Payment for Ecosystem Services:

An Ecosystem Services Trading Model for the Mnweni/Cathedral Peak and Eastern Cape Drakensberg Areas

DBSA
Development Bank of Southern Africa

Maloti Drakensberg Transfrontier Project

WORKING FOR WATER
Patron in Chief Nelson Mandela

Title	An Ecosystem Services Trading Model for the Mnweni/Cathedral Peak and Eastern Cape Drakensberg Areas
INR Report No.	IR 281
Authors	Mander, M., Blignaut, J. Schulze, R., Horan, M., Dickens, C., van Niekerk, K., Mavundla, K., Mahlangu, I., Wilson, A and McKenzie, M.
Document history	First version provided to MDTP, DEAT, DBSA and EKZNW
Current version.	Final report
Changes to previous version.	Editorial
Date	22 January 2008
Status	For distribution to MDTP, DBSA , DEAT and EKZNW and stakeholders
Correct reference for citation	Maloti Drakensberg Transfrontier Project (2007) Payment for Ecosystem Services: Developing an Ecosystem Services Trading Model for the Mnweni/Cathedral Peak and Eastern Cape Drakensberg Areas. Mander (Ed) INR Report IR281. Development Bank of Southern Africa, Department of Water Affairs and Forestry, Department of Environment Affairs and Tourism, Ezemvelo KZN Wildlife, South Africa.

Institute of Natural Resources
P O Box 100396
Scottsville 3209
Fax +27 (0)33 346 0895
Tel +27 (0)33 3460796
Email inr@ukzn.ac.za

Prepared under contract from: Maloti Drakensberg Transfrontier Project and
Development Bank of Southern Africa Limited

Client representatives: Kevan Zunckel and Lindeni Kumalo

Project No. DBSA Ref 101295

Authors

Myles Mander - Futureworks
James Blignaut - Jabenzi
Roland Schulze - UKZN
Mark Horan - UKZN
Chris Dickens – INR
Kate van Niekerk - INR
Khulile Mavundla – Futureworks
Isaiah Mahlangu – INR
Adrian Wilson – Adrian Wilson and Associates
Margaret McKenzie - Futureworks

futureWORKS!
Making Environments Work for People!

Institute of Natural Resources

School of Bioresources Engineering & Environmental Hydrology

Jabenzi

EZEMVELO KZN WILDLIFE

A collaborative effort

This work has been a collaborative effort between a number of authors and a wide range of stakeholders. The work is a reflection of a potential market, with the various possible sellers and buyers of services articulating their perceptions and positions in such a market, in this work. To a large degree the work is a product of the inputs of the market stakeholders.

This report is also a product of many contributors, and a synthesis of all the work that individuals have undertaken. A number of separate reports are available that cover the details of particular aspects of the work, and are available to interested persons.

Acknowledgments

The investigation has benefited from a many people's inputs. Some 536 people and institutions have been associated with the investigation contributing in various degrees. These have included people from KZN, the Eastern Cape and Gauteng. We would like to thank all those people who have contributed to this work, making it a success. We would like point out a few groups who have put considerable effort into supporting the work.

The project steering committee has helped to direct the project, and they include:
Julie Clark - DBSA
Lindeni Khumalo - DBSA
Kevan Zunckel - MDTP
Rabson Dhlodhlo – DEAT (Chairman)
Christo Marais – Working for Water / DWAF
Steve McKean – Ezemvelo KZN Wildlife

There have also been a number of key stakeholder groups that have assisted enormously in the work, including:
The Okhombe Community
The Ongeluksnek Community
Cedarville Farmers Association
The Department of Water Affairs and Forestry

There have also been a number of individuals that have contributed to the work who need be thanked, including:
Terry Everson – University of KwaZulu-Natal
Colin Everson – Council for Scientific and Industrial Research
Graham von Maltitz - Council for Scientific and Industrial Research
Johan van Rooyen – DWAF, Water Resources Planning
Johan Geringer – DWAF, Chief Engineer Option Analysis East
Carl Freese - University of KwaZulu-Natal
Richard Lechmer Oetel - MDTP
Noah Scovronick – Anchor Environmental Consultants
Jane Turpie – Anchor Environmental Consultants
Mazwi Mkhulisi - MDTP

The project implementation was funded by the Development Bank of Southern Africa and the Maloti Drakensberg Transfrontier Project. Their support is gratefully acknowledged.

This document summarises information presented in a number of project reports which provide detailed information for each aspect of the Payment for Ecosystem Services Project. All these reports are included in the complete project document entitled '*Maloti Drakensberg Transfrontier Project (2007) Payment for Ecosystem Services: Developing an Ecosystem Services Trading Model for the Mnweni/Cathedral Peak and Eastern Cape Drakensberg Areas. Mander (Ed) INR Report IR281. Development Bank of Southern Africa, Department of Water Affairs and Forestry, Department of Environment Affairs and Tourism, Ezemvelo KZN Wildlife, South Africa'*.

The specific reports referred to in the above document are referenced below:

Blignaut, B.J. (2007) Estimate of finances available for the purchase of activities to improve the delivery of water related ecosystem services.

Blignaut, B.J. and Mander, M. (2007) Benefits of the Drakensberg: Developing the range of incentives for improved management.

Blignaut, B.J. & Mander, M. (2007) Understanding the catchment services, producers and their economics.

Mander, M. (2007) Report on the willingness to pay for ecosystem services.

Mander, M. (2007) Understanding the catchment services, consumers and their economics.

Schulze, R.E. and Horan, M.J.C. (2007) Hydrological Modelling as a Tool for Ecosystem Services Trading: Case Studies from the Drakensberg Region of South Africa. University of KwaZulu-Natal, Pietermaritzburg, School of Bioresources Engineering and Environmental Hydrology, ACRUcons Report 56. pp 71.

van Niekerk, K., Mahlangu, I., Mavundla, K. and Mander, M. (2007) Identification of current land use management practices and associated costs influencing water related services in the Ukhahlamba region.

van Niekerk, K., Everson, T., Turpie, J., Scovronick, N., Mander, M. and McKean, S. (2007) Identification of land use practices impacting on water related ecosystem services.

Wilson, A. (2007) Developing an ecosystems services trading model for the Mnweni/Cathedral peak and Eastern Cape Drakensberg areas: Institutional options for implementation.

Contents

List of figures

List of tables

List of photos

Acronyms

ASGISA	Accelerated and Shared Growth Initiative of South Africa
BOTT	Build-Operation-Train-and-Transfer
DWAF	Department of Water Affairs and Forestry
CMA	Catchment Management Agency
EKZNW	Ezemvelo KwaZulu-Natal Wildlife
IA	Implementing Agency
IGR	Inter-Governmental Relations
P & G	Preliminary and General
PES	Payment for Ecosystem Services
PMSC	Programme Management Steering Committee
R & D	Research and Development
TCTA	Trans-Caledon tunnel authority
WFW	Working for Water

1. INTRODUCTION

1.1. Motivation for project

Ecosystem goods and services, such as water quality and quantity, are in increasing demand as local, national, regional and global economies and populations expand. With regard to water specifically, Scholes (2001) pertinently states: 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.

In the same vein, prominent economist Herman Daly wrote: More and more, the complementary factor in short supply (limiting factor) is remaining natural capital, not manmade capital as it used to be. For example, populations of fish, not fishing boats, limit fish catch worldwide. Economic logic says to invest in the limiting factor. That logic has not changed, but the identity of the limiting factor has (Herman Daly, pers. communication, 25 Jan. 2005). It is therefore essential to invest in the limiting resource from a developing perspective: Water. An efficient way to invest in water security is to protect it at its source through prudent land management. In this way, investing in land management becomes a water augmentation, quality and regulation intervention.

Within South Africa, the Maloti Drakensberg mountains are the most strategic water source in the region, supplying much of the sub-continent through rivers, and national and international inter- basin transfers. The Maloti Drakensberg mountains fall within the country's most important water supply area. River catchments within the bioregion form the source or contribute to a number of major rivers, including the Umzimvubu, Umzimkulu, Umkomazi and Thukela on the South African side, and the Vaal and Orange / Senqu Rivers on the Lesotho side. The rivers rising on the South African side contribute over 8000 million m^3 in mean annual runoff (MAR) to systems within the region (Diederichs and Mander 2004). This initiative has developed a model for investment in water security by using the trade in ecosystem services as sustainable foundation. Two priority case study areas have been assessed, namely:

- Mnweni/Cathedral Peak and
- The Eastern Cape Drakensberg.

Within these areas, this project assesses the feasibility to develop a payment for ecosystem services system with win-win solutions: improved water security, better water flow regulation and water quality, improved land management, improved livelihoods and reduced vulnerability.

1.2. The background to the project

The Maloti Drakensberg Transfrontier Project (MDTP) undertook a baseline investigation in 2004 to identifying a strategy for developing incentives for land users in the Maloti Drakensberg Bioregion to maintain and / or enhance the supply of ecosystem goods and services for local, national and international users (Diederichs and Mander 2004). There were a number of reasons why these incentives for management were considered necessary:

- The area is important for the quality of life and economic development of households at the local, national and international level.
- The mountains are a World Heritage Site of international biodiversity, cultural and geological significance.
- The Maloti Drakensberg is a strategically important watershed, supplying 25% of South Africa's water.
- The Maloti Drakensberg mountains are a key tourist destination for South Africa and Lesotho.

The investigation by Diederichs and Mander 2004 showed that the demand for ecosystem goods and services supplied by the Maloti Drakensberg Bioregion were significant, and would continue to increase into the future. Table 1 below is extracted from the Payment for Environmental Services Baseline Study (Diederichs and Mander, 2004) and shows those ecosystem services were identified as significant.

Table 1. Ecosystem Services supplied by the Maloti Drakensberg Area

Ecosystem Service	**Description**
Carbon Sequestration	Carbon is taken up by plants in the growth process and stored in above and below-ground plant biomass. In addition, litter production and decomposition lead to the accumulation of carbon in soil. The amount stored in plant biomass is a relatively constant function of total mass, but the rate of carbon uptake from the atmosphere depends on the growth rate of these plants. The amount stored in soils differs according to vegetation cover and land use, but in the Drakensberg environments the bulk of carbon is stored in the soil.
Climate Regulation	Regulation of local climate is a service that is often associated with forests, especially large-scale tropical rainforests. However, the grasslands and open woodlands that dominate the bioregion would also be expected to influence local climate.
Disturbance Regulation	Disturbance regulation is usually associated with wetlands, such as floodplain wetlands and coastal mangrove areas. Floodplain wetlands ameliorate the potential impacts of flood events by absorbing the flood peaks and lengthening the flood period

