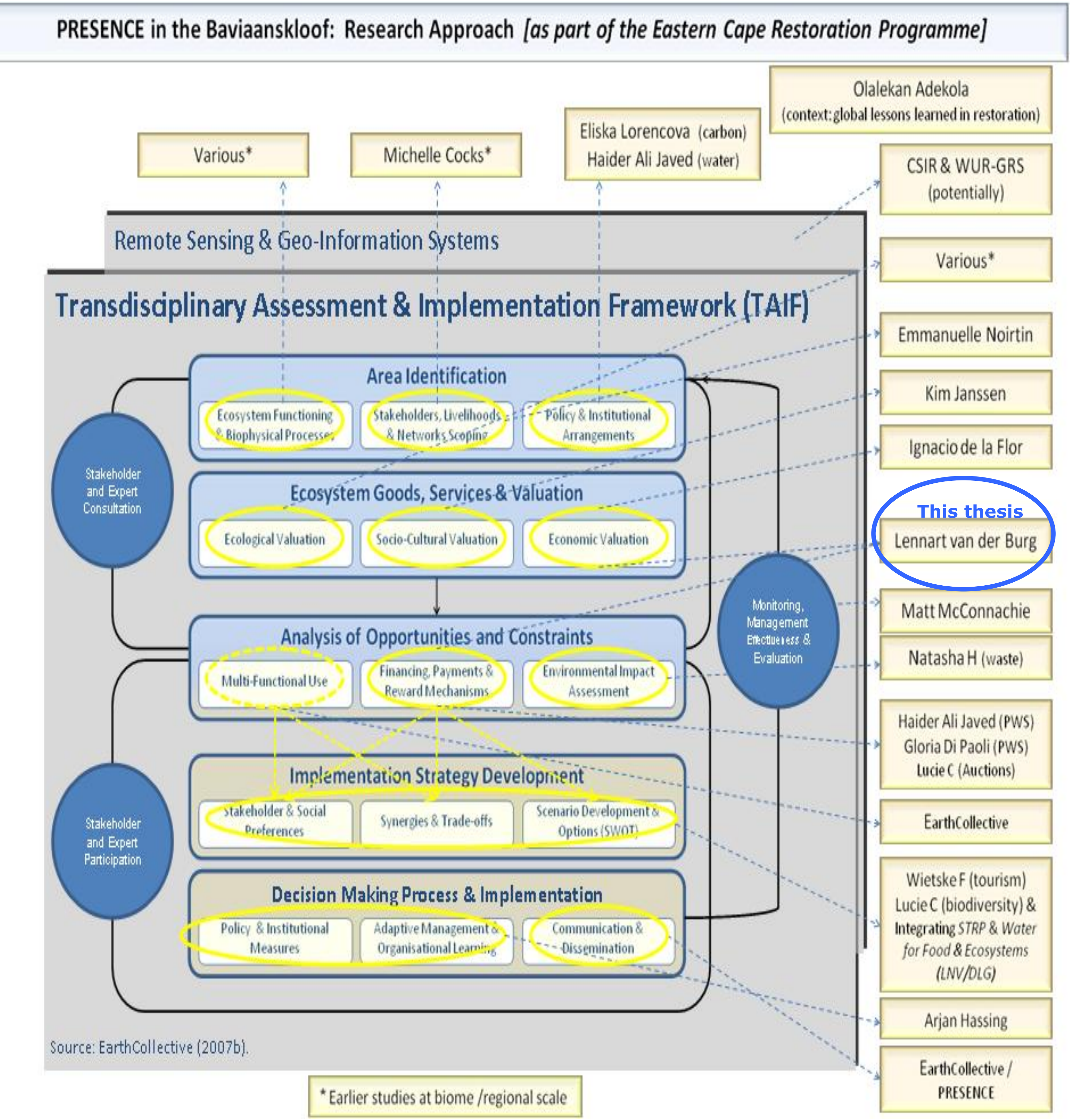
Appendix 1 Stakeholders interviewed and experts consulted

Name	Function	Organization	Location
Farmers Baviaanskloof & Gamtoos valley			
20 Farmers (informal interviews)	Livestock & vegetable farmers; tourism		Baviaanskloof
Merwe & Frikkie du Preez	Citrus & vegetable farmer	Kouga Boerderij	Kouga Dam
Dani Malan	Citrus farmer & chairman farmers union	Malan	Patensie
JL & S Colling	Citrus & vegetable farmer	JL colling & seun Boerdery BK	Kouga Dam
Mozas	Vegetable farmer	Umzamo-wethu trust	Hankey
Lourens Ferreira	Citrus & vegetable farmer	Sonop Boerdery trust	Patensie
P. C. Rens	Vegetable farmer	Rens	Loerie
M.J. Kleingeld	Dairy farmer	Kleingeld	Loerie
D. Ferreira	Citrus & vegetable farmer	Cormick trust	Patensie
Hugh Bosmann	vegetable farmer	Part of Hankey democratische boere	Hankey
J F Landman	vegetable farmer	Farmer Gamtoos valley	Hankey
D. Rautenbach	Citrus & vegetable farmer	Ripple Hill	Patensie
P.W. Du Preez	Citrus & vegetable farmer	Farmer Gamtoos valley	Patensie
M. Odendaal	Citrus farmer	Quacha & Vennoote	Patensie
D. Schellingerhout	Citrus & vegetable farmer	Schellingerhout	Hankey
EC Strydom	Dairy farmer	Mondplaats Boerderij tust	Loerie
GAT Meyer	Dairy farmer	Joletsa	Loerie
JTR Ferreira	Citrus & vegetable farmer	Ferreira	Patensie
Courne Muller	Citrus & vegetable farmer	Muller	Patensie
H. Scheepers	Citrus & vegetable farmer	Scheepers	Patensie
4 owners of the trust	Citrus & vegetable farmer	Peter familie trust	Hankey
M. Colesky	Citrus farmer	Colesky	Patensie
Kleyn boerderij	Vegetable & citrus farmer	W&M Kleyn boerderij	Hankey
Jane Guy	Citrus farmer	Dankbaar boerderij trust	Hankey
Tashies Meyer	Citrus farmer	Manderyn Boerdery	Hankey
Grootboom	Meat cattle farmer	Grootboom community trust	Loerie
Municipalities			
Benny Arends	Technical Services Manager	Baviaanskloof municipality	Willemore
Amos Mbeki	Foremen WTW	Kouga Municipality	Hankey & Patensie
Reg Botha	Technical Services, Manager Civil Engineer	Kouga Municipality	Humansdorp
B.J. Neil Boss	Income manager	Kouga Municipality	Hankey
Eddie Oosterhuize	Technical manager	Kouga Municipality	Jeffreys bay
Carina Strydom	Local Economic Development Officer	Kouga Municipality	Jeffreys bay
Unati daniels	Capacity building & support manager	Cacadu District municipality	Port Elizabeth
Marius keijzer	District road engineer	Cacadu District municipality	Port Elizabeth
John de Kock	Manager WTW Loerie	NMMM	Port Elizabeth
Stuart Fergusson	Water storage planner	NMMM	Port Elizabeth
Paul Duplicit	Water storage planner (assistant)	NMMM	Port Elizabeth

