# BAVIAANSKLOOF - TSITSIKAMMA PAYMENT FOR ECOSYSTEM SERVICES: A FEASIBILITY ASSESSMENT

## EXECUTIVE SUMMARY

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SOUTH AFRICAN national biodiversity institute SANBI

CAPE ACTION FOR PEOPLE AND THE ENVIRONMENT C.A.P.E

WORKING FOR WATER

Patron in Chief: Nelson Mandela

UNDP

# Executive Summary

## Introduction

There has been recognition that current unsustainable land use practices on extensively farmed land in the Baviaanskloof and Tsitsikamma[1] watersheds are highly problematic for the sustainable supply of important ecosystem services. Extensive farming practices tend to deliver relatively poor returns and come at the expense of good veld condition and overall water security for downstream water users including farmers and water-stressed urban areas of Port Elizabeth, Jeffery's Bay and Cape St. Francis. Payment for Ecosystem Services systems offer the opportunity to achieve sustainable outcomes by re-aligning the incentives faced by land owners to better meet the needs of wider society. In response to the potential opportunity offered by PES systems, SANBI engaged Futureworks! to broadly assess the feasibility of establishing a PES system in the Baviaanskloof and Tsitsikamma watersheds, focusing on water and carbon sequestration services.

This assessment was commissioned as part of the World Bank funded Cape Action for People and the Environment (C.A.P.E.) programme's Biodiversity Conservation and Sustainable Development Project co-ordinated by the South African National Biodiversity Institute. It also benefited from co-funding made available by the Department of Water Affairs' Working for Water programme (WfW).

## The Watersheds Have the Capacity to Supply Significant Levels of Ecosystem Services

The Baviaanskloof, Kouga and Kromme watersheds[2] consists of 18 quaternary catchments, with a total surface area of 560,000 hectares. The watersheds are located in a bimodal rainfall zone with greater rainfall in the spring and autumn. Mean annual precipitation ranges widely from 225mm in the northern Baviaanskloof to over 1,600mm per annum in the high-lying Tsitsikamma Mountains. The linked systems of the Baviaanskloof and Kouga currently supply some 101 million $m^3$ of water to users while the Kromme supplies some 37 million $m^3$.

Apart from water, the spekboom thicket prevalent in parts of the watersheds has a prodigious capacity to store carbon below and above ground, with intact vegetation storing some 100 t C per hectare more than degraded areas. This level of storage is not dissimilar to moist forests in other regions.

## The Supply of Ecosystem Services is Changing

The supply of valuable ecosystem services is, however, not secure. While 30% of the watersheds fall within protected areas, 65% is made up of extensive farm land where ecosystem services are at risk. There are 255,000 hectares of degraded farm land which produce relatively poor agricultural benefits and impose social costs primarily in the form of reduced water security and further contribute to climate change due to the loss of soil carbon. Of these degraded lands, approximately 28,000 hectares is covered in condensed alien invasive plant jungle, which significantly reduce water yields. Less than half the natural veld (some 224,000 hectares) remains in good condition. The degraded areas have severely reduced ecosystem services with high social costs, such as:

- elevated storm flows - which damages infrastructure, reduces soil water infiltration, limits vegetation productivity and increases the amount of water spilling over dam walls,

[1] The Tsitsikamma watershed is used to collectively refer to the Kouga and Kromme watersheds, which both originate in the Tsitsikamma Mountains. These two watersheds are discussed in greater detail in sections to follow.

[2] The term watershed is used in preference of catchments, as catchment management in the Department of Water Affairs has a particular institutional connotation. To avoid confusion, watershed management and watershed services are used to focus on the ecological and hydrological aspects of managements and benefits.

- reduced base flows – which reduces access to water in the dry season, exacerbates pollution impacts with less dilution, degrades freshwater and estuarine ecosystems which reduces recreation, visual amenity and biodiversity vigour,
- reduced yields - which reduces access to water for abstraction and limits associated economic activity,
- accelerated erosion – which reduces the lifespan of water infrastructure, increases maintenance costs of water and irrigation infrastructure, and
- greater carbon emissions – the destruction of vegetation, especially thicket which releases carbon into the atmosphere adding to global warming.