	at a lower level. Coastal mangroves are considered to provide important protection to coastal areas from potential storm damage. These types of habitats are maintained to some extent by the freshwater flows that are delivered by the Maloti Drakensberg bioregion. These could be considered as indirect services yielded by the area.
Water Supply and Regulation	The Maloti Drakensberg bioregion falls within the country's most important water supply area. River catchments within the bioregion form the source or contribute to a number of major rivers, including the Mzimvubu, Mzimkulu, Mkomazi and Thukela on the South African side, and the Vaal and Orange Rivers on the Lesotho side. The rivers rising on the South African side contribute over 8000 million m^3 in mean annual runoff (MAR) to systems within the region.
Erosion Control and Sediment Retention	The prevention of soil loss by vegetation cover and its capture in wetlands is a cost-saving service that is provided by conservation of these ecosystems. Soil losses that might otherwise occur due to ecosystem degradation, such as through excessive grazing, would incur costs associated with increased turbidity of aquatic systems, siltation of aquatic habitats and siltation of water supply infrastructure and monitoring weirs. Higher silt loads in rivers and estuaries decrease light penetration and thus primary productivity, which in turn affects fisheries. Silt deposition within rivers, wetlands and estuaries decreases habitat and hence biodiversity in these systems. Siltation of dams and weirs reduces their capacity and lifespan, incurring costs through increased maintenance and/or augmentation and replacement schemes.
Soil Formation and Nutrient Cycling	Soil formation processes and nutrient cycling maintains the productivity of the land, which may benefit biodiversity or other land users such as farmers and pastoralists. These are localised benefits that cannot really be quantified as a separate entity.
Waste Treatment	Aquatic systems can play an important role in the absorption and breakdown of organic and inorganic pollutants. Organic pollutants, such as nitrates and phosphates, and inorganic pollutants, such as heavy metals, are diluted, taken up by plants, trapped along with sediments or broken down within aquatic systems. Waste treatment services obviously only occur downstream of where wastes are generated, and are thus performed mainly beyond the boundaries of the Maloti Drakensberg Bioregion. This service is related to the health of downstream aquatic ecosystems, which is in turn related to the amount of runoff delivered by the Maloti Drakensberg Bioregion. Waste treatment services are thus indirect services of this bioregion.
Pollination and Biological Control	Some ecosystems, such as Fynbos, provide pollinators that are of tremendous value to commercial farmers. However, pollination and biological control services are considered to be of negligible importance in the Maloti Drakensberg bioregion, at least in the context of the Environmental Services Trading Project.
Refugia and Genetic Resources	The Maloti Drakensberg Bioregion serves an important function in the conservation of biodiversity, having been identified as an area of high endemism and species richness for plant species, particularly alpine and grassland species. The high-altitude grasslands within the region have been recognised as being among the richest in the world. The high levels of endemism also extend to other taxa, including mammals (11 species) and birds (32 species), while the region is also recognised as one of the eight centres of reptile and amphibian diversity in southern Africa. While recognised as a highly important service, it is impossible to quantify how these genetic resources may be of use in the future, however.
Food Production, Grazing and Raw Materials	The ecosystems of the Maloti Drakensberg bioregion provide a number of wild foods, medicines, fuel and construction materials which are used by rural communities living in the area. These are of particular importance to communities of communal lands, but are also believed to be harvested to a significant extent on privately owned lands, especially be farm labourers. The importance of firewood is however based primarily

	on alien species planted for this purpose.
Recreation	The biodiversity of the area, along with scenic beauty, has resulted in the establishment of a number of formally protected areas, including the uKhahlamba Drakensberg Park and Coleford Nature Reserve in KwaZulu-Natal; the Golden Gate/Qwa Qwa National Park and Sterkfontein Nature Reserve in Free State; and Ongeluksnek and Ntsikeni Vlei Nature Reserves in the Eastern Cape. The uKhahlamba Drakensberg Park has been awarded UNESCO World Heritage Site status, giving it a central role in attracting tourism and recreation to the region. This park alone can accommodate 2000 people per night, with an equal number of beds available in private enterprises neighbouring its borders. The tourism value of the entire region, including areas outside of formally protected areas, is very high.
Cultural Services	The cultural services of the bioregion include its contribution to education, scientific knowledge and the spiritual well-being of South Africans. Although one could possibly quantify the amount of use of the area by educational groups, scientists, etc., it would never be possible to quantify the true contribution that this makes to society. For example, the educational experience afforded by the area might influence the way in which new generations treat their environments far from this area.

Based on this baseline study, the MDTP then decided to fund the development of a strategy for developing management incentives for priority ecosystem system services – namely water, carbon sequestration, biodiversity and scenic beauty. However, as this feasibility study was initiated it became clear that the market was only ready for water and carbon sequestration services. Ezemvelo KZN Wildlife funded the carbon sequestration potential component of this study.

In a separate and prior process, the Development Bank of Southern Africa (DBSA) had been requested by Mander to fund an investigation into the feasibility of an ecosystem services trading system in the Maloti Drakensberg. The DBSA responded positively to this request, with a particular focus on rural community development opportunities for the Eastern Cape. However, this funding was dependent on locating a joint funder. Once the MDTP had made the decision to fund their strategy development, a joint contract was negotiated and implemented. The two funders were later joined by Working for Water as a formal implementing partner.

1.3. The legal mandate for a trade system

The legislation exists for water users to be charged for the enhancement of water services delivered by the Department of Water Affairs and Forestry (DWAF) or other designated suppliers.

The DWAF Water Pricing Strategy explicitly states that water users can be charged for resource management action, such as the clearing of alien plants. However, this tends to operate as a levy where there is no direct link between the actions taken, the benefits generated and the levy charged. This approach may be used as a payment for ecosystem services option but is not a market mechanism.

The strategy also makes provision for users to be charged on a cost recovery basis for water resource development or asset maintenance. The raw water charge has the necessary mechanisms to secure payment from the users for costs incurred in the development and management of the scheme that supplies water. This is an ideal market mechanism to use in securing payment for ecosystem services.

The strategy also makes mention of various aspects that can be financed by charges, such as operation and maintenance, refurbishment, return on assets and government schemes funded off budget (funded by a capital unit charge to users). While the strategy mentions assets, infrastructure and capital, there is not the explicit discussion of natural assets or natural capital. However, in the opinion of several DWAF officials, natural capital could be considered as capital or assets, and therefore in principle the mechanism exists in law to recover costs for management of water supply assets (built or natural). Importantly, there are opportunities to charge for operation and maintenance (such as maintaining an ecosystem in a state which optimizes benefits to water users) and for refurbishment or betterment (such as the restoration of natural capital).

In principle then, if natural capital does supply services of value, which are cost-effective to implement, then there is the legal mechanism to charge the user for the management thereof.

Furthermore, the strategy makes provision for the establishment of water management institutions, such as the Trans-Caledon Tunnel Authority (TCTA), which can charge DWAF a tariff for water supplied. The implication is that it could then be possible to establish a water management institution that supplies ecosystem services provided that the benefits are shown to be substantial and DWAF is willing to make such an agreement.

There is no legal or institutional impediment to payment for ecosystem services provided that the returns or benefits are such that the activity is deemed an attractive option for enhancing water supply in South Africa.

1.4. The demand for a trade from stakeholders

The DWAF national office has indicated a willingness to engage in assessing the feasibility of the Payment for Ecosystem Services (PES) system in catchments. The KwaZulu-Natal provincial office sees PES as an option to lever funds for essential catchment management action. There are reservations that poor municipalities may not be able to pay for the services supplied by management agents. However, PES was viewed as a potential job creation option in poor municipalities and could be a cost effective option for promoting assurance of supply in non-paying areas.

Water utilities were interested to participate in the PES initiative to learn if cheaper supply augmentation options were available.

Communal and commercial farmers were keen to identify new income streams that would improve the returns to stock farming, and supported the development of a payment for ecosystem services system. In addition, communal farmers and tribal authorities were particularly keen to use such a PES initiative to revitalize local resource management institutions.

In summary there has been widespread interest in participating in the development of a PES trade system by potential buyers and sellers of services.

1.5. Project Approach

The project was undertaken over a 14 month period focusing on two case study sites the Upper Thukela, otherwise know as Mnweni and Cathedral Peak, and the Eastern Cape Drakensberg, from Matatiele to Maclear and incorporating the Upper Umzimvubu (including the Tina and Kinira rivers).

The following general steps where taken in executing the project:

- identified the demands for water services from the mountain catchments,
- identified the supplies of water services (baseflow, stormflow, sediment reduction) supply from the mountains,
- identified the grassland management that was necessary and feasible to enhance basal cover in the mountains,
- modelled the eco-hydrological impacts of preferred grassland management and the impacts of current poor management practices,
- identifed the costs of the preferred management in commercial farming, communal farming and protected area contexts,

- identified the benefits of enhanced baseflows in winter months, sediment reduction and carbon sequestration in mountain grasslands,
- developed a model that would integrate the eco-hydrology outputs, with the costs and benefits of increased water and carbon sequestration services supply,
- assessed the economic feasibility of mountain grassland management and restoration in 27 sub-catchments in the Upper Thukela and 33 sub-catchments in the Upper Umzimvubu system,
- developed an institutional framework for implementing a PES system for those sub-catchments wherein management was economically feasibility.
- An intensive stakeholder participation and capacity building process was conducted in order to align the assessment with supplier and buyer needs.

Critical to this approach was the underlying fact that plant cover or basal cover of plants on the land plays a fundamental role in enhancing hydrological benefits in catchments (Figure 1). Management action that maintains and restores a robust basal cover within the grasslands, will result in greater supplies of water retention or storage services, greater storm flow reduction, greater erosion prevention and greater soil carbon accumulation. Whilst some of these services are tradable, such as baseflow enhancement, sediment yield reduction and carbon sequestration , a myriad of ancillary services (not tradable at this point in time) are generated by the more robust natural assets, thereby providing additional value to local and downstream ecosystem service users. For example services such as less severe flooding, more productive grazing and high volumes of harvestable thatch would be generated in greater volumes.

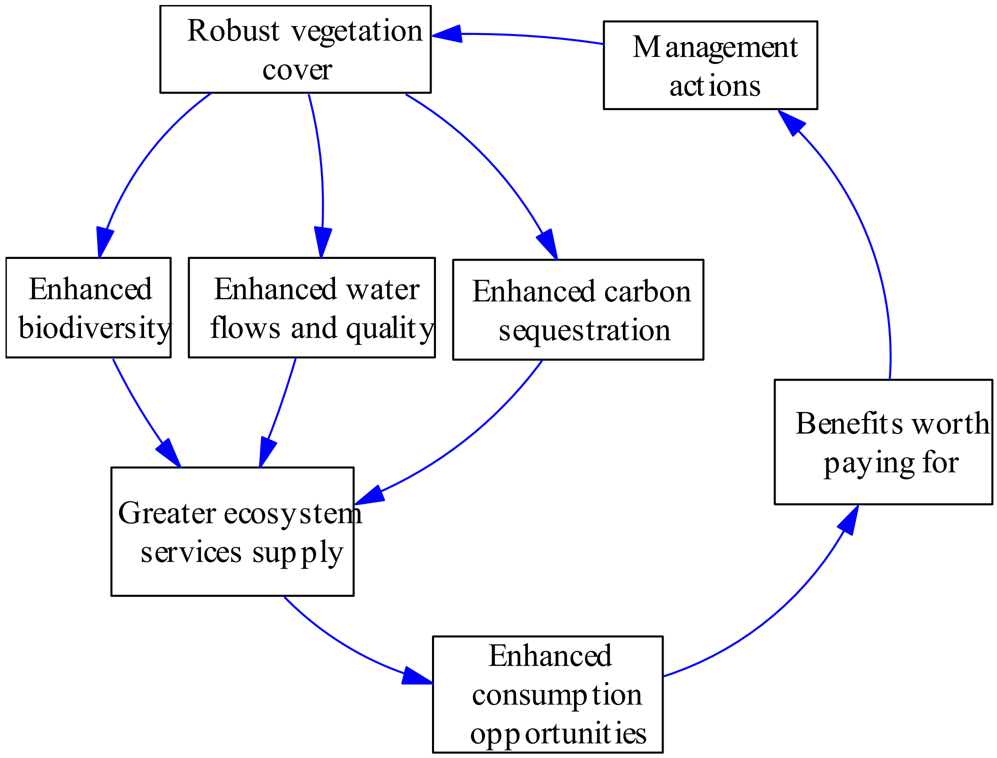

Figure 1. The payment for ecosystem services process proposed in this study

Importantly, the study needed to identify the optimal plant cover that generates the highest levels of hydrological benefits, whilst also maintaining a robust biodiversity asset. The issue of maintaining a robust biodiversity was a critical factor in the approach, given that much of the grasslands fall within a World Heritage Site, and whose functional integrity could not be compromised.

2. HYDROLOGICAL MODELLING OF ECOSYSTEM SERVICES SUPPLY

2.1. Background

2.1.1. Hydrologically Related Ecosystem Services

Ecosystems contribute either directly or indirectly to fresh water, which is fundamental to life, and from this fresh water benefits are provided to people. The hydrologically related services from ecosystems have been described by Aylward et al. (2005) in the Millennium Ecosystem Assessment as

- Provisioning Services, which include sustained quantities and acceptable quality from inland water ecosystems such as perennial and ephemeral rivers and streams, and making this water available for consumptive uses, for example for drinking, domestic, agricultural (dryland and irrigation) and industrial purposes, as well as for non-consumptive uses such as power generation and transportation/navigation;
- Regulating Services which include maintenance of water quality through natural filtration and water treatment, buffering of flood flows, as well as erosion control;
- Supporting Services, which include nutrient cycling and ecosystem resilience; and
- Cultural Services, which contribute to human well-being through, for example, recreational activities, tourism and scenic values, and existence values such as the satisfaction gained from free-flowing rivers.