Name	Function	Organization	Location

Governmental departments & institutions			
Mazwi Mkhulisi	People & Parks Program	ECPB	East London
Wayne Erlank	Regional Manager West	ECPB	Patensie
Matthew Norvall	Project Management Unit (PMU) manager	PMU of Baviaanskloof Mega Reserve (BMR)	Port Elizabeth
Christo Marais	Acting Head: Operations Support WfW	DWAF	Cape town
Zanelle Sishuba	Environmental officer	DWAF	East London
Andrew Lucas	Water resources protection	DWAF	East London
Marcia Rasmus Patience Jackie Oosthuizen	(Hydrological) Data provision	DWAF	Cradock
Philllip de Wet	Surface Water Use	DWAF	Cradock
Jackui Murray	Water regulation & use	DWAF	Cradock
Jacques vd Merwe	Water allocation & licensing	DWAF	Cradock
Stephen Mullineux	Representative various planning studies	DWAF	Cradock
Martin Labuschagne	Agricultural water conservation and demand management	DWAF	Cradock
Hein Lodewyk	Head of siltation survey section	DWAF	Port Elizabeth
Pieter Roetive,	Pollution control officer	DWAF	Port Elizabeth
Jolani Juzani or Lonne Ntshebe	Water Resource Protection	DWAF	Port Elizabeth
Pierre Joubert	CEO	GIB	Patensie
Andrew Murray	Manager WfW & water allocation advisor	GIB	Patensie
Edwill Moore	Regional manager WfW	GIB	Patensie
Leon	Kouga Dam manager	GIB	Kouga Dam
Advisors, consultants, experts & supervisors			
Ian Griep	Production manager	Patensie citrus Coop	Patensie
Jaco Kruger	Water quality advisor	Gamtoos valley AgriBeperk	Patensie
Phillip Dempsey	Eastern Cape Regional Manager	Southern Fruit Growers Endulini Pakhuis	Patensie
Wouter Vermaak	Water consultant / agricultural advisor	Retouw consultant	Hankey
Japie Buckle	Environmental consultant	Working for wetlands	Port Elizabeth
Mat McConnachie	Master ecological economy	Rhodes university	Grahamstown
Mike Powell	Director R3G	Rhode restoration group (R3G)	Grahamstown
Richard Cowling	Professor ecology	NMMU	Port Elizabeth
James Blignaut	Professor ecological economy	Pretoria University	Pretoria
Josefien Oudemunnik	Consultant	Ministry LNV	Netherlands
Herco Jansen	Hydrologist	WUR	Netherlands
Petra Hellegers	Environmental economist	LEI	Netherlands
Matthew Zylstra	Supervisor & facilitator	EarthCollective	Kouga Dam
Dieter van der Broeck	Supervisor & facilitator	EarthCollective	Kouga Dam
Rolf Groeneveld	Supervisor & examiner	Wageningen University	Netherlands
Dolf de Groot	Co-supervisor & examiner	Wageningen University	Netherlands

Appendix 2 Research context



Name	Affiliation	Nature of Study / Research
Andre Boshoff Richard Cowling Anthony Mills Mike Powell	**Various**	Authors of various publications and reports in recent years – including Subtropical Thicket Ecosystem Planning (STEP) - which have described the greater Baviaanskloof area, **ecological functioning** and related importance of the subtropical thicket biome in conservation and restoration.
Michelle Cocks *(South African)*	**RU-ISER & WUR**	*PhD thesis:* including contribution of **biocultural diversity** to rural livelihoods in Eastern Cape. Independent study on Coleskeplaas community, Baviaanskloof.
Matt McConnachie *(South African)*	**RU**	*MSc thesis:* including an analysis of current **costs** involved in restoration and linked with **management effectiveness** and potential restoration benefits.
Olalekan Adekola *(Nigerian)*	**WUR** *(from May - Aug07)*	*MSc internship:* review of **lessons learned** from ecosystem services approaches and restoration case studies implemented across diverse ecosystem types & locations.
The following explicitly focus on the EASTCARE Baviaanskloof pilot study the under the PRESENCE programme		
Emmanuelle Noirtin *(French)*	**WUR** *(from Sept 07-Apr08)* *STRP R3G ECP**	*MSc thesis:* assessing the **stakeholder networks**, interactions, dependence on and willingness to restore ecosystem services in the western Baviaanskloof.
Kim Janssen *(Dutch)*	**WUR** *(from Sept 07-Jul 08)* *STRP R3G ECP*	*MSc thesis:* assessing the **socio-cultural values** derived from ecosystem services provided by subtropical thicket in the western Baviaanskloof.
Ignacio de la Flor *(Spanish)*	**WUR** *(from Sept 07-Apr08)* *STRP R3G ECP*	*MSc thesis:* assessing the **economic values** derived from ecosystem services provided by subtropical thicket in the western Baviaanskloof. Economics of land-use.
Eliska Lorencova *(Czech)*	**WUR** *(from Oct 07-Jul 08)* *STRP R3G ECP*	*MSc thesis & internship:* assessing **policy and institutional aspects** related to restoration across various scales with a focus on **carbon** sequestration (CDM).
Haider Javed *(Pakistani)*	**WUR** *(from Apr - Oct 08)* *LNV STRP R3G DWAF ECP*	*MSc thesis:* assessing **policy and institutional aspects** related to restoration across various scales with a focus on **water** (PES mechanisms & arrangements).
Lennart van der Burg *(Dutch)*	**WUR** *(from Mar – Aug08)* *LNV STRP R3G GIB ECP*	*MSc thesis:* assessing the **economic benefits of restoration for water** regulation at various geographic scales (within and downstream of the Baviaanskloof)
Gloria de Paoli *(Italian)*	**WUR** *(from Jul- Dec 08)* *LNV STRP R3G DWAF ECP*	*MSc thesis & internship:* assessing the potential to implement **financing mechanisms** (e.g. PES) for **water** (economics of willingness to pay/accept etc)

**Italics* under Affiliation indicates partners and partner programmes which directly seek to benefit from the research being carried out

Appendix 3 Baviaanskloof restoration model

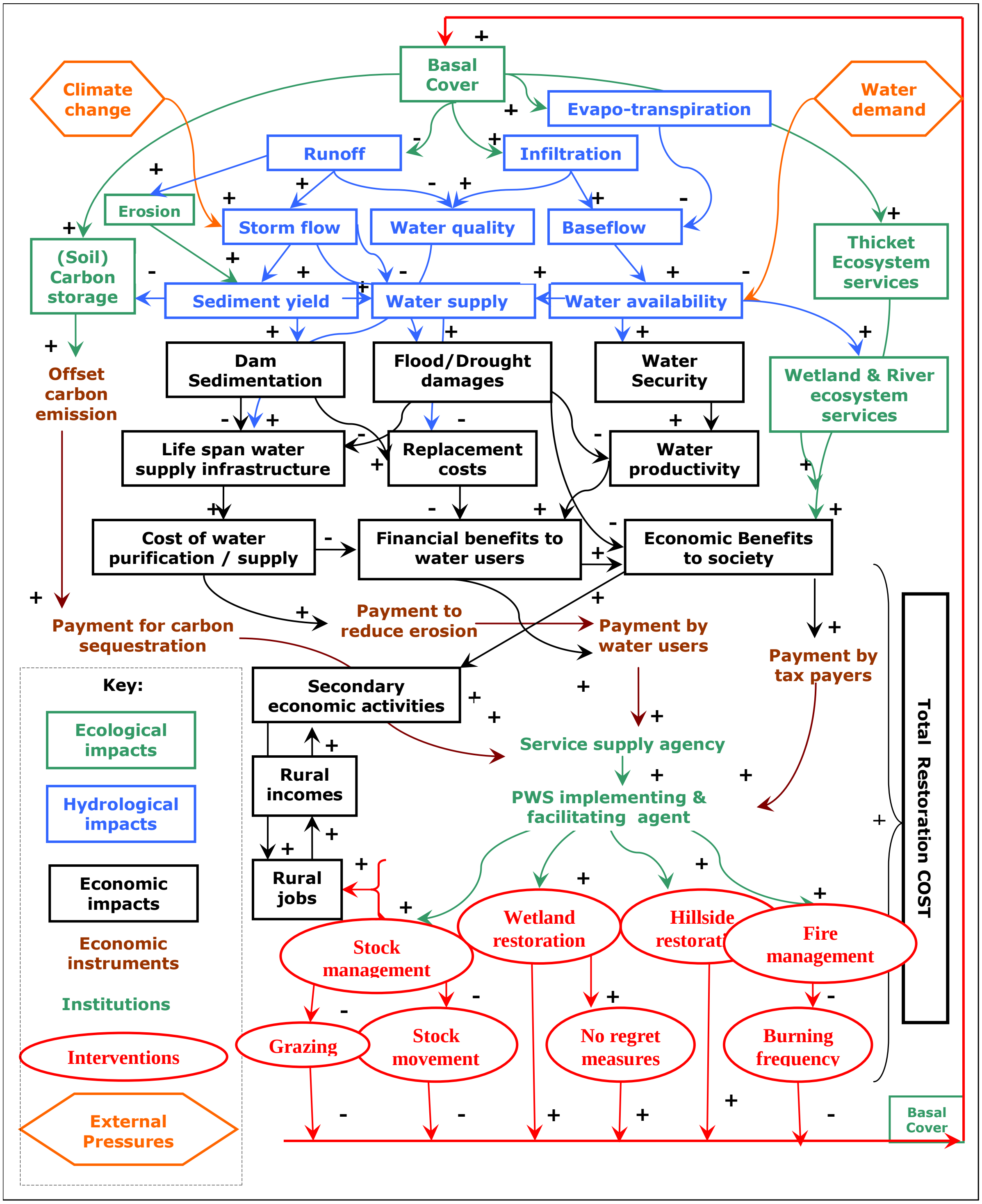


Figure A:0:1 Baviaanskloof restoration model. Based on (Mander et al. 2007).