## There is Demand by Landowners to Shift to More Sustainable Land Uses

Current livestock-based land use practices generate poor returns. At present, farmers net some R42 per ha per year for cattle in the Kromme and Kouga watersheds, and some R87 per ha per year farming goats in the Baviaanskloof. Importantly, these marginal returns to stock farming are not sustainable – as the extensive nature of large scale veld degradation attests - with some 255,000 hectares already degraded. Farmers are looking for more sustainable land uses with better annual returns, such as game farming, tourism and intensive cropping. Intensively cropped lands are attractive with annual returns from a few thousand Rands to R 150,000 per hectare. However, such land use depends on access to fertile bottom lands, large volumes of water and associated water licences – all of which are in very short supply.

## The Need for Ecosystem Services Within the Watershed is Great and Growing

The Nelson Mandela Bay Municipality (NMBM) has a long history of water access crises and relies on numerous inter-basin transfers, with some water coming from as far afield as the Gariep dam. The continued growth of the city, the establishment of the Coega Industrial Development Zone and the growth of Jefferies' Bay and St Francis Bay, are driving high levels of growth in water demand, with total demand predicted to double in the next few decades. Expensive options such as waste water recycling and desalination are being seriously considered in spite of the high likelihood that the electricity critical for such processes, is likely to double in price in the next 3 to 4 years. Furthermore, the existing storage capacity of large and small dams needs to be protected against accelerated sedimentation.

The need to optimise the supply of ecosystem services from existing natural capital or natural infrastructure, through effective watershed restoration and management is growing daily and should be viewed as an economic development imperative for the region.

## Watershed Management Options Available Have a Range of Hydrological Impacts

The watershed management benefits supplied by a range of watershed management options were quantified using the *ACRU* Agrohydrological Modelling System linked to an ecological-economic model. Four feasible management options were developed and their impacts modelled. The outputs are illustrated in Table 1.
The watershed management options include:

- Control & Clearing of Invasive Alien Plants - This management option considers only alien plant clearing across all invaded habitats – with no revegetation of denuded areas at all.
- Revegetation of Denuded Areas - This management option would entail only revegetation of denuded areas across denuded habitats – with no invasive alien plant removal (i.e. revegetation is applied only in those quinaries where denuded landscapes exist)
- Maximising the Baseflow (dry season flows) - This option includes a combination of invasive alien plant removal and revegetation, but optimising for baseflow only.
- Maximising Yield (stream flow) - This option includes a combination of invasive alien plant removal and revegetation, but optimising for yield.

Table 1: Changes in yield, baseflow, and sediment reduction with implementation of four management options