2.1.2. Changes in Services Resulting from Modified and/or Damaged Ecosystems

Over much of South Africa, terrestrial and fresh water ecosystems are not in pristine condition, but rather in a modified and often damaged state, usually

- through human exploitation, by virtue of a lack of sustainable practices through which the ecosystem is exploited, and
- often linked with failure to enforce policy, which is usually the case.

The modification of ecosystems to enhance any one service generally comes at the expense of other services (IIED, 2007). In a South African context modifications may generally be classed into

- resource intensive development and utilization, usually by the more developed sectors of the economy and which include dam construction, wetlands drainage or inter-basin transfers which all alter flow regimes, as well as replacement of natural vegetation by transformation of natural areas to agricultural crops; and
- resource extensive development and utilisation, often by the more impoverished sectors and/or communities and which include
  - clearing of natural vegetation to use for heating and building purposes;
  - overgrazing, which is a form of over-harvesting of a natural resource, with resultant alterations in the partitioning of rainfall into more "flashy" stormflows and reduced baseflows, as well as increases in sediment yields; and/or
  - burning of grasslands, either as an ecological management tool or to enhance new season growth of sour grass species, with consequences along the same lines as those of overgrazing.

While some of the developments may augment the natural availability of fresh water or provide a more constant flow regime, they have at the same time become direct drivers of ecosystem degradation through

- changes in the total amount of water generated,
- changes in the spatial and temporal distribution of water when compared with pristine conditions, and
- reductions in the quality of water through addition of either nutrients, salts or suspended solids (Aylward et al., 2005).

2.1.3. Management as a Determinant of Ecosystem Services

The trade-offs and balances between these different developments described above, which alter the magnitudes, timing, components and uses of fresh water, have become major challenges to equitable and sustained water use in light of increasing water demands from the numerous sectors seeking to utilise and benefit from, what is over much of South Africa, a scarce and over-allocated resource.

From the above discussion it becomes evident that it is the manner and the extent to which fresh water ecosystems and their catchments are either

- well managed or
- misused by humans

that largely determines the attributes of the water resource over an area, for it is through the management of the land that the partitioning of the rainfall into either

- baseflows on the one hand, vs
- stormflows on the other hand, and with that,
- sediment yield is largely controlled.

2.1.4. Objectives of the Hydrological Study

Given the above background on water as an ecosystem good and service, the overall objective of this study was as follows, *viz.* in the

- Upper Thukela catchments around Bergville, Oliviershoek and Cathedral Peak in the KwaZulu-Natal Drakensberg and the
- Umzimvubu catchments around Qacha's Nek, Ongeluksnek, Mount Fletcher and Matatiele in the Eastern Cape Drakensberg

the downstream impacts of two dominant resource extensive upstream land management scenarios, *viz.*

- burning of grassveld, whether controlled by ecological / physiological considerations or not, and in regard to the timing and frequency of burns, and
- grazing/overgrazing by different degrees

are to be assessed hydrologically from the premise that the provision of water for downstream users is interpreted as an environmental service by upstream users, who then may need to be rewarded or compensated by the downstream users as an incentive to improve/rehabilitate their land uses in order to improve this service.

This payment for ecosystem services (PES) raises two sets of questions, *viz*. those related to economics and to hydrological modelling.

2.1.5. Economics Related Questions

- If management of environmentally sensitive/critical upstream land uses in the Upper Thukela catchments through
    - controlled burning
    - reduced stocking and/or
    - rehabilitation of already degraded areas

  produces

    - more sustained streamflows in critical times of the year, and
    - cleaner water, i.e. with a lower sediment yield,

- then, what is the cost of various options of management by, for example,
  - cattle herding (to control rotational grazing and prevent overgrazing)
  - controlled firebreaks (to prevent runaway fires)
  - application of fire as a management tool
  - restoring grassveld to a more pristine state (to ensure higher productivity and enhance infiltration of rainwater) or
  - rehabilitation of already existing gullies/dongas (to prevent excessive sediment losses)
- versus the return on the investment for cleaner water and/or more sustained low flows?

Furthermore:

- Are downstream beneficiaries, for example
  - Thukela Water, as a local bulk water supplier, and/or
  - the Department of Water Affairs, as the operator of large downstream dams which are fed by these catchments, and/or
  - Rand Water, as a recipient of the water through an inter-basin transfer
- willing to pay or reward the upstream land users/managers such as
  - Ezemvelo KZN Wildlife, the conservation agency which controls large parts of the upper catchments, or
  - local communities of subsistence farmers
- for environmental stewardship, i.e.
  - managing the land for more sustained and cleaner water production?
- Will the benefits of enhanced land management/rehabilitation be sustainable?
- Are the trade-offs fair?
- Where, in the catchments is the benefit:cost ratio higher than elsewhere, i.e.
  - where, within the catchment do you invest first, or most?

Many of these questions can only be answered adequately by resource economists once answers on the directions and magnitudes of key hydrological responses are known. These are provided by appropriate hydrological models.

2.1.6. Hydrological Modelling Related Questions

Key questions relating to hydrological modelling of impacts of land management on responses, in a context of ecosystems goods and services and payments for ecological services, include the following:

- What are the hydrological responses resulting from different veld burning regimes, or from grazing/overgrazing, on
  - total streamflows, either within a specific sub-catchment, or accumulated downstream from the headwaters to the exit of the entire catchment,

  and/or on the components making up the total streamflow, *viz*.
  - stormflows, i.e. surface/near surface flows generated from specific rainfall events, and
  - baseflows, i.e. dry weather flows derived from rainwater which had previously infiltrated into and then percolated through the soil profile into the groundwater store from which it is released slowly into the stream,

  and, furthermore, what effect do the veld burning and/or grazing regimes have on
  - *sediment yield*, i.e. eroded soil reaching the stream and being transported downstream?
- How do these responses vary between wet, median and dry years?
- Which of the operational catchments at which decisions are made, in the case of South Africa these being the Quaternary Catchments (QCs)[1], are impacted more than others by the two land management scenarios under consideration?
- Are there certain areas within a specific QC where the impacts are more severe than elsewhere within that QC, either because of physiographic characteristics (e.g. slope and/or soil properties) or because the land management may be carried out more intensively or more frequently?

The above questions place specific requirements which need to be satisfied by the hydrological model selected.

- The model needs to distinguish explicitly, in its internal representation of hydrological processes, between the generation of
  - stormflow events, with their unique attributes of magnitudes, rates and carrying capacity of soil particles;

[1] Quaternary Catchments are 4th level divisions of major drainage basins defined by DWAF and are usually based on the broad bifurcation of rivers.

- baseflows, with their unique attributes of magnitudes, rates of release into a stream and chemical properties; and
- sediment yields, dependent on the catchment's hydrological response, soils, slope, land use and management characteristics, and generated on an event-by-event basis.

- The model needs to distinguish explicitly, in its internal representations of hydrological processes, how management scenarios related to burning and grazing regimes of veld are accounted for through
  - changes in above-ground biomass and its effects on interception of rainfall, transpiration and soil erodibility;
  - changes in on-the-ground material (or land cover which includes litter, mulch and basal (and not exclusively basal cover)) and its effects on soil water evaporation, infiltration of rainwater and soil erodibility;
  - changes in soil surface properties (e.g. soil crusting, changes to infiltrability); and
  - changes in the recovery of above-ground, on-the-ground and soil properties under different natural vegetation and climatic regimes after a veld burn.
- The model needs to simulate the above at appropriate
  - time scales, i.e. on an event-by-event basis, hence using daily time steps; and
  - spatial scales, i.e. at a scale finer than Quaternary Catchments.

On the basis of the overall objectives, the daily time step, physical-conceptual *ACRU* model (Schulze, 1995 and updates) was selected to answer the relevant hydrological questions posed.

2.2. The Upper Thukela Catchments

The Upper Thukela area in western KwaZulu-Natal between latitudes 28° 33' and 29° 04' and longitudes 28° 53' and 29° 20', is 1 727.46 km² in area extent and is made up of the nine Quaternary Catchments V11A to V11H and V11J. With the exception of V11F, these QCs are shown in Figure 2. The topographically rugged area (Photo 1) ranges in altitude from ~1150 in the east to ~3000 m along the northwest to southeast trending top of the Drakensberg mountain range in the west The sub-delineations the QCs have mean sub-catchment slopes ranging from 3.8% to 52.1%.

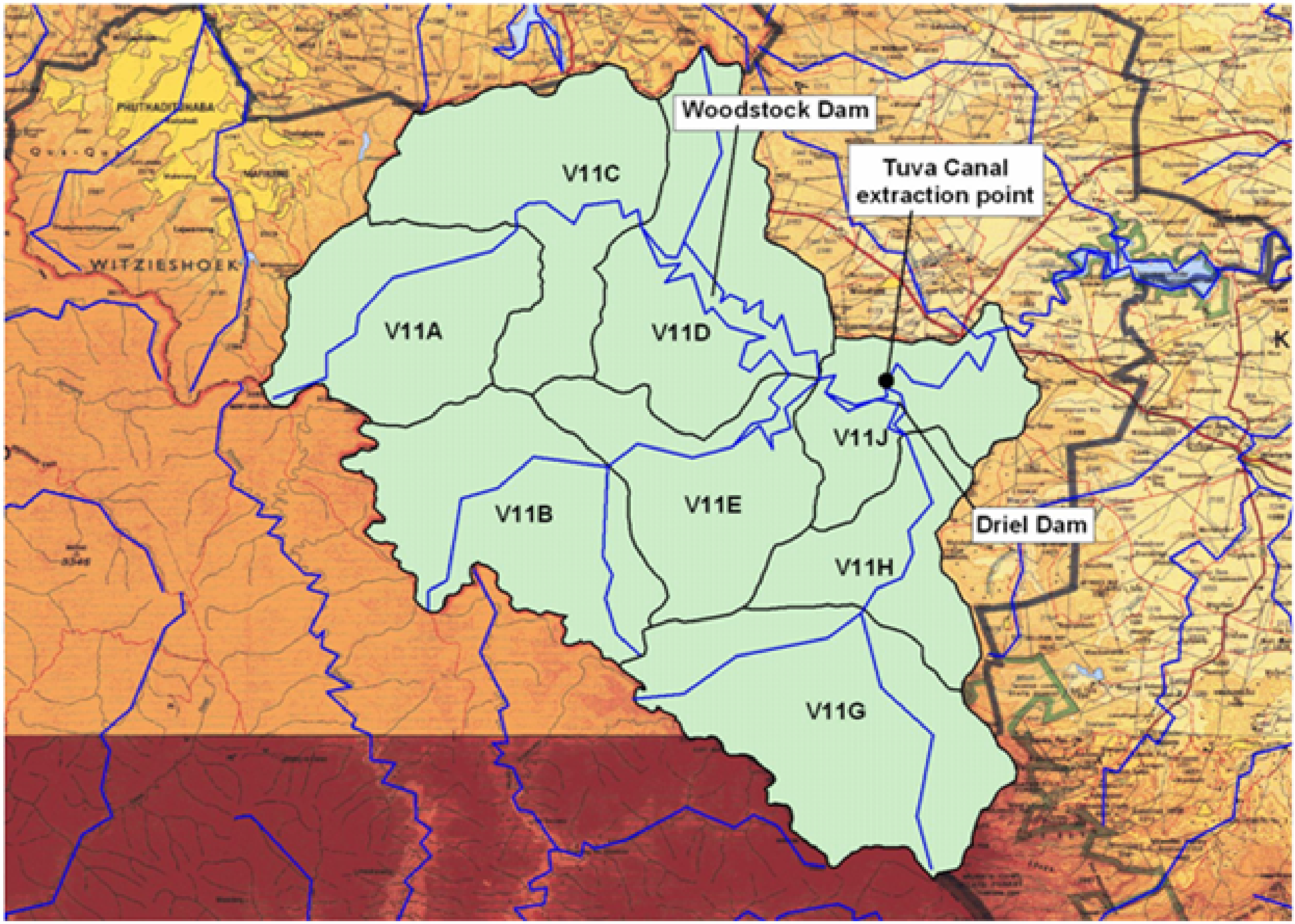

Figure 2. Location of the Quaternary Catchments making up the Upper Thukela case study area (Source: *Futureworks!*, 2007)

Photo 1. Aerial views of the Upper Thukela catchments

2.3. The Eastern Cape Drakensberg Catchments

The Eastern Cape Drakensberg area, located in the upper Kinira (Tertiary Catchment 33) and Tina (Tertiary Catchment 34) tributary catchments of the Mzimvubu River to the southwest of the border with Lesotho, is between latitudes 30° 15' and 30° 46' and longitudes 28° 14' and 28° 41', and is 3 977.71 km² in areal extent, i.e. more than twice the size of the Upper Thukela area. It is made up of the 11 Quaternary Catchments, *viz*. T33A to T33E and T34A to T34F, with two distinct catchment exits. These QCs are shown in Figure 3. The mean QC altitudes of this study area range in altitude from ~1530 m in the east to ~2050 m in the west and mean sub-catchment slopes range from 6.5% to 29.1%.