Appendix 4 Letter of support GIB

GAMTOOS-BESPROEIINGSRAAD
Posbus 237 P.O.Box
6335 Patensie

GAMTOOS IRRIGATION BOARD
Telefoon/Telephone: (042) 283 0329
Faks/Fax:: (086) 675 0113
E-pos/E-mail: gamtoos@lantic.net

2008 National Award Winner: Water Conservation and Water Demand Management
Implementing Agent for Working for Water and Working for Wetlands projects

REF: 2/23

ENQ: P JOUBERT

9 APRIL 2008

Dear water user,

<u>Letter of support</u>

I am writing this letter of support that Lennart van der Burg, a student from the Netherlands, can undertake an economic valuation study in the Gamtoos valley. The objective is to *estimate financial benefits, of rehabilitating subtropical thicket in the Baviaanskloof, for the water users in the valley*.

Gamtoos Irrigation Board fully supports the study that is carried out within the PRESENCE study group platform and in collaboration with the Subtropical Thicket Rehabilitation Program (STRP).

In the next few months Lennart will randomly approach water users in the valley. This to acquire (monetary) information on cost, damages and benefits related to your water requirements, water quality, water security and water availability. Cooperation to the study is highly appreciated and important. Possible future benefits may arise for water users in the valley.

Yours faithfully,

P Joubert

CHIEF MANAGER: GIB

Appendix 5 Farmers survey Gamtoos valley

Objective scoping study:
Estimate the financial benefits, of restoring the subtropical thicket and the wetlands in the Baviaanskloof, for water regulation and availability downstream.
In cooperation with Gamtoos Irrigation Board

Interview Code: ________ Date of interview ________
Interview location________________ (No. map) District: Patensie / Hankey / Loerie

Interviewee Personal and Farm Information

Interviewee Name –
____

Property Name(s) –
____

Contact details -
____

Total property surface[14] size: – ____________ (ha)

Main activity[15]: -
____

Number of workers (*incl. family*): -
____

[14] The actual ground surface area instead of geographical area
[15] E.g. crop farming, game farming, trading ('pakhuizen')

- To get an indication of the water productivity per crop -

1. Overview farming practices: 2007 – 2008

CROP	**RANGE** (e.g. 8-12)	Area (ha)	Total Input costs[16] (R/ha)		water requirement[17] (m^3 / ha)	Gross yield (ton / ha)
			Fixed	variable		
Total in production		…	-	-	-	-
1. Beans-Dry		-	-	-	[2,870]	-
2. Beans-Green		-	-	-	[3,234]	-
3. Beetroot		-	-	-	[2,662]	-
4. Broccoli		-	-	-	[3,153]	-
5. Cabbages		-	-	-	[2,856]	-
6. Carrots		-	-	-	[3,218]	-
7. Cauliflower		-	-	-	[3,218]	-
8. Chicory		-	-	-	[6,489]	-
9. Citrus		-	-	-	[7,810]	-
10. Cucurbits		-	-	-	[4,607]	-
11. Decid. Fruits		-	-	-	[10,940]	-
12. Fodder- Teff+Sorghum		-	-	-	[6,125]	-
13. Kikuyu-Ryegrass		-	-	-	[12,810]	-
14. Lettuce		-	-	-	[2,188]	-
15. Lucerne		-	-	-	[12,810]	-
16. Maize		-	-	-	[5,780]	-
17. Potatoes		-	-	-	[4,880]	-
18. S Potatoes		-	-	-	[5,822]	-
19. Sweetcorn		-	-	-	[3,128]	-
20. Tobbaco		-	-	-	[5,037]	-
21. Tomatoes		-	-	-	[3,595]	-
22. Wheat		-	-	-	[4,285]	-
23. Grassland		-	-			
24. …		-				
Livestock		…				**Number**
1. ….		-				
2. ….		-				
3. …		-				
Out of production		…	-	-	-	-
1. Cleared land		-	-	-	-	-
2. Nature		-	-	-	-	-
2.a Potential land (to be cleared)[18]		-	-			

[16] Include variable cost per specific crop [seeds, labour, water, energy, transport, boxes,…] and fixed / set cost [machinery, buildings, insurance,…]
[17] If there are no records, estimations can be given of the water use per hectare /irrigation block based on the design specifications of the C. pivot sprinklers or drip irrigation. The design irrigation stream is $5.83m^3$/hr/ha or a 150m3/hr per irrigation point (± 20ha).The benchmark numbers are there for verification.
[18] Thus now part of the natural areas, but suitable for agriculture and can therefore be cleared. When is the land suitable, maximum angle (%), regulations?

- To get an indication of the present and future use -

2. Water requirements

a. Do you use the maximum water allocation of 8,000 (m^3/ha/a)?

(0) yes (1) No, reason[19]:________________________________

b. How much of your total water allocation are you using on average?

________ (% of allocation) or ________ (m^3 / ha / a),

c. Are you planning to increase your water use in the future? (Complete allocation?)

(0) yes (1) No Specify (amount):______________________________

d. Do you buy or sell part of your water rights?
(0) yes,:
(1) No, but I'm willing to buy / sell water rights for:
(2) No
Specify: Amount: _______ (ha[20]), Price: _______(R/ha[3]),
Date:_____________
Reason[21]:_________________

e. What is your minimum water requirement to maintain your production?
___________ m^3 / ha

f. Do you use water for any other purposes than agriculture, livestock, and domestic use? Specify: _______________

g. Are any water related recreation possible in your area?
Specify:___________________________

- Estimate the importance and benefits of a secured water supply -

3. Water security

a. Are you completely reliant on the water provided by the irrigation channel?
(0) yes (1) No, specify:_____________________

b. Are your farming practices limited by the current water security of 80%[22]?
(0) yes specify:______________________________ (1) No

c. If you were assured of a water security of 90%[23], would there be any additional benefits?

---

[19] Reason for not using the complete allocation
[20] The water allocation of 8000m3 is based per ha of land per year.
[21] Reason why someone bought or sold his water rights (e.g. financially / had to much water)
[22] Water security of 80 % means that restrictions will be in place once every 5 year.

(0) yes specify:___________________________ (1) No

d. Would you change your management practices if there is a 90% water security?
(0) yes, please indicated in the table (1) No

Changed management practices	Specification (reason)	Expected benefit (R/ha)
...		
...		
Examples		
1. **Change** production planning		
2. **Long-term** production planning		
3. Changed crop rotation		
4. Increase crop / fruit quality (size)		
5. Use high yielding seed varieties		
6. Plant different crops [24]		
7. Invest in new (risky) agronomic practices		
8. Different water use planning		
9. Sell surplus water rights retained four restrictions		
10. Optimize the dosage of irrigation		
11. Change your input / material use		
12. Increase production area		
13. Increase land value		
14. Get a (more) stable contract with (vegetable) companies / pakhuizen		

e. Can you indicate how the total benefits, of an higher water security, are distributed over time? (%)

1	2	5	10	>25 year

f. Do you have your own water storage to increase your water security?
- If yes please specify:
  - **i.** Capacity: ______________(m^3)
  - **ii.** Building costs: ______________(R)
  - **iii.** Maintenance costs: ______________(R)
  - **iv.** Reason for use _________________________________
  - **v.** Man purpose ______________
  - **vi.** Problems with siltation: ______________ /_____________ (%)

g. Are you considering about investing in a water storage reservoir?
(0) yes, specify: _______________ (1) No

[23] Water security of 90 % means that restrictions will be in place once every 10 year.
[24] High valued crops that involve more risk, but has a higher economic return (per unit of water consumed). E.g. plant more citrus than a low value / income crops such as Lucerne.