| | Kromme | Kouga | Baviaanskloof | Total |
|---|---|---|---|---|
| Control & Clearing of Invasive Alien Plants | | | | |
| Change in yield[3]: $m^3$ per year | 4,441,006 | 3,838,286 | - | 8,279,293 |
| Change in baseflow: $m^3$ per year | 2,409,231 | 2,276,552 | - | 4,685,782 |
| Sediment reduction: $m^3$ per year | - | - | - | - |
| Comments: Results show a significant increase in stream flow or yield of some 8.2 million $m^3$ per annum, with management in the Kromme river delivering the greatest volumes. | | | | |
| Revegetation of Denuded Areas | | | | |
| Change in yield: $m^3$ per yr | -1 931 146 | -10 599 850 | -1 708 949 | -14 239 945 |
| Change in baseflow: $m^3$ per yr | 20 028 219 | 15 861 808 | 5 649 308 | 41 539 335 |
| Sediment reduction: $m^3$ per yr | 91 522 | 112 693 | 44 571 | 248 786 |
| Comments: This option results in the greatest reduction in yield with a 14.2 million $m^3$ per annum reduction, largely from the Kouga. On the other hand, this option generates a 41.5 million increase in baseflow, with substantial contributions from all three systems. | | | | |
| Maximising the Baseflow (dry season flows) | | | | |
| Change in yield: $m^3$ per yr | -1 931 146 | -9 227 209 | -1 708 949 | -12 867 304 |
| Change in baseflow: $m^3$ per yr | 20 028 219 | 16 688 029 | 5 649 308 | 42 365 556 |
| Sediment reduction: $m^3$ per yr | 91 522 | 112 693 | 44 571 | 248 786 |
| Comments: In this management option, a mix of revegetation (in 49 quinaries) and limited invasive alien plant removal (in 5 quinaries), results in an increase of 42.3 million $m^3$ in baseflow flows per year. However, the total stream flow or yield is reduced by some 13 million $m^3$ per year. This management option also generates the same reductions in sediment loads as for the revegetation option, with the Kouga making the biggest sediment reduction contribution. | | | | |
| Maximising Yield (stream flow) | | | | |
| Change in yield: $m^3$ per yr | 5,986,263 | 3,838,286 | 1,267,183 | 11,091,733 |
| Change in baseflow: $m^3$ per yr | 8,936,255 | 2,276,552 | 2,781,529 | 13,994,335 |
| Sediment reduction: $m^3$ per yr | 13,492 | - | 8,747 | 22,239 |
| Comments: This option generates the greatest increase in yield, some 11 million $m^3$ per annum, with an increase of 14 million $m^3$ per annum in baseflow. Importantly, interventions in the Kromme have the greatest positive impacts on both yield and baseflow. | | | | |

## The Economics of a Payments for Watershed Management System

### *At the Farm Level*

The benefits, costs and net returns to farmers for the above management options have been estimated and are outlined in Table 2.

Table 2: The relative value of benefits, costs and net returns to farmers per hectare per year

| Returns to ecosystem services | Control and clearing of IAP | Baseflow maximisation | Revegetation of denuded areas | Yield maximisation |
|---|---|---|---|---|
| Above ground carbon / ha | R - | R 71.10 | R 72.95 | R 21.08 |
| Avoided loss: soil carbon/ ha | R - | R 1.72 | R 1.72 | R 0.20 |
| Water: Value of sales / ha | R 2.54 | R 22.93 | R 22.48 | R 7.57 |
| Land use change: (Agric., biodiv & tourism)/ ha | R 20.77 | R 44.18 | R 42.80 | R 28.95 |
| Sediment reduction / ha | R - | R 1.39 | R 1.39 | R 0.12 |
| Total benefits: R/ha/yr | R 23.30 | R 141.32 | R 141.35 | R 57.92 |
| Total management cost[4]: R/ha/yr | R 64.43 | R 43.20 | R 35.89 | R 68.36 |
| Net returns: R/ha/yr | R -41.13 | R 98.12 | R 105.46 | R -10.44 |

[3] The yield refers to the increase in streamflow in the watershed modelled by ACRU.

[4] Total cost includes the opportunity cost of reducing stock levels to sustainable levels.

Both the ‘baseflow maximisation’ and ‘revegetation of denuded areas’ options are feasible for farmers, with the sale of above ground carbon sequestration services playing a critical role in generating financial feasibility. Both these options include revegetating degraded areas which leads to substantial carbon sequestration services worth around R70 per hectare per year. This service is a critical driver in re-orienting farming towards the supply of ecosystem services.. The ‘clearing invasive alien plants’ and ‘yield maximisation’ options do not include much revegetation and consequently the benefits carbon sequestration cannot be realised, making management unfeasible. Figure 1 shows that invasive alien plant control and yield maximisation options are not financially feasible, but that the baseflow maximisation and revegetation options are feasible, with the revegetation option showing the greatest present value (PV) of revenue to land owners.