2.4. Management scenarios for which hydrological responses are to be simulated

2.4.1. Management Issues and Questions They Raise

Current and envisaged future land management scenarios raise two overarching sets of questions:

- In regard to burning of veld and overgrazing,
    - what is the current situation?
    - what are the factors which have influenced the current situation, e.g. the settlement history, conservation practices, accessibility/inaccessibility of livestock to grazing areas, types and attributes of the natural vegetation which is burnt and/or is used for grazing?

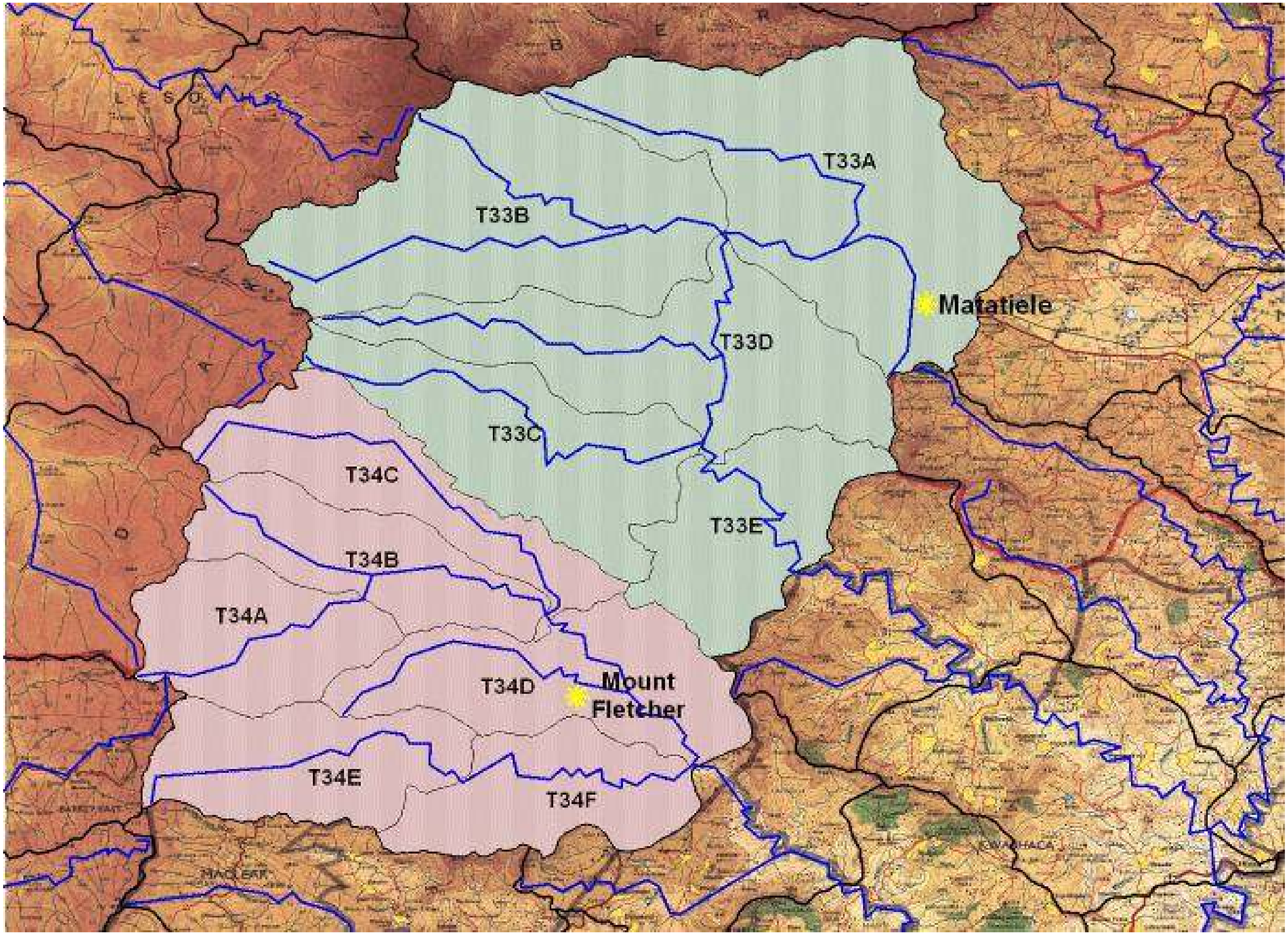

Figure 3. Location of the Quaternary Catchments making up the Umzimvubu case study area (Source: Futureworks!, 2007)

- what is an “attainable” future land management if there were incentive for rehabilitation?
- since both overgrazing and burning of veld involve only the grasslands and not any other land uses, how are the other land uses accounted for in simulations?

- For a given Quaternary Catchment (QC),
  - where is the grazing more intense, or the burning regime different, in different parts within that QC?
  - that being the case, how then should that QC be sub-delineated into more homogeneous response zones to account hydrologically for such differences in management regimes?
  - what, then, are the flow patterns of water within a QC and between one QC and the next one downstream?

These issues are discussed in more detail below.

2.4.2. Delineation of Case Study Areas into Catchments and Sub-Catchments

South Africa has been delineated hydrologically into 1946 cascading Quaternary Catchments. In Figure 4 the QCs and their flowpaths within the Upper Thukela area are shown.

Within many Quaternary Catchments considerable physiographic heterogeneity exists and natural sub-zones, which are essentially altitude related, may be delineated. Each sub-zone has somewhat different rainfall and temperature regimes, different soil properties and land uses and hence display different hydrological responses. For these reasons QCs have had to be sub-delineated into fifth level Quinary Catchments. To employ a consistent methodology of sub-delineating QCs into Quinaries according to altitude determined “natural breaks” in topography (and hence not into equal area sub-divisions), the Jenks’ Optimisation procedures in ArcInfo were applied to sub-divide each QC into three Quinaries, *viz*. an upper, middle and lower Quinary, also designated 1, 2 and 3. The outflow of the lower Quinary in a QC does ***not*** enter the upper Quinary of the next downstream QC because valley bottoms feed into valley bottoms and never valley headwaters. Rather, it enters the downstream QC at its exit. A schematic example of the flowpath configuration between Quinaries and Quaternaries is given in Figure 5.

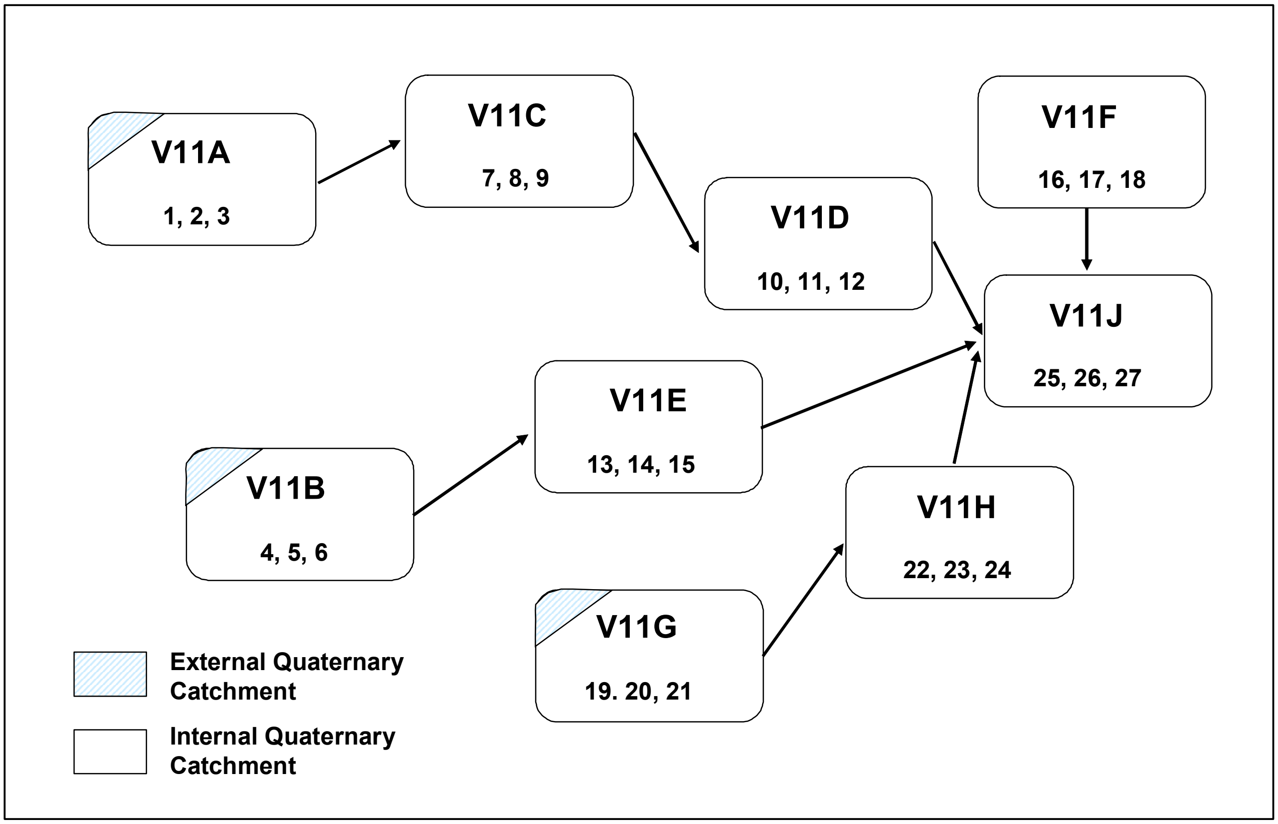

Figure 4. Flowpaths of the Quaternary Catchments making up the Upper Thukela case study area.

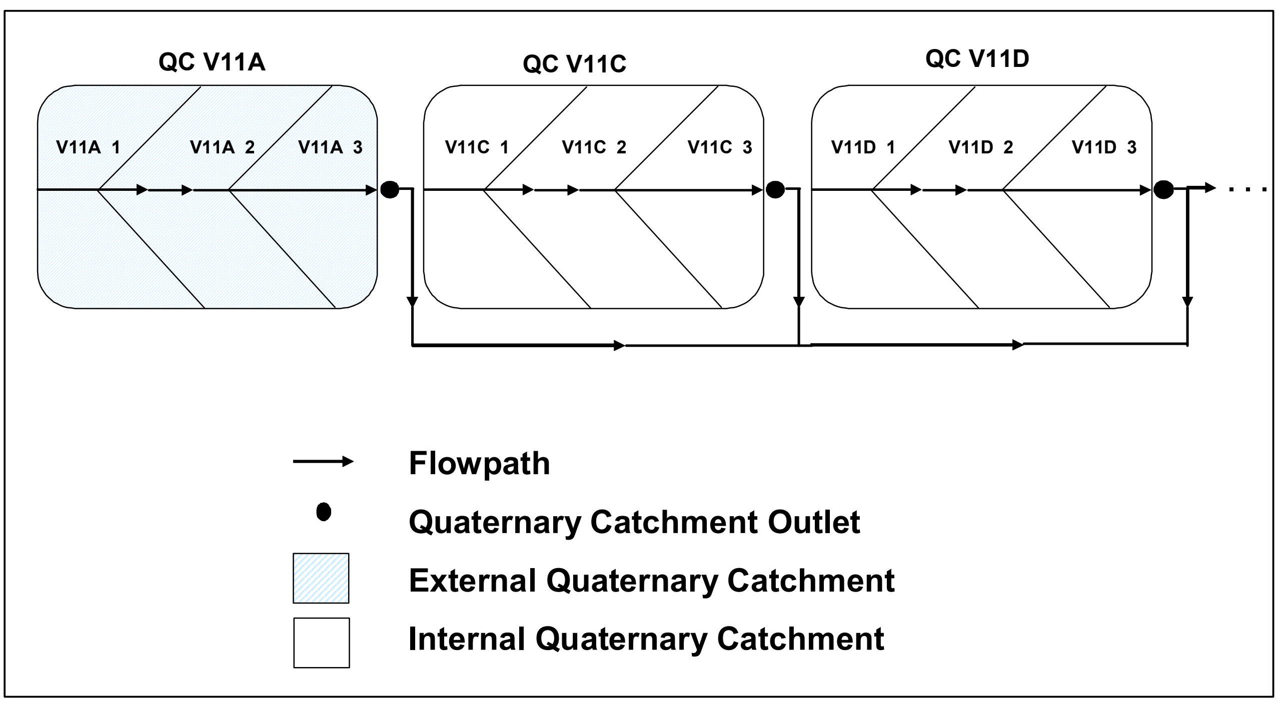

Figure 5. A schematic of the flowpath configuration between Quinary and Quaternary Catchments when modelling at Quinary scale.