- Estimate the influence of the Kouga Dam yield on farm management practices -

4. Cost & benefit

a. Do you experience any kind of cost (damage) or benefit when the **Kouga Dam** is overflowing?
   - If yes, could you specify the damage per period of overflowing in the next table:

Period of overflow		**Specification cost / benefit**	**Estimation / specification cost/ benefit (R/..)**
Month(s)	Day(s)		
2008 [6]			
February	14 – 20		
2007 [107]			
Nov/Jan	23 / 27		
October	29		
October	12-24		
Aug/Sep	22 / 09		
July	03-19		
May/June	27 /19		
2006 [30]			
Aug /Nov	03 /03		
2003 [32]			
June/July	09 /11		
2002 [46]			
Aug / Oct	31 / 16		
2001 [37]			
Sep/Oct	21 / 15		
Jan/Feb	19 / 01		
2000 [98]			
Nov/Dec	19/06		
June/July	23/02		
Mar/June	28/08		
1996			
1981			
1971			

Examples of damages:

2. Holes in private gravel roads
3. Longer travelling time (higher fuel cost)
4. Disturbed work planning.
5. Damage to the vehicle by driving through water
6. Damaged crops in wetlands or lowlands
7. Reduced life span of materials
8. Damaged pumps / irrigation pipes

b. Do you experience any kind of damage or benefits when there are water restrictions in place?

- If yes, could you specify the damage per water restriction year in the next table:

Period	Restriction (% allocation)	Restricted area	Specification Cost /benefit	Estimation Cost / benefit (R/..)
1st July '06 – 30th August '06	35			
1st July '05 - 30th June '06	25			
1991				

Example cost:

1. Reduced crop productivity (smaller area, no rotation)

Example benefit:

2. Higher crop prices

c. Do you limit your water use (in a normal year) to avoid future water restrictions?
(0) yes, by ___________ (%)
(1) No, but I limit water use to avoid paying more than the basic rate[25]
(2) No

d. Do you reduce your water use during the period when the Kouga Dam had a low yield?
- No I'm not aware of the dam level
- No, because ___________________________
- Yes, could you specify the damages / losses per 'low yield period' in the table:

Date	Dam level	Reduction of water use (%)	Specification damages or losses	Estimation damage (R/..)
...				
...				
2006				
March 1st	37 %			
2005				
Sep 1st	56%			
March 1st	61%			
2004				
Sep 1st	54%			
March 1st	70 %			

- Influence of present water quality on farm management practices -

[25] There is a basic rate for the first 75% of the allocation you always need to pay even if not used. Other 25% is additional.

5. Water quality

a. Do you experience any kind of damage from the present water quality out of the **Kouga Dam** irrigation channel?
   - If yes, could you specify the plausible cause, the damage and the cost in the next table:

Cause	Specification of damage	Estimation of the Costs	Since
…			
…			
…			
…			

Examples of damages:
1. Blockage drip irrigation due to suspended material
2. Reduced life span of materials
3. Residue on crops leaves by irrigation due to siltation / sedimentation
4. Higher concentrations of Manganese (due to low level of the dam)

b. Can you indicate whether the situations, as mentioned in the following table, have changed in the past few years?

Occurrence of/ changes in	(a) Floods	(b) Drought	(c) Water quality	(d) Landscape	(e) Wildlife
Increase					
Decrease					
Since					
Specify					

6. Expert judgment

a. Do you believe in the benefits of restoration? And what will be the possible / expected benefits of the thicket restoration in the Baviaanskloof?

b. What other benefits *or cost* do you expect from restoration?

c. What is the value of an assured yield of the dam? And what is the 'optimum' best level?

7. Willingness To Pay

If the project goes through and there are measurable hydrological effects, such as:

i. Improved water quality
ii. Higher water security *(improved assurance of supply)*
iii. Higher water availability / quantity
iv. Stormflow reduction

a. Are you Willing To Pay for (one of) these benefits of restoration?

(0) yes (1) No Specify:____________________________

Amount:____________________________(cR/m^3)

b. What criteria need to be met before you are WTP for the benefits of restoration?[26]

c. Which organization / institutions should facilitate the payment process?

8. Institutional

1. Have you sold any land to the Government which has been redistributed between the emerging farmers in past?
(0) yes, area:_______ (1) No

2. What do you think about the productivity of that redistributed land at the moment?
Specify:____________________

Additional comments:

Calculation EXAMPLE This is minimum / Maximum water use: *MINIMUM*				
Crop	**Irrigation system**	**Intensity (amount x week)**	**Intensity (amount x week)**	**Total (m^3/ha)**
Potatoes	*Centre pivot*	*20mm x 8 weeks*	*25mm x 12 weeks*	*4,600*
Wheat	*Centre pivot*	*20mm x 20 weeks*		*4,000*
Citrus	*Drip irrigation*	*2.3 l/h/drip* *8 drips / three* *Avg. 2.5 h/day,* *313 days* *450 three/ha*	*6 days / week*	*6,479*
Chicory	*Centre pivot*	*15mm x 10 wks*	*25mm 14 wks*	*5,000*
Grass	*Centre pivot*	*20mm x 16 wk*		*3,200*

[26] Thus what are your requirements before you are WTP

Appendix 6 Survey outcomes (Q. 2-5)

Explanation:
1. Survey question topic

a) Sub questions?

(Answers in percentage %)

Specify:

"Bundled and summarized reactions, using most of the same expressions of the farmers as possible" (Used in report chapters)

- *Reactions as given by the farmers (cited)*

2. Water requirements

c. Do you use the maximum water allocation of 8000 (m^3/ha/a) at present?

Yes (23%) **No** (65%) **Unknown** *(12%)*

Specify:

"By efficient irrigation, savings and 'not planting to use all my water' I never exceeded my water allocation"

- *Not needed*
- *Never exceeded their allocation ('run out of water')*
- *Use water from Klein River*
- *Efficient drip and micro irrigation.*
- *Save*
- *I'm not planting to use all my water*
- *My planting based on advice from advisor. Irrigate according to that.*

"Use more / all my water during dry years, depended on rainfall"

- *Reason water use is variable on rain and weather conditions*
- *Will use al my water at a dry year*
- *Only when there are dry periods. If enough rain I don't need al my water*
- *Normal year, other years maybe full quota*

"Leave 20% off allocation over as a 'security policy' for when there will be restriction halfway in the year"

- *Leave 20 % over as a ' security policy' for when there will be restriction halfway in the year*

"When year is finished water must be finished, I'll use all my surplus water"

- *When year is finished water must be finished, I'll use surplus to level up the water table.' Because my threes are still young.*

"water supply is closed since not paying the bill"

- *The water supply form Gamtoos is closed since beginning of 2008, cause of not paying the bill*

d. How much of your total water allocation are you using on average?

Average (85%)

"Don't know how much water I use" *(23%)*

- *Don't know his water allocation (only knows how much he pays per year)*
- *Don't know, since there is no water meter in place*
- *Don't know how much water used*

c. Are you planning to increase your water use in the future? (Complete allocation?)