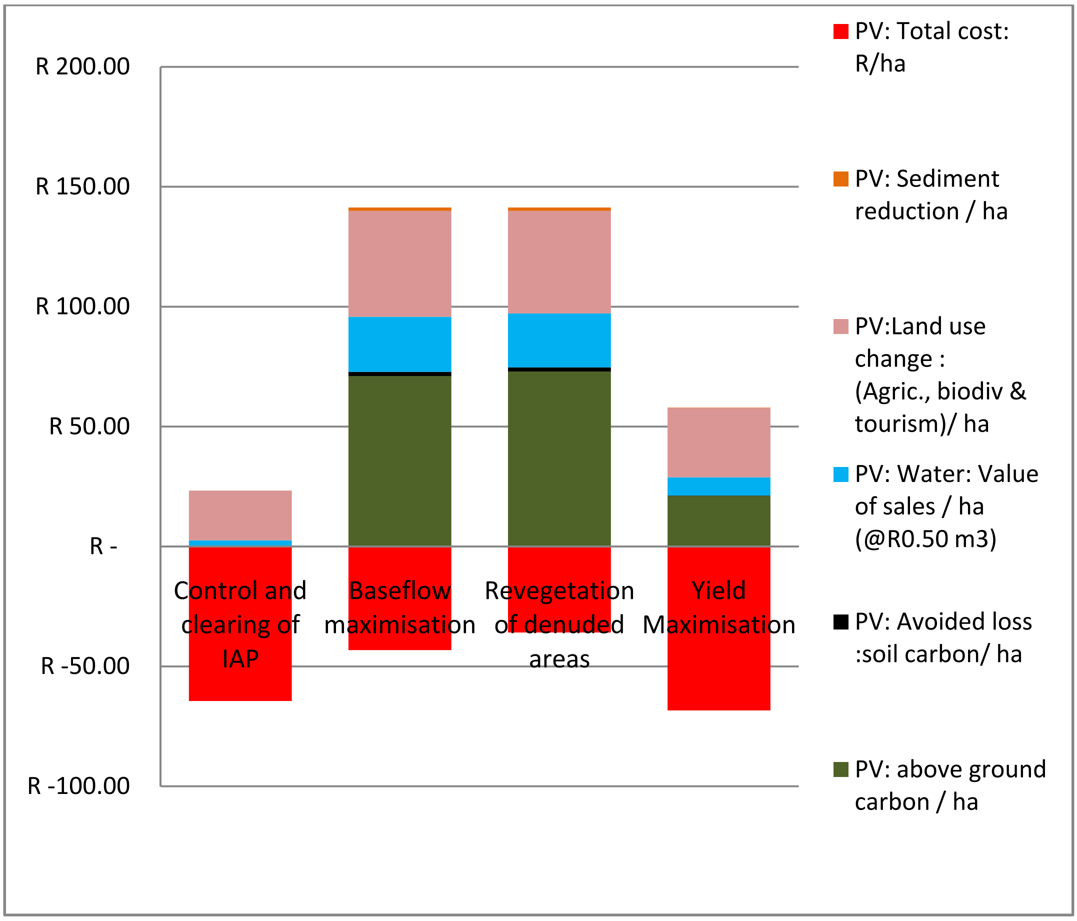


**Figure1: Returns per hectare for restoration and management per year**

### *At the Societal Level*

Aside from assessing private financial returns to land owners, the economic feasibility of paying for the management of watersheds for ecosystem services delivery can also be modelled and understood at a societal scale. In Table 3 and 4 below, a summary of all the aggregated estimates for each management option in all three watersheds is outlined. Table 3 summarises the water services changes, costs, and benefits of the four management options. Table 4 presents the benefit-cost ratio, unit reference values (URVs), and the potential jobs generated for each management option. Please note:

1. All these estimates are the totals for a 30 year project period at a 4% discount rate.
2. The hectare based estimates are averages for an entire watershed.