2.4.3. Considerations when Simulating Effects of Veld Burning on Hydrological Responses

In Photo 2 examples are shown of extensive veld burning in the Upper Thukela catchments and of the denudation impact it can have. From the photos the following hydrological effects of veld burning are illustrated:

- a reduction in above-ground biomass, which
  - reduces transpiration at rates dependent on whether the natural veld which was burnt had a relatively high or low biomass, i.e. dependent on the prevailing baseline land cover;
  - reduces canopy interception of rainfall by a magnitude dependent on the biomass removed;
  - reduces the canopy's protective properties in the soil loss process; and
- a reduction in surface litter/mulch, which
  - enhances rates of soil surface evaporation and dries out the topsoil horizon at a faster rate;
  - removes the protective surface layer which retards soil erosion
  - enhances soil hydrophobia, i.e. repellency of water to entering the soil profile, and thereby
  - reduces the infiltrability of the soil.

These effects, which have a *temporary seasonal impact* on hydrological responses by generating higher stormflows and sediment yields and lower baseflows while the veld recovers from a burn, have to be encapsulated by, and imbedded in, the various process representations in a hydrological model. In addition, account has to be taken in modelling of

- the frequency of the burn, i.e. whether annual or biennial;
- the timing of the burn, i.e. whether it is in autumn/winter, in which case denuded conditions prevail for several months, or in spring, in which case recovery of the veld is more rapid;
- the ambient climate in which the veld is burnt, whether in a relatively cool climate in which recovery to full canopy is slow, or in warmer climates in which recovery is faster; and / or

- the baseline land cover, i.e. whether it consists of grasses with relatively higher or lower biomass, which is an indicator of whether the burn had a more drastic hydrological effect (with high biomass being burnt) or a less drastic effect.

Photo 2. Examples from the Upper Thukela catchment of veld burning

2.4.4. Considerations when Simulating Effects of Overgrazing on Hydrological Responses

Photo 3 shows different degrees of overgrazing in the Upper Thukela catchments, illustrating clearly what the status of the grassveld should be (left), what it frequently is (middle) and what it can be under extreme circumstances (right). From the photos the following hydrological effects are illustrated:

- a reduction in above-ground biomass, which
  - reduces transpiration at rates that are dependent on whether the natural veld which was overgrazed had a relatively high or low biomass, i.e. dependent on the prevailing baseline land cover;
  - reduces canopy interception, dependent on the biomass removed;
  - reduces the canopy's protective properties in the soil loss process;
- a reduction in surface litter/mulch, which
  - enhances soil water evaporation and dries out the topsoil at a faster rate;
  - removes the protective surface layer which retards soil erosion; and
- a compaction of the soil surface by trampling, which
  - reduces the infiltrability of rainwater into the soil.

These effects have an *impact throughout the year*, and enhance the production of stormflows and associated sediment yield while simultaneously reducing the percolation of soil water into the groundwater zone, hence resulting in diminished baseflows. All the effects have to be encapsulated by the relevant process representations in a hydrological model. Additionally, the model has to account for

- the severity of overgrazing;
- where, within a catchment, overgrazing is more severe than elsewhere; and
- what the baseline land cover consists of, i.e. whether it is grasses with relatively higher or lower biomass, which then is an indicator of whether the overgrazing would have had a more drastic hydrological effect (with high biomass being overgrazed) or a less drastic effect.

The points raised above lead to a discourse on the veld management decisions made for present land use conditions and for proposed modeling scenarios. The study catchments' natural land covers have undergone significant modifications. By way of example, the distributions of "present" land uses for the Upper Thukela, mapped from 2001 satellite images at 100 m resolution, are shown in Figure 6.

Photo 3. Examples from the Upper Thukela Catchment of grazing management

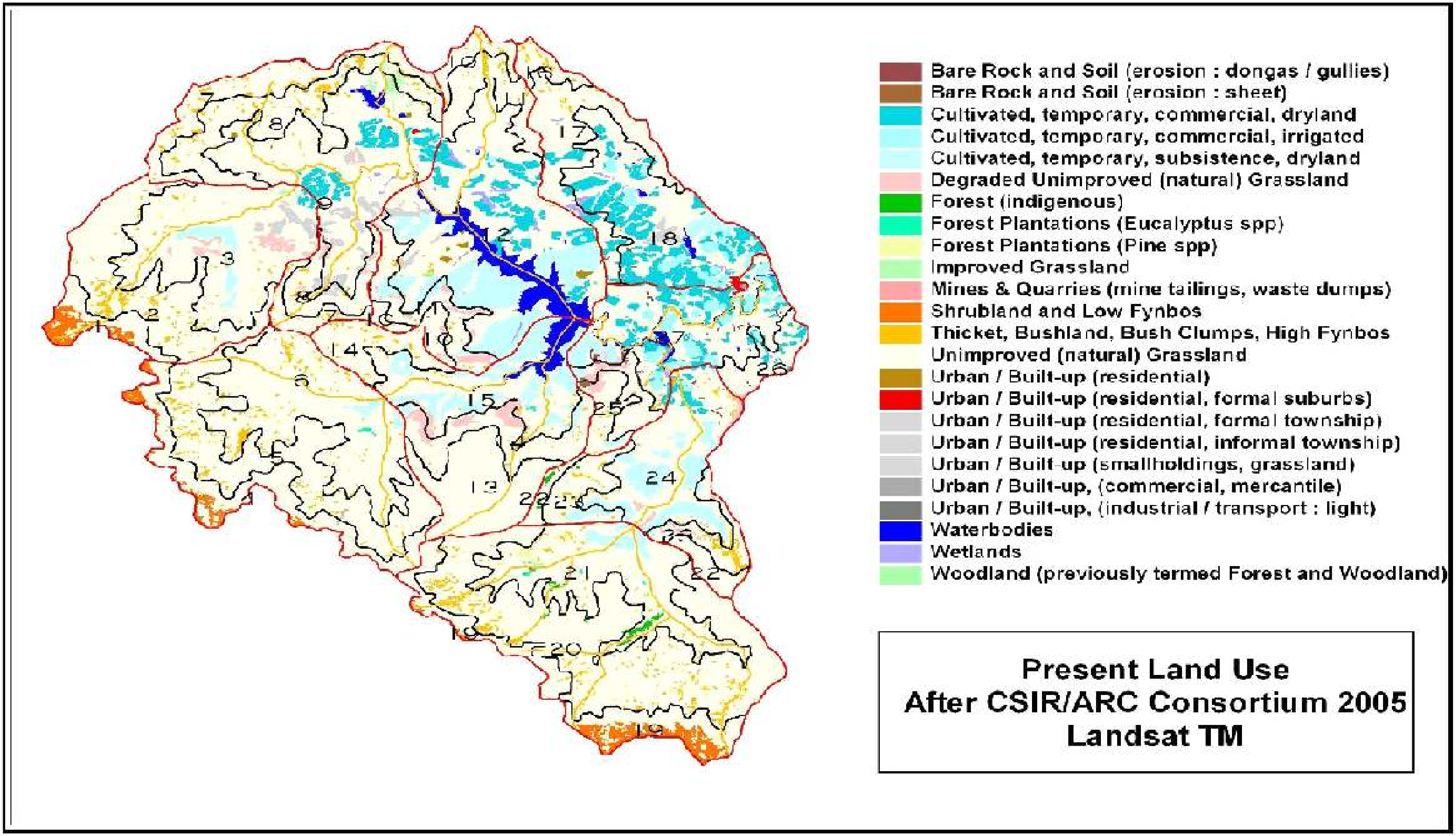

Figure 6. Present (2001) land use in the Upper Thukela catchments (NLC, 2005)

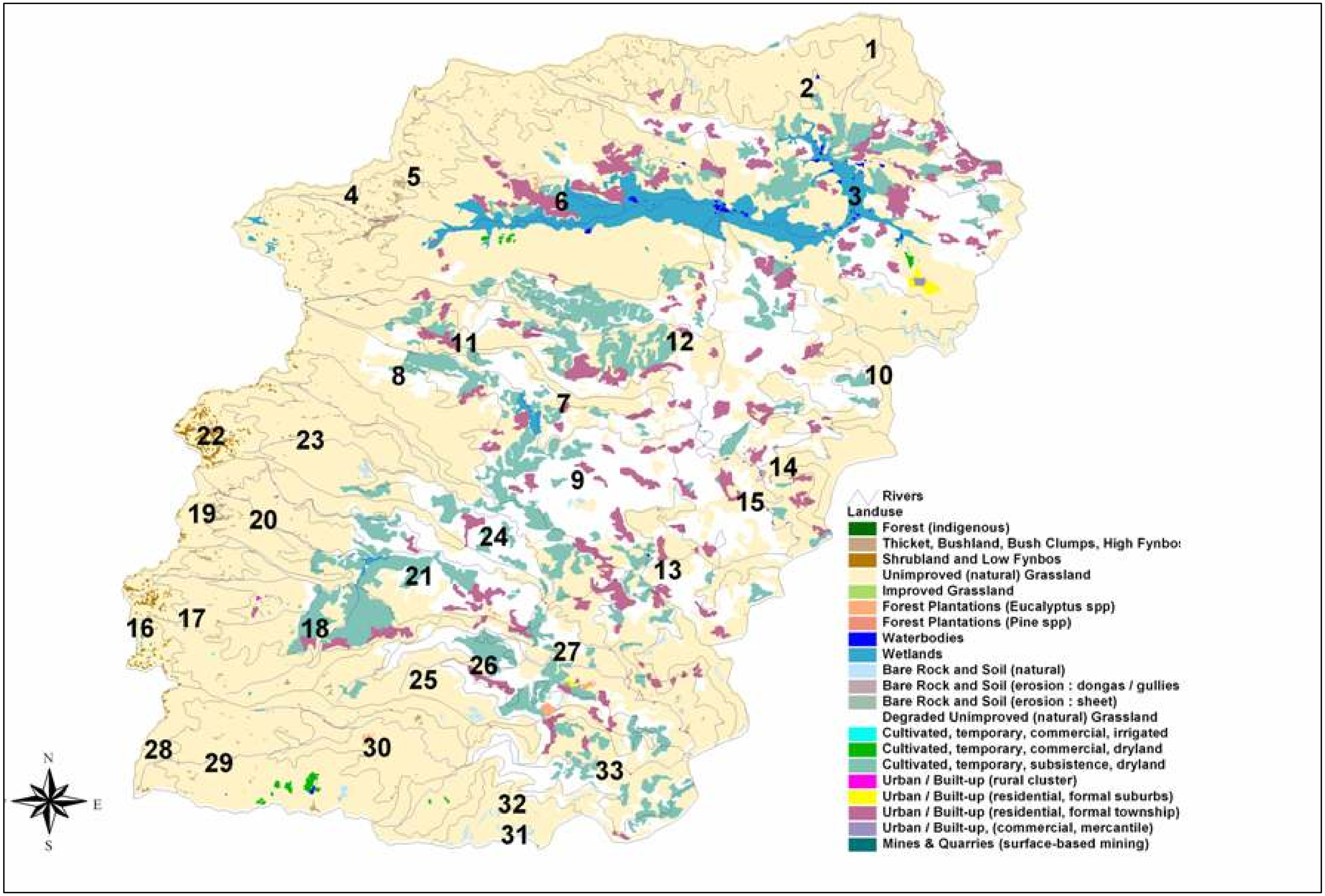

Figure 7. Present (2001) land use in the Umzimvubu catchments (NLC, 2005)

2.4.5. Veld Management Decisions for Hydrological Simulations

Based on the evidence provided above and on the experimental knowledge of grassland ecologists (e.g. Everson and Everson, 2007; pers com), "present" and "attainable" veld management scenarios were developed for the Upper Thukela and Umzimvubu catchments.