Yes *(60%)* **No** *(40%)*

Specify:

"Increase land in production (through clearing) and improve efficiency"
- *I can increase production without using more water, increase efficiency (e.g. use drip irrigation). So I will not use more water per ha, but overall use more water in total through clearing and planting more land*
- *Water use is efficient at the moment, good equipment, no losses, water savings, effective strategy*
- *Plant whole area*
- *If possible irrigate more land*
- *I'm thinking to utilize top lands, but now the electricity supply is expensive and unreliable in order to do so. (other limitations)*

"Use more / all my water in the future, to increase production since the citrus threes are full grown"
- *Use 100% when plants are older and need more water*
- *When plants getting older they will need more water*
- *When the threes are older*
- *When my plants are full grown*
- *Citrus plants are not full grown yet, thus use less*
- *To increase production*

"Only if water is available and to be less vulnerable"
- *Only if more water will be available .*
- *To be less vulnerable*

" Don't want to pay the extra charge above 80%"
- *Because need to pay more for water above 80%*

"Already use maximum allocation"
- *Can't, already on maximum usage*
- *Already use maximum (but stable)*

f. Do you buy or sell part of your water rights?[27]

Yes buy*(19%)* **Yes sell** *(12%)* **No** *(8%)* **No reaction** *(8%)*

No, but I'm willing to buy / sell water rights for *(54%)* **Rental** *(31%)*

Specify:

(Nr.#)	**Yes buy** (4/2)		**Yes sell** (2)		**Total renting** (8)		**Willing to buy** (15/12)		**Total average** (21/16)
	Total	Avg.	Total	Avg.	Short	Long	Total	Avg.	Avg.
Amount (ha[28])	*160*	*40*	*45*	*22,5*	*49,1*	*230*	*250.50*	*16.7*	*21.7*
Price (R/ha^3)	*31*	*15,5*	*75*	*37.5**			*268*	*22.3'*	*23.4*

* One included lands as well
` One depends the price on present returns

[27] Total percentage is more than 100% since some farmers choose more than one option what is possible.
[28] The water allocation of 8000m3 is based per ha of land per year.

Reason[29]:

"Short-term water rights are rented on a yearly basis during dry periods"
- *When running short*
- *Extra rights during drought*
- *Ones exceeded his allocation and rented 1.1 ha extra for 3 months*
- *Temporary (yearly basis) 3 ha when it's dry*
- *I rent 6 ha water on a yearly basis*

"Can put more (un-cleared) land under irrigation and thus increase (citrus) production"
- *Not used now, sub rent it for free (cost price).Convert farm 2 into dairy farming. Therefore secure water supply needed. To increase production*
- *Can put 10 ha un-cleared land in production*
- *To put more land under irrigation*
- *To put more land under irrigation & increase security*
- *Increase citrus area*

"Increase land price / value"
- *Increase land price / value (now lower because of small allocation)*

"Have extra water available for drought periods, so increased security"
- *Increase water security*
- *Extra for drought periods as safety measure*
- *Always handy to have extra water, but for current area not limited*
- *For when there is a drought. (Renting is done on a 'relation basis' always someone who has spare water*
- *Was available*

"Willing to sell the surplus water so don't have to pay the full amount"
- *I only use 40% of the water, but had to pay for 80%, so surplus is sold*
- *If there is a meter (so we can measure the water) we are 'WTSell' the surplus water*

g. What is your minimum water requirement to maintain your production?

(77.1%)

Comments:

a. Depends largely on what level of production you want to maintain, stay at the optimum?

b. Low for dairy, since it is relatively flexible compared to Citrus, cause they have options to deal with shortage, e.g. By food / move cattle. Where citrus plants are there for 15yrs.

h. Do you use water for any other purposes than agriculture, livestock, and domestic use?

No *(100%)*

i. Is any water related recreation possible in your area?

Yes (5%*)* **No** (95%*)*

Comments:
- *Maybe in the Klein River*

[29] Reason why someone bought or sold his water rights (e.g. financially / had to much water)

3. Water security

a. Are you completely reliant on the water provided by the irrigation channel? [at present],

Yes (*81%*) **No** (*19%*)

Specify:

"The use of river water is not allowed by GIB (DWAF)"

- *Possibility of using river water, but not allowed from GIB.*
- *Want to pump water from Loerie river, but is not allowed from GIB (?)*
- *Taking river water is not allowed*

"River water is possible (during drought), but: it is too salty / brackish it need to be mixed with fresh water (negative impact on soil can occur). It is expensive to pump up (electricity & diesel cost)"

- *River water is possible, but to salty (will have negative impact on my soil) and expensive to pump up (diesel cost)*
- *Can use river water, but 3x more expensive*
- *Is expensive, but profitable during drought*
- *The river water, partly from Groot, is to brackish and need to be mixed with canal water when used*
- *I can use river water but it's from a bad quality (incl. sediments and salts) during dry periods.*
- *In times of drought possible to use the ' brak' water (mixed with the canal water) out of the Klein River*
- *Now to salty and to less fresh water (before the dam possible)*
- *River is to salty to use will cause more damages to the soil than benefit. Bore holes closed, because to salty*
- *Water to salt to mix*
- *River to salty*
- *River water not possible*

" Other water sources are the Klein River, local runoff, boreholes, backwash water WTW"

- *Natural water flow from hill*
- *Receive some water from water treatment plant Patensie that flows into a natural pool. Around 16,000 m^3*
- *Has a borehole on his property which is used for domestic and small agricultural use.*
- *Use water from Klein River which supply relatively stable (improved through the WfW project). But also depends on rainfall.*

"The emerging farmers are willing to use river water but have no equipment"

- *I can use the river water but now equipment*
- *Have no pumps to pump the water out of the river*
- *When dry we can use the water from the Klein River. But we have no pump available*

b. Are your farming practices limited by the current water security of 80%[30]?

Yes *(65%)* **No** (35%*)*

Specify:

"Are limited in my vegetable crop planning, since I can not plant the whole area. This result in lower production and turnover"

- *Can't put whole land into production*
- *Crop planning is limited (e.g. less maize)*
- *Lower productivity / quantity*
- *Lower vegetable production*
- *Planted less so the TURNOVER will be less*
- *Can't / lose 3 ha of crop planted*
- *I can than plant whole area with vegetables, now need to leave land open*
- *Planted less vegetables*

"Needed to buy dry feed for my livestock"

- *Need to buy in dry feed*

- *Less security due to shortage*
- *Just started with a new allocation*
- *When they cleaning the canal he has a limit supply*

c. If you were assured of a water security of 90%[31], would there be any additional benefits?

Yes (73%*)* **No** (27%*)*

Specify:

"More security is needed otherwise there will be more restrictions in the future"

- *More security is needed (future more restrictions)*
- *More security*

"Can use all my water and there is no need to save 20% of my allocation"

- *More security, so there will be no need for only using 80% (and 20% save for restrictions) thus will use than full allocation*
- *Don't need to rent the extra hectares*

"I can plant the entire area and increase my production"

- *Increase production*
- *can plant maximum*
- *Plant entire area*
- *Give optimal water to the three*
- *Can start dairy farming at farm*

"Less severe restrictions <50% will benefit my production"

- *Increase in milk production (however small restriction (>50%) doesn't effect me cause just use less water, what may result in lower production)*
- *Only heavy restrictions will effect me, hereby I will have a lower production*

[30] Water security of 80 % means that restrictions will be in place once every 5 year.
[31] Water security of 90 % means that restrictions will be in place once every 10 year.

d. Would you change your management practices if there is a 90% water security?

Yes *(58%)* **No** *(42%)*

Specify:

- *Not limited by the water supply at present*
- *More secure water is needed for long-term production*
- *It keep me back from development'*
- *Changing management practices and strategies are based in a combination of different factors, water is one important one. This importance increases when restrictions are coming up, more effective to start up water saving programs.*
- *Must be 'a fact' that there is a higher water security*
- *Use now only 75%, but in dry years will use all. "*

A high water assurance would motivate farmers to:

Changed management practices	Yes (%)	#	**Given field examples**
Increase production (quantity) & quality	31	8	*Increase tonnage production, fruit size and reducing squeezing on the citrus skin.* *Maximize return.*
Increase production area	15	4	*If we have clearable (flat) land we would definitely clear it for production, but we cleared it all already.* *It 'should' increase* *80ha irrigate remaining field* *30 ha*
Utilize maximum area for planting cash crops (potatoes / maize) on yearly basis	15	4	*Utilize labour and fixed cost better*
Reduce risk management cost	12	3	*Less varieties > more efficient. At the moment: 'I don't put my eggs in one basket'*
Plant cash crops potatoes / vegetables or high yield varieties (e.g. carrots, cauliflower) which has a high input cost	12	3	*Plant different citrus cultivars who produce more fruit / bigger size / less squeezing (efficient)* *Due to wind can't plant more citrus*
Change to Dairy farming (long-term)	12	3	*More milk cattle* *Over the long-term*
Possibility to get a long-term and stable contract with (vegetable) warehouses (e.g. Mc. Cain)	12	3	*Getting a long-term contract with Mc Cain / wholesalers will increase the prices with (20%). At the moment deliver on a yearly ' sub-contract'* *If you can provide every year you built a relationship. If not buyers go to somewhere else.*
Increase efficiency	8	2	*Increase water efficiency by removing wind brake threes (have high water use). Increase efficiency*
no need to buy more allocation	8	2	*Maximize return* *Won't by any more water rights when there won't be anymore severe restrictions.*
Plant according water availability	4	1	
Change and optimize crop rotation (planning & pattern)	4	1	
Long-term production planning	4	1	*Easier more long-term planning, especially required for citrus (not really for vegetables)*
Invest in new (risky) agronomic practices (equipment)	4	1	*We will have a better outlook for the future, so it will be safer to invest in new equipment*
Increase in land value	4	1	
Secondary impacts	4	1	*sleep better, lower stress, living longer, less*

			smoking"
No changes			
Stabilize production	8	2	*I won't change anything, but my production will be more stable.*
Not planning for restrictions (max production)	8	2	
Literature / expert judgment			
Change water use planning and input / material use			
Plant high yielding seed / crop varieties that involve more risk			
Plant different crops			
Different water use planning			
Sell surplus water rights retained for restrictions			
Optimize the dosage of irrigation			
Change your input / material use			
use fertilizers adequately			
switch to more water efficient crops			

NOTE: Numbers influenced by the emerging farmers, none of them interested in water security

e. **Can you indicate how the total benefits, of an higher water security, are distributed over time? (%)**

1	2	5	10	>25 year
		50	*50*	
40	*30*	*30*		
		30	*30*	*40*
30	*60*	*10*		
		40	*60*	
	20	*30*	*50*	
100				
30	*70*			
				Long-term
Avg.: 25	**22.5**	**23.75**	**23.75**	**5**

f. **Do you have your own water storage to increase your water security?**

Yes (*41%*) **No** (59%)

- **If yes please specify**:
  - vii. **Capacity:** *avg. 14 / total 56 (1,000m^3)*
  - viii. **Building costs:** *150 (1,000R)*
  - ix. **Maintenance costs:**
  - x. **Reason for use / main purpose**

- *Save electricity / extra water source available for irrigation / daily supply/ Saving water use / domestic use / small one for cattle drinking water/ increase irrigation efficiency / surplus water from pomp is stored in the tank*

xi. **Problems with siltation:**

- *Yes plan to dreg it and optimize the reservoir*

g. **Are you considering about investing in a water storage reservoir?**

Yes (*21%*) **No** (79%)

Specify:

- *Built a balancing dam to capture the small water flow form the hillside. This provides extra water and reduces the damage to the farm land. Permission of GIB required.*

- *Increase irrigation efficiency by pumping up surplus water in dam*
- *optimize the pool for more water storage*
- *To expensive*
- *To save electricity*

4. Cost & benefit

e. Do you experience any kind of cost (damage) or benefit when the Kouga Dam is overflowing?

- **If yes, could you specify the damage per period of overflowing in the next table:**

Year	Respondents with damage	Overflow days Kouga Dam / year
Total	65%	
2007	56 %	107
2006	15%	92
2003	4%	32
1996	22%	?
1983	12 %	?
1981	4%	?
1971	22%	?

- *2007 big losses in the whole Gamtoos valley*
- *More years with small damages*

Estimated (economic) damages by farmers:

Damage	Cost (*1000R)		Description
	Established farmers (#)	Emerging farmers (#)	
Land erosion problems			*Erosion damages*
Broken fences	20 (2)		
Land overflow & flooding	1,322 (5)	625.5 (4)	*Lost 10 ton chicories in the low lands* *Lost 4ha broccoli + 4 ha carrots* *2ha land destroyed to unusable. Lots of maintenance (grading) required* *Damage to irrigation lines* *Lost plant material* *Lost investment cost & harvest* *Lost carrot & cabbage* *2 ha of carrots lost at 2 years*
	Unvalued	Unvalued	*15 ton potatoes lost* *5 ha of carrots lost* *30 ton maize lost* *5ha citrus flooded. Citrus (less quality> more marks) / less production. Know at the end of the year.* *Extra spraying required for citrus* *Orchard under water through overflow* *Damage occurs often*
Damage	40 (2)		*Repair works*

private road			
Public road closed	1.4		*Extra fuel through using back road* *2 ton couldn't transported cause bridge was closed*
	Unvalued	Unvalued	*Loss in quality (lower price) of tomatoes, Citrus and Potatoes because transport to pack house (with freezer) was delayed.* *Road inaccessible for 12h* *1 week 1h extra drive* Farmers dirt road Kouga Dam damage

Examples of damages (assumptions):

1. Holes in private gravel roads
2. Longer travelling time (higher fuel cost)
3. Disturbed work planning.
4. Damage to the vehicle by driving through water
5. Damaged crops in wetlands or lowlands
6. Reduced life span of materials
7. Damaged pumps / irrigation pipes

Note:
Emerging farmers have relative more damage since they have the lower lands near rivers which are more susceptible for flooding

"A low intensity or short period (<3 days) of overflow of the Kouga Dam does not lead to any damage"
- *No, problems at small overflow*
- *If overflowing for more than 3 days*
- *Perceive damages only from a heavy overflow*

"Floods in the Gamtoos valley are caused by a combination of different factors: inflow Indian ocean at high tide / inflow from the Groot, Klein and Gamtoos Rivers / overflow Kouga and Loerie Dam / rainfall in the valley"
- *Land overflows often, caused by different factors: Inflow sea, water Groot River, rainfall Gamtoos and overflow Kouga Dam.*
- *Floods cause by the Groot River, the Klein River, Gamtoos River, Kouga Dam and rainfall*
- *Sometimes floods form the Klein River, but not form the Kouga Dam*
- *Flooding is influenced by 3 aspects: inflow of the Indian ocean (tide), Out/overflow from Loerie Dam caused by overflowing Kouga Dam, inflow Gamtoos River through rain*

f. Do you experience any kind of damage or benefits when there are water restrictions in place?

Yes (42%) **No** (54%) **No reaction** (4%)

Reason for no damage:
- *Saved by the rain*
- *Enough allocation at that time*
- *If happens now probably lower production*
- *But in the future need to rend more hectares*
- *At that date I had only young threes, so know damage*
- *Enough water available due to no meter*
- *Future maybe yes, when threes are bigger*

- **If yes, could you specify the damage per water restriction year in the next table:**

Period & restriction	Specification Cost /benefit		Estimation Valued Damage *1000R
	Not Valued	**Valued**	**Total**
1st July 2005 - 30th June 2006 35%	*10ha maize planed not planted (100ton)* *10 ha of maize not planted* *15 ha maize and broccoli not planted*	*5 ha planted only* *7 ha not planted.* *Different, Lower value (less water use) veggies planted*	*1,575*
	40 ha less potatoes planted *30 ha no chicory planted*	*Irrigated less land, so dry feed had to be bought.*	*1,111*
	Pumped water from river, 3 more than normal water price (high fuel cost)*	*Bought extra water rights*	*24*
	Land is left unused; don't want to waste water on crops we may not harvest. *No, just less water used*		
1st July 2006 / 30th August 2006 25%	*10 ha less potatoes planted*	*4ha not planted* *Dry feed need to be bought*	*80* *178*
	No Benefits	**Benefit in %**	***2,968***
2005/2006	*No benefit through higher prices, restriction was only in the Gamtoos valley* *Gamtoos valley is to small to make influence on the veggie markets* *Cause citrus is exported, no benefit* *Prices for veggies where fixed*	*30 % higher potatoes prices* *80% higher vegetable prices* *15% Potatoes prices increased with*	
1991	*Big loss whole valley* *Only 20/30 % planted*		

Example cost: Reduced crop productivity (smaller area, no rotation)
Example benefit: Higher crop prices

- *Less planted = less revenue*
- *Depends on timing restrictions, summer (nov-feb) most damages*

Values stated are lost revenue and not lost profit

g. Do you limit your water use (in a normal year) to avoid future water restrictions?