**Table 3: Summary of feasibility assessment values**
***(Colour codes: green = good values; yellow/orange = moderate or marginal values; red = suboptimal or poor values)***

| Water services changes: per annum | Control and clearing of IAP | Baseflow maximisation | Revegetation of denuded areas | Yield maximisation |
|---|---|---|---|---|
| Change in yield: $m^3$ | 8 279 293 | -12 867 304 | -14 239 945 | 11 091 733 |
| Change in baseflow: $m^3$ | 4 685 782 | 42 365 556 | 41 539 335 | 13 994 335 |
| Sediment reduction: $m^3$ | - | 248 786 | 248 786 | 22 239 |
| Comments: The baseflow maximisation and revegetation options show the greatest gains in baseflow, but also show significant losses in yield. The yield maximisation option also shows good increases in both baseflow and yield. The control and clearing of invasive alien plants generates the least additional water services. | | | | |
| **Cost & Benefits of implementation: over 30 yrs** | **Control and clearing of IAP** | **Baseflow maximisation** | **Revegetation of denuded areas** | **Yield maximisation** |
| PV: Total cost | R 975 591 539 | R 654 140 529 | R 543 480 909 | R 1 035 040 122 |
| PV: Total benefits (excluding economic value of water) | R 352 854 400 | R 2 139 758 069 | R 2 140 140 287 | R 876 898 296 |
| Comments: Management that focuses exclusively on invasive alien plant clearing has no carbon sequestration benefits, resulting in benefits 2.5 to 7 times less than the other options. The baseflow maximisation and revegetation options generate similar levels of benefits. In these two options the carbon and tourism benefits are both substantial. The yield maximisation benefits are 2.5 times greater than the invasive alien plant control option, but 2.5 times smaller than the baseflow maximisation and revegetation options. The motivation for a nature-based economy is even more attractive if the economic value of water is considered (See below). | | | | |
| PV: Economic value of water | R 626 604 334 | R 5 665 316 559 | R 5 554 830 565 | R 1 871 386 757 |
| Comments: It is important to note that apart from the financial returns of management action, the additional water services supplied can add a substantial value to the regional economy. Note that the baseflow maximisation and revegetation options are likely to contribute an additional R5 billion to the economy, due to additional economic activity resulting from access to additional water. | | | | |

**Table 4: Summary of the benefit-cost analysis, URVs, and job creation**
***(Colour codes: green = good values; yellow/orange = moderate or marginal values; red = suboptimal or poor values)***

| Benefit-Cost Ratio | Control and clearing of IAP | Baseflow maximisation | Revegetation of denuded areas | Yield maximisation |
|---|---|---|---|---|
| Restoration + Management: Carbon | 0.00 | 1.69 | 2.08 | 0.31 |
| Restoration + Management: Water sales | 0.04 | 0.53 | 0.63 | 0.11 |
| Restoration + Management: Land use change | 0.32 | 1.02 | 1.19 | 0.42 |
| Restoration + Management: Sediment | 0.00 | 0.03 | 0.04 | 0.00 |
| Restoration + Management: Total | 0.36 | 3.27 | 3.94 | 0.85 |
| Comments: The control of invasive alien plants option does not break even. The yield maximisation option gets close to breaking even at 0.85, but the revegetation and baseline maximisation options, show significantly positive ratios. These latter two options are therefore highly feasible. These results also show that water sales alone cannot pay for the management and restoration required. To make a watershed restoration and management programme economically feasible and sustainable, then carbon sequestration and/or tourism/game need to be added to the suite of sales. | | | | |
| **Unit Reference Value** | **Control and clearing of IAP** | **Baseflow maximisation** | **Revegetation of denuded areas** | **Yield maximisation** |
| URV: Water only | 7.19 | 0.93 | 0.80 | 3.59 |
| URV: Water & above ground carbon | 7.19 | -0.60 | -0.82 | 2.48 |
| URV: Water, above ground carbon, landuse change & sediment | 4.87 | -1.58 | -1.81 | 0.96 |
| Comments: In terms of water sales, the control of invasive alien plant species and yield maximisation have similar URVs to waste water recycling and the construction of dams. The baseflow maximisation and revegetation options have URVs less than 1 which is very attractive. The negative values show that carbon sequestration, land use changes, and sediment reduction services are very costly to society if not implemented. A negative URV indicates a societal loss for every day the project is not implemented. | | | | |