Upper Thukela

For the "present" veld management scenario in the Upper Thukela the upper Quinaries are assumed to be in 100% condition of their natural state as represented by Acocks' (1988) natural vegetation classification, i.e. veld is well managed with barely any grazing, and this largely due to inaccessible steep terrain; the middle Quinaries have their natural vegetation in a 70% condition, i.e. that they are lightly grazed but not overgrazed; while the accessible lower Quinaries are heavily overgrazed, with the condition of their respective Veld Types consisting only of the 15% of surface cover of grass tufts which remain after overgrazing (Figure 8, left). In all Quinaries an annual early winter (June) burn is taken as the norm. Once rehabilitated, the "attainable" veld management scenarios (Figure 8) envisage a 100% condition (i.e. well managed) of the respective baseline grasslands in all Quinaries, with a spring burn only every second year, as recommended by ecologists and practised by Ezemvelo KZN Wildlife.

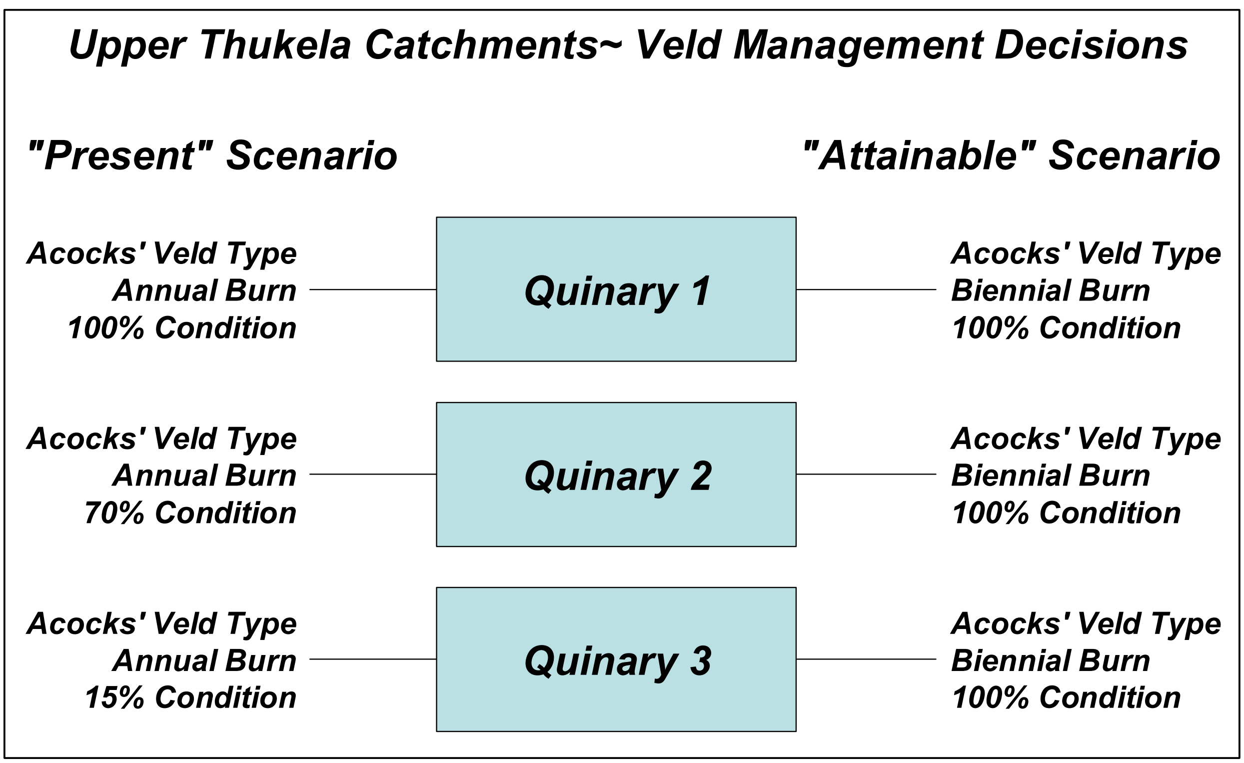

Figure 8. Veld management decisions for hydrological simulations in the Upper Thukela catchments

Umzimvubu

The Umzimvubu veld management scenarios are somewhat more complex. First, a distinction is made between those areas under "*natural grasslands*" (green boxes in Figure 9) vs those identified by satellite imagery as already being "*degraded natural grassland*" (pink boxes in Figure 9), which are assumed of such a large area that it would not be possible to rehabilitate using market based instruments. Under present conditions the *degraded natural grassland* of the respective natural vegetation represented by Acocks' (1988) Veld Types in all three Quinaries of all Quaternaries are at the 15% condition due to overgrazing and, additionally, are subject to an annual early winter burn. The areas currently under *natural grassland* (and not already degraded) are lightly grazed (i.e. 70% condition) in the upper Quinaries, but totally overgrazed in the middle and lower Quinaries (Figure 9), in addition to being subjected to annual June burns. The Umzimvubu experiences greater resource use pressure than the Thukela, in the lower and middles quinaries due to generally lower altitudes of the Umzimvubu quinaries. Considered "attainable" for the *natural grasslands* (i.e. those not yet degraded) in the Umzimvubu area would be a 100% veld condition (essentially no grazing) in the upper Quinaries, with a 70% condition (controlled grazing) in the middle and lower Quinaries (Figure 9; right, in green). However, for the already *degraded natural grassland*, which is in such a poor state, it is not considered practical to rehabilitate, and thus remains in a heavily degraded 15% condition (Figure 9; right, in pink).

The daily time step *ACRU* model (Schulze, 1995 and updates) was selected as an appropriate simulation tool with which to make the above assessments as it can distinguish explicitly, through its internal representations of hydrological processes, between the generation of stormflows, baseflows, total sub-catchment and accumulated flows, as well as sediment yields, on a daily/event-by-event basis for the various land management scenarios sketched above. A summary of results are presented in below, with all results being tabulated on a month-by-month and annual basis for median and drought year conditions in appendices to the full report, which also contains more maps than shown below.

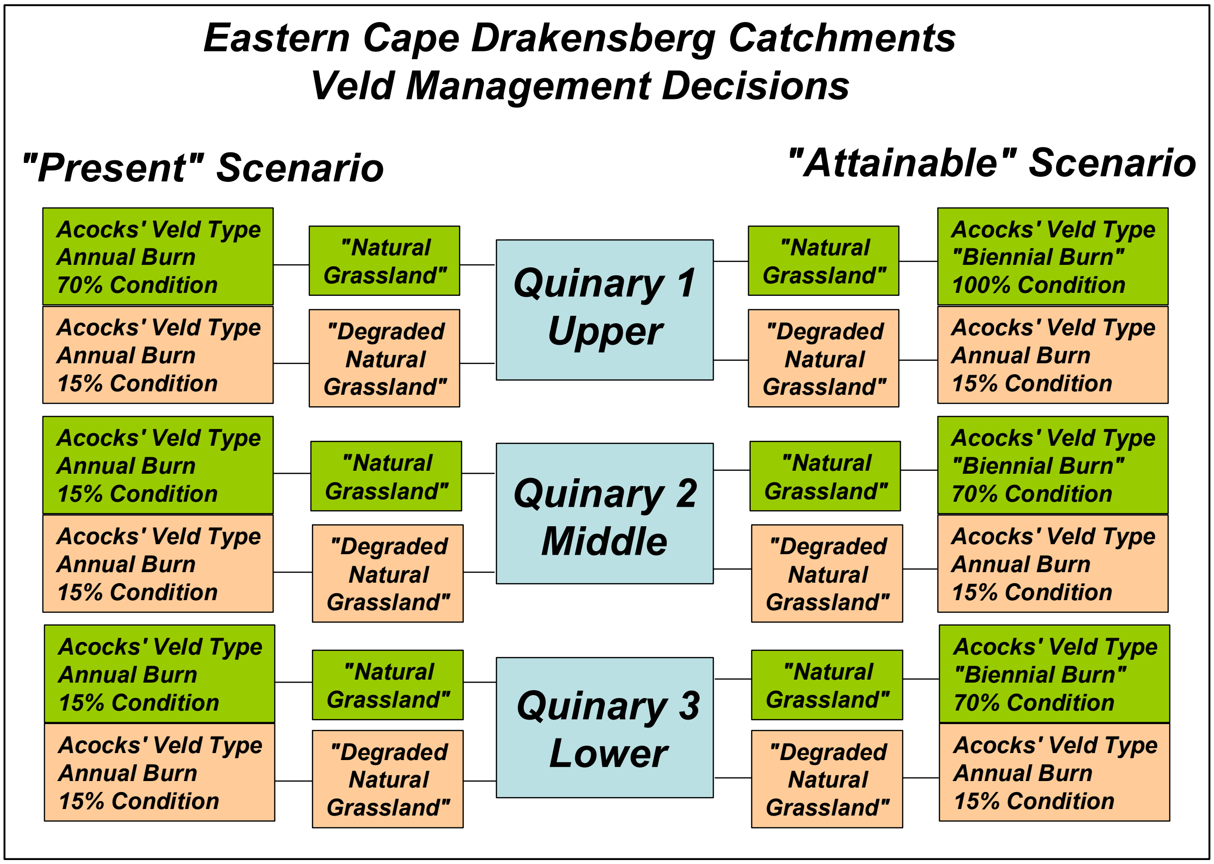

Figure 9. Veld management decisions for hydrological simulations in the Umzimvubu catchments

2.5. Results 1: Changes in accumulated stormflows due to degradation

Upper Thukela

- Overall, the present state of degradation results in a slight reduction of accumulated annual streamflows at the exit (Quinary 27) of the Upper Thukela catchment (Figure 10).
- Some of the degraded lower Quinaries within certain Quaternaries display increases in annual streamflows, however, as would be expected where communal grazing is the dominant land use and the stormflow component of total streamflow is enhanced due to overgrazing.
- If the veld in the Upper Thukela were to be rehabilitated as envisaged in Figure 8, the slight increase in accumulated flows at the catchment outlet would be equivalent to only 0.40% in 1:10 drought years, increasing to 0.73% in median and 1.56% in 1:10 wet years.
- Although seasonal flows change substantially, the overall annual flows change very little due to degradation.