Yes *(15%)* **No** *(65%)* **No reaction** *(19%)*

Specify:

- *There is no encouragement to save the water.(Water above the 80% basic rate is nearly free (8c/m3), because of the large quantities)*
- *I limit water use to avoid paying more than the basic rate*
- *Just save water and use it efficiently*
- *Depends on rainfall*
- *We save water by not giving anything 'extra'*
- *We can't limit cause its already optimized the permanent crop*
- *Citrus can't use less water, without losing production. Especially not in the critical phase*
- *Not in the fruit setting phase, but in the period where less water is needed*

h. Do you reduce your water use during the period when the Kouga Dam had a low yield?

Yes *(44%)* **No** *(56%)*

Specify the damages / losses per 'low yield period:

- *No I'm not aware of the dam level*
- *Someone else will than use it*
- *No I'm not aware of the dam level, but if " I Plant lower water use crops"*
- *We'll do less planting or no vegetable planting when the Kouga Dam has a low yield*
- *Plant 10-15 % less, e.g. potatoes*
- *when low yield I plant only 30 ha*
- *Depends per time of year <30%*
- *Need to use normal amount for what planted*
- *save water so I've enough left, when restriction come in*

5. Water quality

a. Do you experience any kind of damage from the present water quality out of the Kouga Dam irrigation channel?

Yes *(47%)* **No** *(53%)*

ii. If yes, could you specify the plausible cause, the damage and the cost in the next table:

Cause	Specification of damage (nr.#)	Cost estimation (R)
Sediment (14)	*Domestic problems(e.g. geyser clogged) (9)* *Invested in cleaning system for drink water*	
	Clogging & cleaning filters (3) *Filters cleaning max 2x/day* *Extra filter cleaning required (manual) 1h/day for 4 months* *Filters need to be cleaned often at the 'top' once a hour! / now self-cleaning filter* *Filters need to be cleaned chemically*	*6,000* *10,000*
	Clogging drip irrigation (2) *Sediment can reduce lifespan drip system (2)* *Will reduce life span, cleaning drip line required at 300R/ha 3/yr (instead 1/yr)*	

	Residue on cabbage crops, couldn't sell 2ha *Get into the cabbage and gets rotten, 6.000 plants lost*	*36,000* *18,000*
	Certain chemicals work less with high sediment contents	
(Low) PH	*More base needed* *Problems with spraying (log is required) to make chemicals work* *Soil becomes acid*	
E-coli	*Caused by dead animals in the canal*	
Algae in canal	*"corrosive water"*	

Examples of damages:

1. Blockage drip irrigation due to suspended material
2. Reduced life span of materials
3. Residue on crops leaves by irrigation due to siltation / sedimentation
4. Higher concentrations of Manganese (due to low level of the dam)

Since: *November 2007 after floods*

b. Can you indicate whether the situations, as mentioned in the following table, have changed in the past few years?

Occurrence of/ changes in	(a) Floods	(b) Drought	(c) Water quality	(d) Landscape	(e) Wildlife
Increase	9 %	27%	0%	10%	42%
Decrease	18 %	14%	41%	30%	5%
Since	73%	59%	59%	60%	53%
Specify	1971, 1981, 1983, 1994, 1996,	1998, 2003	2007 November	2007	2006, 2003

Comments:

Floods

- *Recurrence 1:10*
- *Areas getting less rain*

Drought

- *More extremes (dry / wet)*
- *More rain upstream, dam yield is higher*
- *More before the dam was built*
- *Normal frequency*
- *Peak extreme rainfall*
- *Through climate change*

Water quality

- *EC /ph change only at 'special coactions'*

Landscape

- *Spekboom is flowering due to drought*
- *More Alien threes in the river beginning Gamtoos*
- *No development last 3 years*
- *More land clearing*
- *However more citrus in the area, instead of cash crop*
- *"Caused by people"*
- *Clearing for production, cause land & soil runoff*
- *Getting dryer*

Wildlife

- *Less due to pesticide use*
- *Last 4 years more kudu. Caused by less fences*
- *More Baboons, Monkeys. Dues to use of more biological pesticide.*
- *Cause of the Baviaanskloof*
- *At dry times animals coming down to drink / less spraying [turtles / baboons/ monkeys / birdlife / worms]*
- *People are more aware*
- *More birds due less chemicals*
- *Comes down to find food (baboons)*
- *Less people are living on the land (moving to the communities)*

Appendix 7 Survey outcomes (Q. 6- 8)

Explanation:
1. Survey question topic
b) Sub questions?
(Answers in percentage %) OR
Specify:
"Bundled and summarized reactions, using most of the same expressions of the farmers as possible" (Used in report)
- *Reactions as given by the farmers (cited)*

6. Expert Judgment

a) Do you believe in the benefits of restoration?

Yes	No	unanswered
69 %	8%	23%

And what will be the possible / expected benefits of the thicket restoration in the Baviaanskloof?

"The improved water holding capacity and water supply to the dam"
- *Improved infiltration and baseflow*
- *Upstream vegetation works as a sponge to retain water*
- *Full dam*

"There is a (high) need for restoration to protect the quantity and quality of the limited water resources and there will be definitely benefits"
- *I'd like to see it happen'. Beliefs in a holistic attitude*
- *If you don't do restoration, we can be stuffed. Get the original status back. Must be a priority, cause water is our most limited resource*
- *Good, benefits will be huge*
- *Good, idea to combat erosion, include carbon credits*
- *Excellent idea*
- *useful, prevent erosion, support the idea*
- *Yes will definitely benefit*
- *Positive, 'we receive our water from a world heritage area, so it must be the cleanest in the world!*

"There is disbelief if thicket restoration actually has an effect on the water supply"
- *Doesn't belief in Spekboom / thicket restoration.*
- *I support the project, but don't belief that Spekboom will give an effect on water*
- *How achieved?*

Others:
- *I expect the total benefits of restoration to water regulation will be low, because it's an enormous catchment area. The ecological value of planting Spekboom will be far more value than the improved water service* (S. Milieux, DWAF)
- *Restoration will give us benefits on the long-term. There will be a permanent stream (baseflow)*(W. Vermaak, agricultural advisor)

b) What other benefits or cost do you expect from restoration?

"Most of the farmers do not see any negative aspects (costs of restoration)"
- *No cost*
- *Unknown / don't know*
- *Maybe increase amount of predators in the Gamtoos valley* (not a problem)
- *Can't be a problem for us*

"The thicket restored upstream may use much water"
- *Use much water. Is negative*

c) What is the value of an assured yield of the dam? And what is the 'optimum' level? *(81.2%) [min. 50 /max. 100]*

"A high dam yield gives you a (feeling of) water security"
- *High level will be enough water for year water supply*
- *Gives you a feeling of water security*
- *Is a realistic level*
- *Don't know dam level*

"Extra space in the dam should be reserved (in certain months) to catch the rainfall and reduce & slow down the flooding"
- *Kouga Dam is not used for flood protection according to DWAF. Flood gates should be used to level off the floods. Extra space should be available to catch extra rain.*
- *The dam should be kept on a lower level (75%) during certain months to catch the expected rainfall and reduce flooding damage (buffer function)*
- *Flood storage*
- *space for overflow*
- *Slows down the flood so other rivers (e.g. Groot River) can pass*
- *Space for rain*
- *can deal with flood*

7. Willingness To Pay

If the project goes through and there are measurable hydrological effects, such as:

i. Improved water quality *(58%)*
ii. Higher water security / improved assurance of supply *(65%)*
iii. Higher water availability / quantity *(73%)*
iv. Storm flow reduction *(50%)*

a) Are you Willing To Pay for (one of) these benefits of restoration?