| Jobs creation: over 30 years | Control and clearing of IAP | Baseflow maximisation | Revegetation of denuded areas | Yield maximisation |
|---|---|---|---|---|
| Total: Person-days | 3 857 228 | 4 736 296 | 4 380 881 | 4 828 682 |
| Total: R/person-day | R 253 | R 138 | R 124 | R 214 |
| Comments: The invasive alien plant control option will generate some 640 jobs a year for 30 years, while the yield maximisation and baseflow maximisation will generate some 800 jobs a year for 30 years. | | | | |

From Table 3 and 4, it is evident that baseflow maximisation and revegetation of denuded areas options are financially and economically feasible as market-based PES schemes. The yield maximisation option, while not financially feasible, is economically justifiable as a public works PES scheme, given the value added to the economy by the additional water generated.

The alien plant removal option is neither financially nor economically feasible because it focuses on managing light and dense infestations across the entire watershed, which greatly increases management costs. The actions of the Working for Water programme (WfW) are most comparable to the yield maximisation option (aside from this option including undertaking revegetation where WfW doesn't) as both focus only on the management of densely infested areas, thereby reducing management costs.

## A Suggested Framework for PES in Baviaanskloof-Tsitsikamma Watersheds

One of the key challenge associated with establishing a PES schemes is to convert economic benefits into financial returns since it is the latter that acts as incentive for land-use change. The former motivates why such a change in land-use is advisable or preferred from a societal perspective, but it is the financial returns that makes it viable for the farmer. In essence, society needs to pay farmers to produce public services such as water security and carbon sequestration so that they can cover their veld restoration and/or management costs (including their opportunity cost of giving up the unsustainable portion of their stock farming returns) while generating good land for game and tourism opportunities that farmers can then exploit themselves. This analysis has shown that some watershed management is capable of improving watershed services supply cost effectively and Figure 3 suggests a possible payment for ecosystem services system.