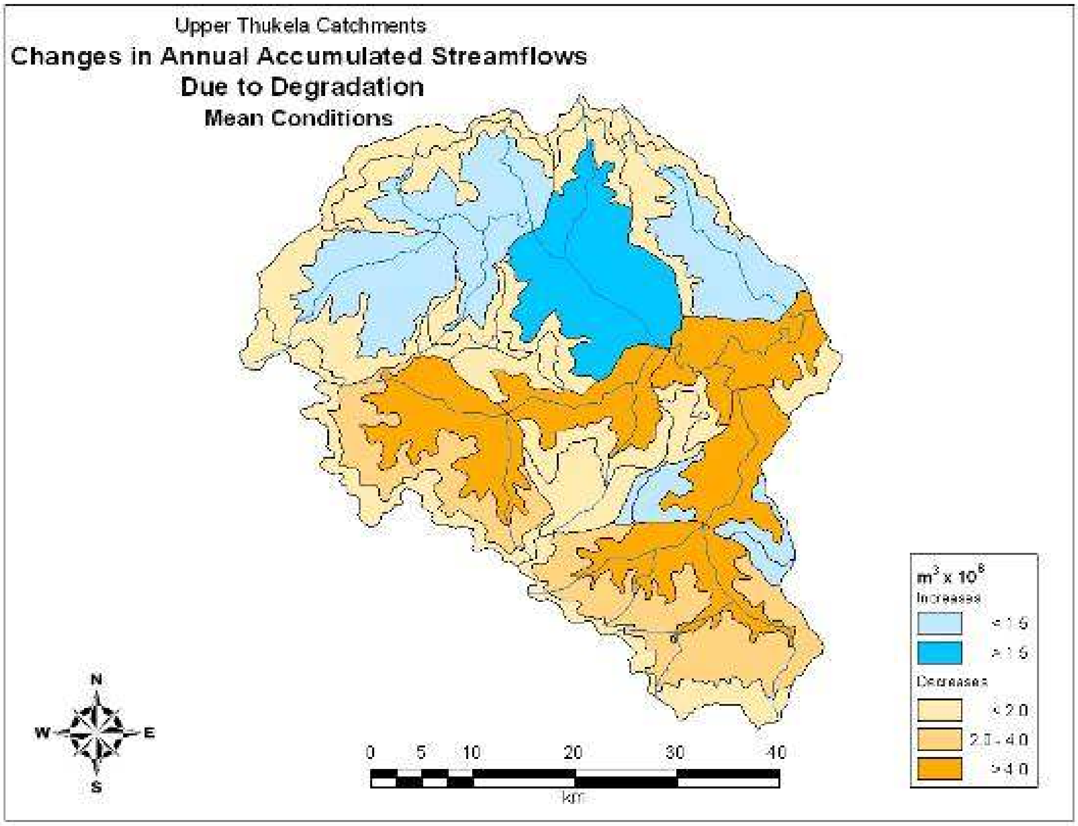

Figure 10. Changes in median annual accumulated streamflows due to degradation in the Upper Thukela catchments

Umzimvubu

- In contrast to the Upper Thukela, the Eastern Cape catchments display an overall increase in annual accumulated flows as a result of prevailing burning/ grazing regimes (Figure 11).
- The proposed veld rehabilitation would therefore decrease the overall annual accumulated flows, and this differently in the more northerly Kinira sub-catchment T33 (by ~7.9%, 4.7% and 4.3% in dry, median and wet years respectively) than in the more southerly Tina sub-catchment T34 (by ~11.1%, 4.7% and 3.9% respectively in dry, median and wet years)
- Rehabilitation would similarly decrease high season accumulated flows in January, by ~ 21.3%, 4.2% and 3.3% in dry, median and wet years respectively in the Kinira sub-catchment vs somewhat higher 26.1%, 6.6% and 4.3% respectively in dry, median and wet years in the Tina sub-catchment.
- However, the proposed improved management is simulated to increase July low season accumulated flows in the Umzimvubu catchments significantly, by ~ 17.9% in median and

7.0% in wet years in the Kinira sub-catchment and by 11.8%, 27.3% and 18.3% respectively in dry, median and wet years in the Tina sub-catchment.

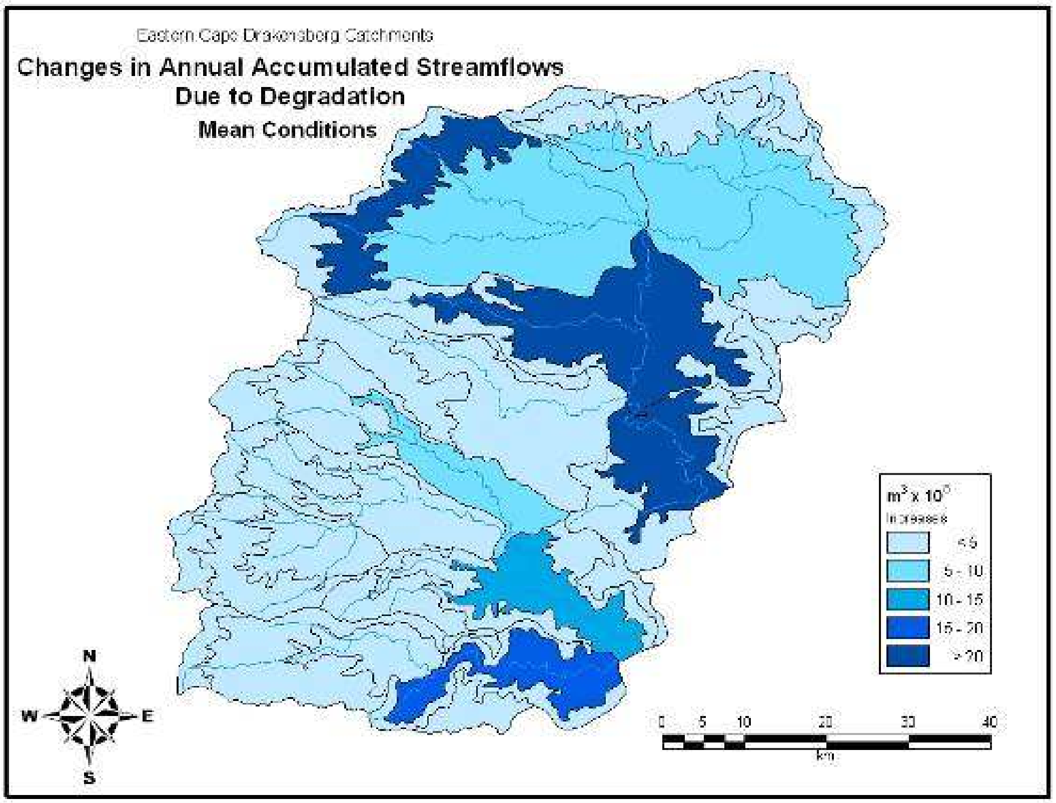

Figure 11. Changes in median annual accumulated streamflows due to degradation in the Umzimvubu catchments

2.6. Results 2: Changes in sediment yields due to degradation

Upper Thukela

- The increases in sediment yields under degraded conditions are significant (Figures 12a and 12b), with an overall mean annual increase at the catchment exit at Quinary 27 being equivalent to ~95%, and ranging from a 71% increase at Quinary 15 to 142% at Quinary 9.
- January (high flow season) mean increases are higher still at ~118% at Quinary 27, but display a narrower range from 109% to 135%.
- What is clearly evident from Figures 12a and 12b is that the biggest changes (increases) in sediment yield due to degradation occur in the lower Quinaries where overgrazing has reduced veld to a 15% cover condition.

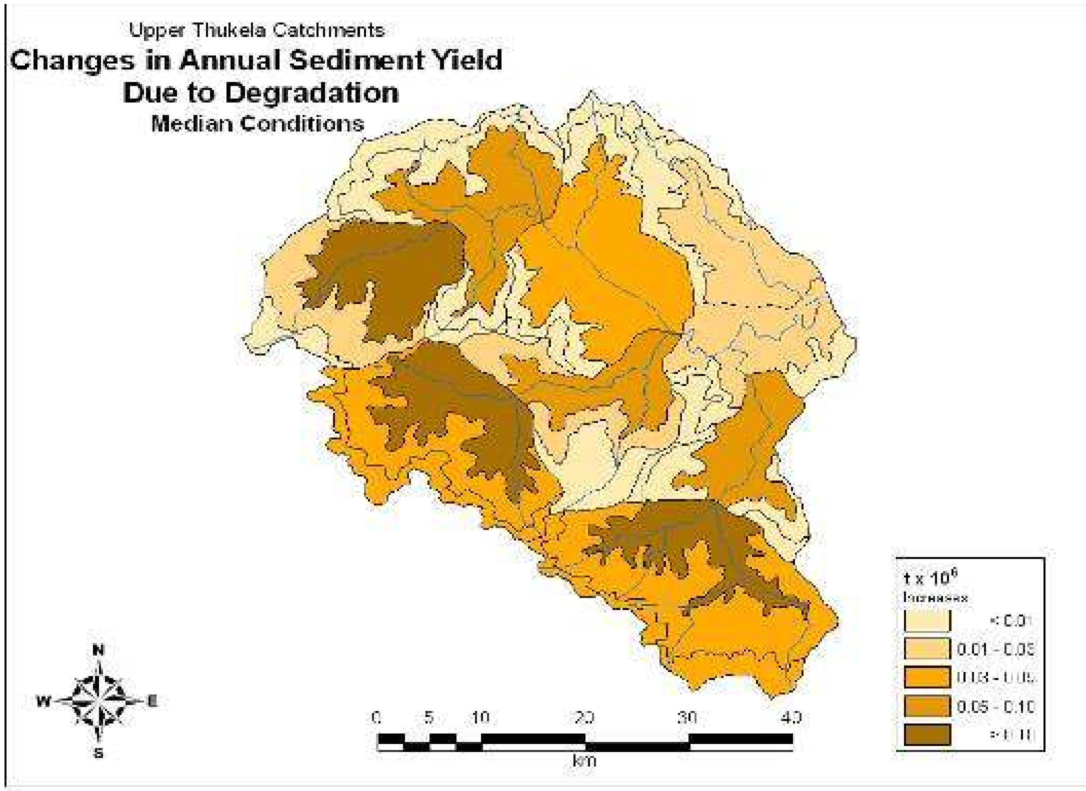

Figure 12a. Changes, due to degradation, in median annual sediment yields in the Upper Thukela catchments

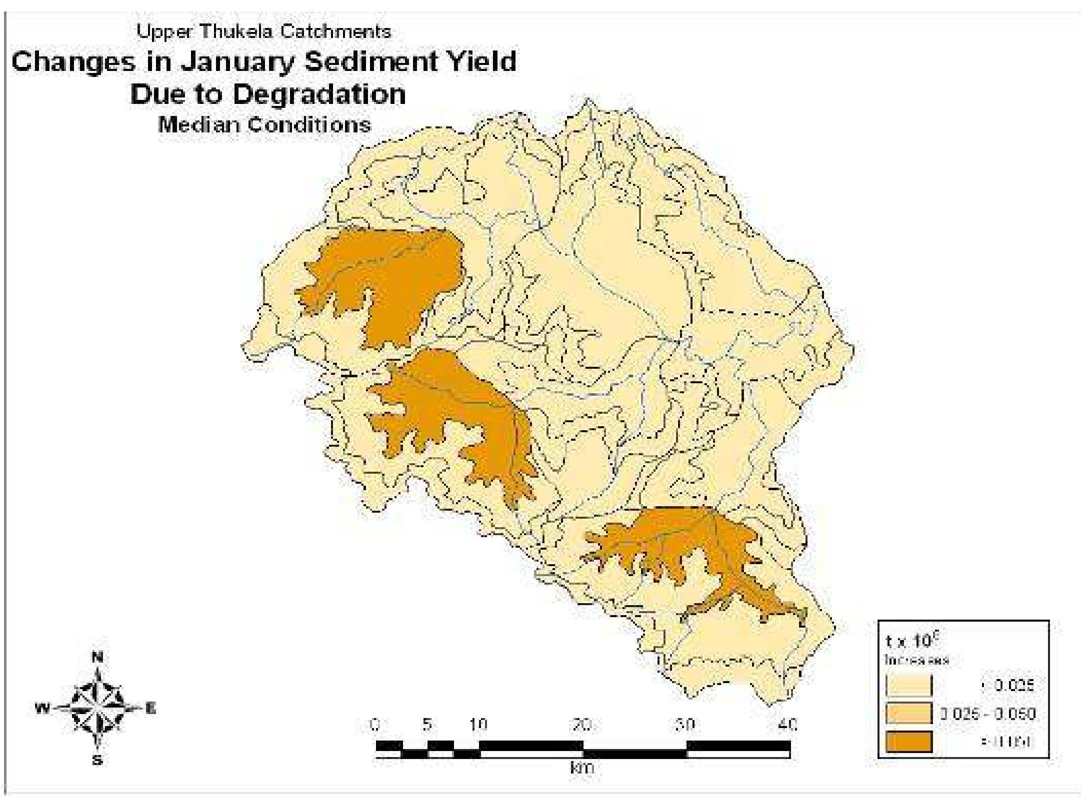

Figure 12b. Changes, due to degradation, in median January sediment yields in the Upper Thukela catchments

Umzimvubu

- As was the case in the upper Thukela catchments, the increases in sediment yields under degraded conditions in the Umzimvubu are significant (Figures 13a and 13b), with an overall mean annual increase at the Tina catchment exit at Quinary 33 being ~98%, and ranging from a 77% increase at Quinary 27 to 112% at Quinary 12.
- Contrary to the case in the Upper Thukela, January (high flow season) mean increases in the Eastern Capes' sediment yields are lower than annual increases at ~84% at Quinary 33, and they display a relatively narrow range from 67% to 105%.
- Again in contrast to the Upper Thukela, July's (low flow season) percentage increases in sediment yields are surprisingly low not only in absolute terms, but also in relative terms, at only 65% at the Tina sub-catchment exit at Quinary 33.
- The high degree of degradation in all Quinaries in the Umzimvubu catchments implies that, unlike the case in the Upper Thukela, the lower Quinary does not stand out as being more degraded than the middle and/or upper Quinaries.