(1) Yes *(77%)* (2) No *(23%)*

Specify:

"To ensure that the future water supply of the Gamtoos valley is secured and of a good quality"
- *This is required to secure the future of the valley, where other places will perceive scarcity and bad water quality*
- *Guarantees water for the future*

"To receive the benefits off (all) these services"
- *Interested in all services (also interested in doing conservation on own farm)*
- *To certain extent all these aspects benefit me*
- *Benefits perceived*
- *Reduced cost*

- *(Indirect) I can use more water*
- *Extra allocation given*

"Already paying (high) enough levies anyway"
- *Already paying levies to DWAF*
- *Farmers need to pay for everything more, but won't get more money on the market*
- *Water tax is already quite high in the Gamtoos compared to other WCA e.g. Fish stream*
- *Pay already enough taxes. I don't want that everyone say yes and we all need to pay extra*

"The water should be to good standards anyway"
- *GIB should provide good water anyway*

"Restoration should happen nearby, e.g. on the slopes in the Gamtoos valley"
- *I prefer restoration nearby (e.g. slopes above Loerie Dam which are causing runoff, flooding and erosion)*

Amount:

"Insights in the cost & possible benefits are needed to specify the WTP amount"
- *10% increase of the water price*
- *Want to see first the cost of the restoration and the perceived benefit than its easier to make up a price to pay*

b) What criteria need to be met before you are WTP for the benefits of restoration?

"There should be direct, visible and clear benefits with enough evidence"
- *When direct and clear benefits*
- *If benefits are visible*
- *What is our benefit?*
- *Evidence need to be visible*
- *Evidence*
- *Evidence of restoration process*
- *Doesn't matter. If we have benefits, than its ok*

"If there is a benefit we must contribute to cover the restoration cost (as an investment)"
- *If we have a benefit of restoration we must pay & contribute to cover the cost*
- *In the end I'll pay when there is enough evidence*
- *I see it not as an extra cost, but it's an INVESTMENT (You should approach it like that!)*

"The price should be reasonable, affordable and profitable"
- *Reasonable & affordable*
- *Should be affordable & reasonable.*
- *Reasonable and fair*
- *reasonable & well managed*
- *Is it profitable?*

"Farmers should only contribute a small amount of the restoration cost, other water users (NMMM) and sectors (tourism) should pay more"
- *I am willing to pay a levy, but I think farmers should only contribute a small amount towards the cost of restoration whereas PE & municipality have more benefit*

- *Farmers will pay increasing prices anyway*
- *There are many other opportunities where the Baviaanskloof can pay for itself as a 'World Heritage area'*

"Feedback is required, so I can see where I pay for"
- *Feedback of the results is needed. I'd like to know where I pay for*

"Get insights in important project aspects such as: project size, time span, planning, financials, returns and monitoring"
- *Want to know how they accommodate the project, project time span*
- *When will the effects be visible and do I receive a return?*
- *Long-term plan required, including: project size, project time span, financials, practices, monitoring of success and feedback*

"The project should be well managed and implemented"
- *Money should be well spent, they should do what they say, a proper organization should be responsible. I want something that does not only look good on the paper!*
- *Good management, a field manager is required to see if workers are really productive, better result, focus should not only be on jobs, but on a 'higher outcome' as well*

c) Which organization / institutions should facilitate the payment process?

Preferred			NOT preferred		
GIB	15	60%	(Kouga) municipality	11	44%
GIB & NGO	2	8%	NGO	2	8%
DWAF & GIB	2	8%			
Don't care	1	4%			
No reaction	5	20%			

Motivation:

GIB; "They are familiar, trustful, transparent, efficient, experienced (through WfW) and a good implementation agency"
- *Trustful and experienced*
- *Experienced & efficient*
- *Experienced*
- *Transparent. Experience through WFW. There objective is to finish their projects*
- *Experienced (WfW)structures in place should be the 'main player'*
- *They have the same goal as the farmers*
- *Good implementation agency doing good work for the WfW and is managed properly*
- *No criteria. I'm fully convinced that GIB will do a good job*
- *Cause we are paying them know already*

GIB & NGO; "a balanced cooperation where GIB is focused on water and financial aspects and the NGO (as subcontractor) on the interest of nature"
- *Balanced cooperation between GIB (economic / water interest) and NGO (green / biodiversity interest)*
- *GIB with maybe a subcontractor and a Nature conservation NGO*

DWAF & GIB; "DWAF supported by GIB for the implementation, since they are close by"

- *DWAF Supported by GIB for the implementation (trustful). They are closer to us, because farmers are in their steering board*

Don't care; "if they equipped and cheap it's ok"

- *If they equipped and cheap its ok*

No reaction

These most (emerging) farmers did not or could not answer the questions due to language barrier, lack of knowledge or lack of interest.

Not municipality; "since they do not have the capacity (experience, skills, materials, time), are not trusted, cost effective and can not operate a long term project (sustainable)"

- *They are useless and money will disappear*
- *They are corrupt, not experienced and not skilled*
- *They think they know everything. I have bad experience with the municipality*
- *With the municipality there won't happen anything*
- *They are not interested, useless and all the money will disappear*
- *They can't supply service we pay for at present and don't have the infrastructure*
- *No consistency, no trust, don't do project on a sustainable, long-term way*
- *No expertise & to many things on their mind, should focus on their current service delivery*
- *No trust, can't even manage their own water, lack of skilled people*
- *Is useless. They don't steal the money, but they eat it. Cause of the black empowerment*
- *Not effective. Don't have the people*
- *Don't help us with anything. Can't* do it

Not NGO; "are not effective and are limited in their implementation by the men in charge"

- *Not effective*
- *Are limited in their implementation by 'the men in charge'*

8. Institutional

a) Have you sold any land to the Government which has been redistributed between the emerging farmers in past?

- *Why should I give the others my land, to small*
- *Sold land through the land bank to 5 persons*
- *Got the land from the land bank (2x)*

b) What do you think about the productivity of that redistributed land at the moment?

" There is a low to zero production with bad results"

- *They have zero production*
- *LOW*
- *Bad results*
- *Not much profit knows. Market prices in PE / Humansdorp is highly variable so no security of income*
- *High pack out loses (60%) through damages. To be profitable must be less than 40%*

"The emerging farmers (from outside the area) have a lack of interest and problems to work within a team"

- *Wrong people (not interested in farming and are not form the area ' outsiders') are getting the land.. Local people should get the land*
- *Lack of interest emerging farmers. Still problems with 'apartheid', e.g. black guy don't want top work for a black guy*
- *Personal "greed", biggest problem. Hampers hierarchy, cooperation and teamwork*
- *No emerging farmers in Loerie as far as I know*

"The lands need to be larger and better situated so they are less vulnerable for floods"

- *Mentor needed and bigger lands*
- *Is difficult, area is to small (1 ha) and they need to do (and rent) equipment themselves*
- *Main issue is that the lands are to small, lack of equipment,*
- *Requested the citrus coop for help to manage their citrus, but was to small*

"Training & long-term support by mentors is required (and need to be accepted) to improve capacities"

- *Unsuccessfully on their own. Mentoring is required to make them successful. They have no experience in management & farming and don't want to cooperate with other farmers*
- *Simple crop activities needs to be coordinated*
- *Strong mentor needed with 'unlimited power', required to achieve things*
- *Provide training & support for their own workers (e.g. housing)*
- *Lack of capacity & sort-term thinking*
- *Cash flow management required*
- *Training alone is not enough*

"Through a shortage of good lands and enough water, the emerging farmers can not start or further increase their production"

- *GIB has no extra water available at the moment. " GIB says: we're full know, so you need to apply for extra water through DWAF*
- *Want to plant vegetable (e.g. Lucerne) for cattle feed. Now limited by availability*
- *More emerging farmers will possibly start farming, when lands in the area become available (now shortage). Want to stay and work in this area*

Additional comments:

- *If the government not bother us we don't bother them*
- *Future plans for dairy farming*
- *Government is not seeing the importance of the farmers, it's now improving because food pricing are rising"*
- *More support to agriculture is needed in SA. We producing to less food so everything need to be imported. Expensive now through the currency difference*

Comments emerging farmers:

- *We want to pay for our water to GIB annually instead of every month (because we get our money after harvest)*
- *Receive production advice from a local contact person from the Department of agriculture.*
- *Planning to rend 14 ha to a white farmer for 5 years. This to earn some money form rent and get more farmers skills through mentoring.*
- *Come back and see our slowly improvements*
- *50,000R cabbage plants provided from DWAF, out of a total 130,000R*