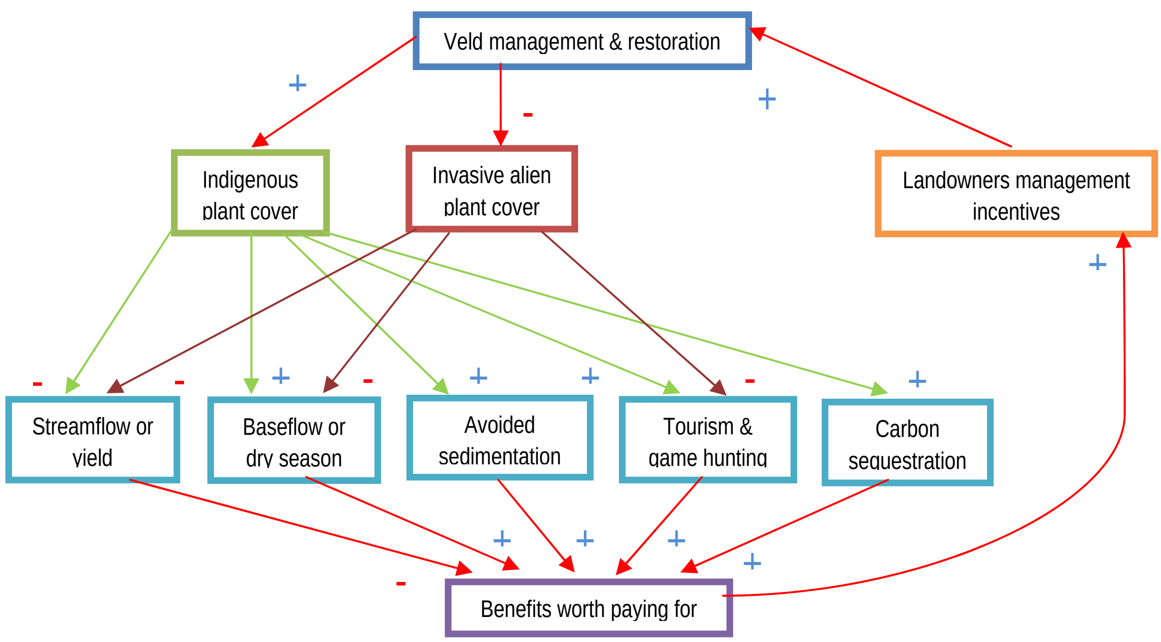


**Figure 2: A suggested PES system in the Baviaanskloof-Tstitiskamma watersheds (the + or – symbols denote that nature of the relationship)**

## The Implications of the Assessment for Watershed Users

### *Farmers:*

- It is financially feasible to change from stock farming to an ecosystem service focus, which includes:
    - reduced but sustainable stocking rates,
    - vegetation restoration and management to generate carbon sequestration, game habitat, tourism assets, sediment avoidance, avoided soil carbon loss and increased water security. This is however all dependent on accessing a market.

### *Water suppliers or managers:*

- Watershed management has been shown to be a feasible water supply augmentation option.
- A critical element in promoting water security would be for water managers to support the establishment of associated carbon and tourism markets.
- The 'new' water may be useful for meeting the environmental flows of the affected rivers if the assurance of supply is considered too low for human use.
- The findings of the study indicate that water management programmes, such as Working for Water, could be substantially bolstered if their approach was broadened to include additional management actions in addition to alien invasive plant clearing.

### *Water consumers:*

- Water consumers have an alternative or additional mechanism to support water security. The options to increase baseflow and/or yield offer opportunities for 'new' water albeit having a lower assurance of supply given its links to land surface conditions.
- For run-of-river water users, water security will be enhanced.

### *Conservation agencies:*

- If conservation agencies wish to facilitate land use changes to support the growth of local biodiversity on private land, then they need would to support farmers in accessing carbon trading and tourism markets to ensure that sufficient incentives are in place for farmers to switch land use.
- In terms of gaining additional revenue streams from carbon and water services supply, for the conservation estate, the following is recommended.
    - Conservation agencies go into bilateral agreements with carbon buyers who are willing to accept the risks of buying from a seller who may not be able to assure 'additionality' in the long term.

### *Sustainable land use agencies – such as PRESENCE:*

- An agency needs to be established to facilitate the trade in carbon offsets which have high potential to be produced in this system, particularly the Baviaanskloof system through spekboom restoration. A facility needs to be established to promote tourism, as a vibrant tourism trade would support farmers in reducing stock numbers and in pursuing habitat restoration.

### *Government – local, district, provincial and national:*

- The Baviaanskloof-Tsitiskamma watersheds house natural assets with ecosystem services of considerable value to all levels of government, such as:
    - ✓ A critical water resource for the local municipalities,
    - ✓ An outstanding tourism asset for the province to attract national and international visitors,
    - ✓ A flood reduction service for district, provincial, and national roads,
    - ✓ A basis for the revival and diversification of the district's rural economies,

- ✓ An option for augmenting water security for the Nelson Mandela bay Municipality, and for enhancing the longevity of existing water infrastructure, and
- ✓ A World Heritage Site which offers RSA prestige and tourism marketing opportunities.

- This asset is, however, being run down by disparate use and excessive consumption of ecosystem goods or plain neglect. The loss of these assets will have large and significant costs for government – already illustrated by regional flood damage repairs and water shortages. A concerted effort is required by government to promote the integrated and harmonious use of the Baviaanskloof-Tsitsikamma watersheds as the combined benefits of a suite of compatible ecosystem services far outweigh the management costs and the individual benefits of destructive over-consumption.