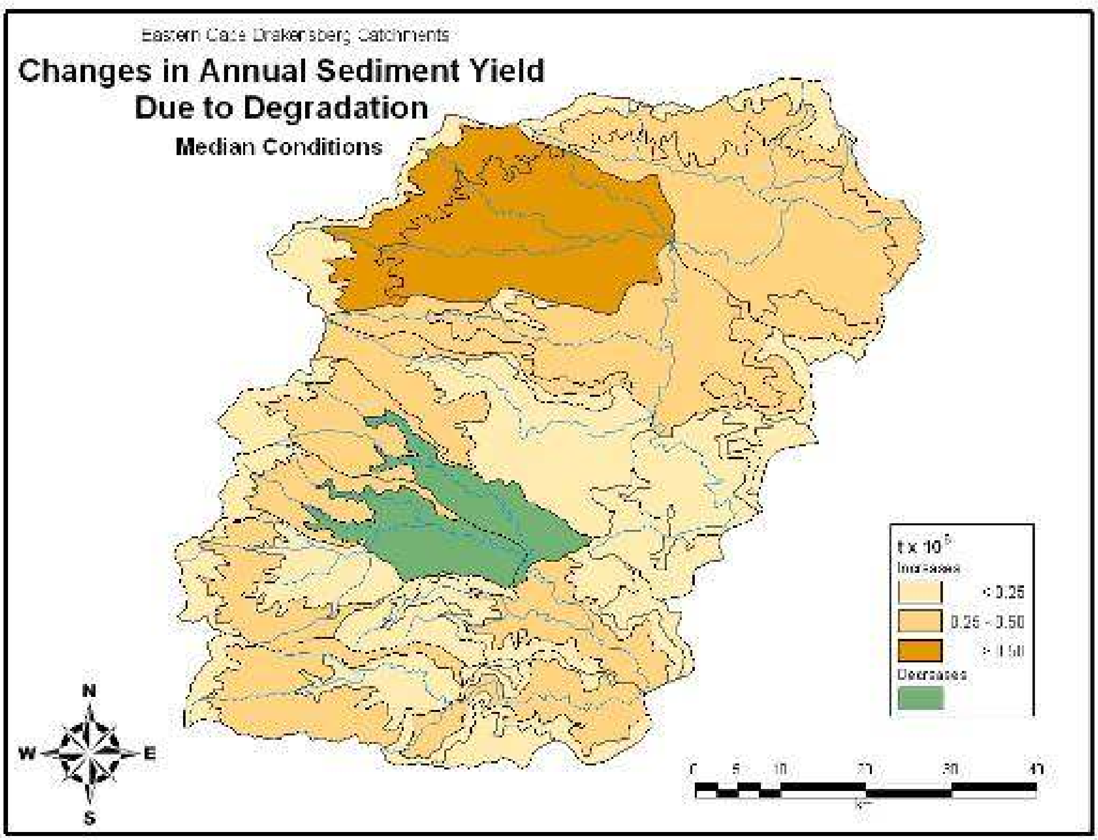

Figure 13a. Changes, due to degradation, in median annual sediment yield in the Umzimvubu catchments

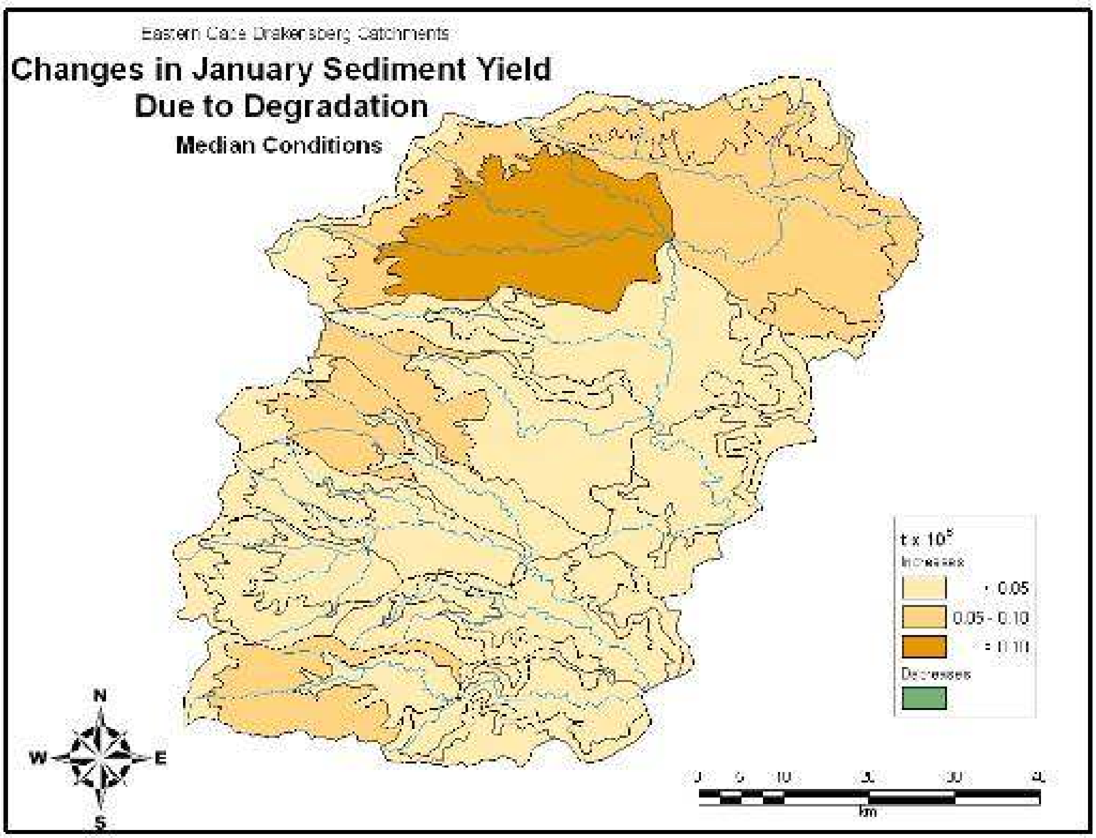

Figure 13b. Changes, due to degradation, in median January sediment yield in the Umzimvubu catchments

2.7. Results 3: Changes in baseflows due to degradation

It was shown above that changes to long term annual flows accumulated downstream, as a result of degradation due to veld burning and overgrazing, were very slight and negative, in the Upper Thukela catchments while being higher, and positive, in the Umzimvubu catchments, but with the enhanced runoff also evident in the high flow summer months being reversed in the low flow winter months. These complex patterns are explained by analysing the two major components that make up total flows, *viz*. baseflows and stormflows, since it is hypothesised that both burning and overgrazing would have opposing effects on these two components in that

- stormflows would be increased as a result of a combination of either temporary/seasonal reductions (in the case of burning) or year long reductions (in the case of overgrazing) in above-ground biomass and on-the-ground cover (or land cover). Furthermore, trampling and the possible creation of a hydrophobic soil surface layer, all of which tend to reduce the infiltrability of rainfall into the soil and encourage surface runoff, at the expense of
- baseflows, which would be diminished as their generation is dependent on infiltration and the redistribution of water through the soil profile into the groundwater zone under

"saturated" conditions (Without the upper soil layer being saturated, percolation into lower layers which in generate baseflow will not occur).

Upper Thukela

- In contrast to annual accumulated streamflows, baseflows show a distinct reduction (Figure 14) as a consequence of degradation by a combination of annual burning and different degrees of overgrazing.
- These changes are particularly severe in the lower Quinaries, which are the most degraded with only a 15% basal cover left, and also in the more westerly high altitude areas where the effects of degradation are exacerbated by a higher rainfall regime (Figure 14). Thus, for example, high rainfall Quinaries 3, 6 and 9 have annual reductions in baseflows of 27%, 36% and 32% respectively, while Quinary 27, in the lower rainfall east, has an annual baseflow reduction of only 14% (calculated from tabulated appendices).
- Rehabilitation of veld by reduced stocking rates and biennial spring burning, as outlined in the "attainable" management scenario in Figure 8, would therefore certainly result in more sustained low season flows.

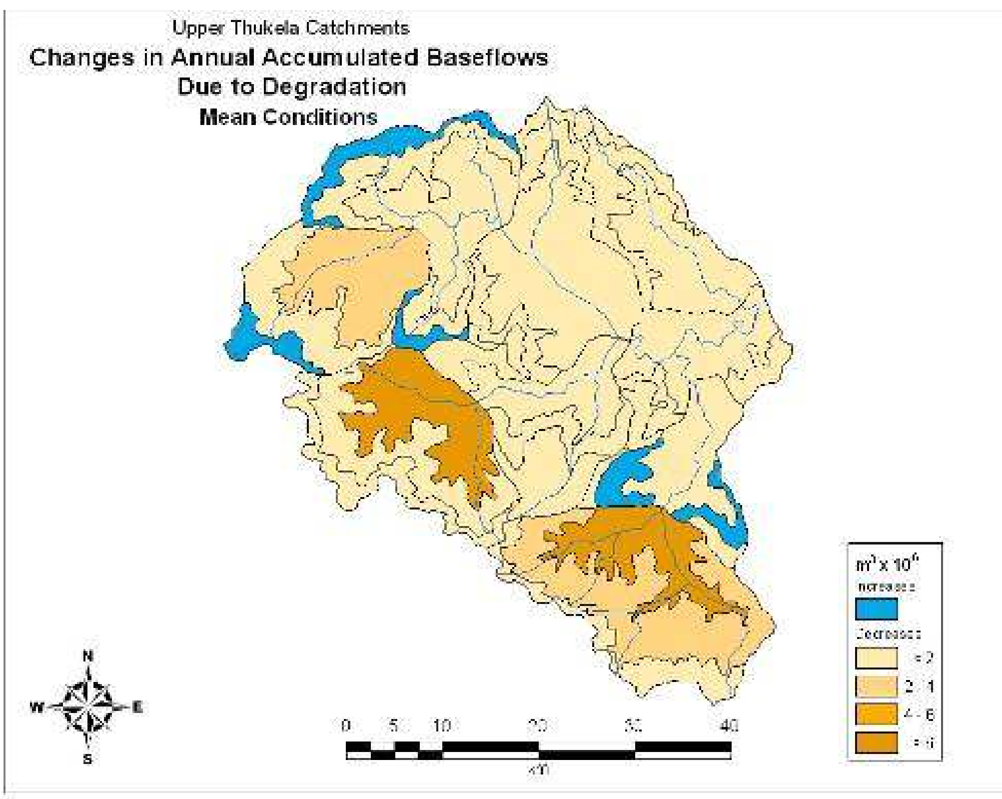

Figure 14. Changes, due to degradation, in median annual baseflows in the Upper Thukela catchments

Umzimvubu

- The Umzimvubu catchments distinguish themselves from those of the Upper Thukela in that
  - they display a higher degree of degradation of their natural veld with even the middle Quinaries already at only a 15% veld condition (Figure 9), and
  - they contain significant areas so badly degraded (Figure 9) that it is postulated that they are not readily rehabilitable .
- Nevertheless, the overall trend is for a reduction in baseflows with degradation (Figure 15), but at lower magnitudes than in the Upper Thukela because the degraded areas already generate low baseflows and the level of attainable rehabilitation is considered lower in the Eastern Cape catchments.
- From values given in the tabulated hydrological data as discussed in section 2.4.4, Quinaries 3, 6, 18, 24 and 33 showed reductions in simulated baseflows with degradation of 4%, 14%, 10%, 6% and 6%, respectively, with the reductions dependent *inter alia* on the proportions of natural veld in the Quinaries.

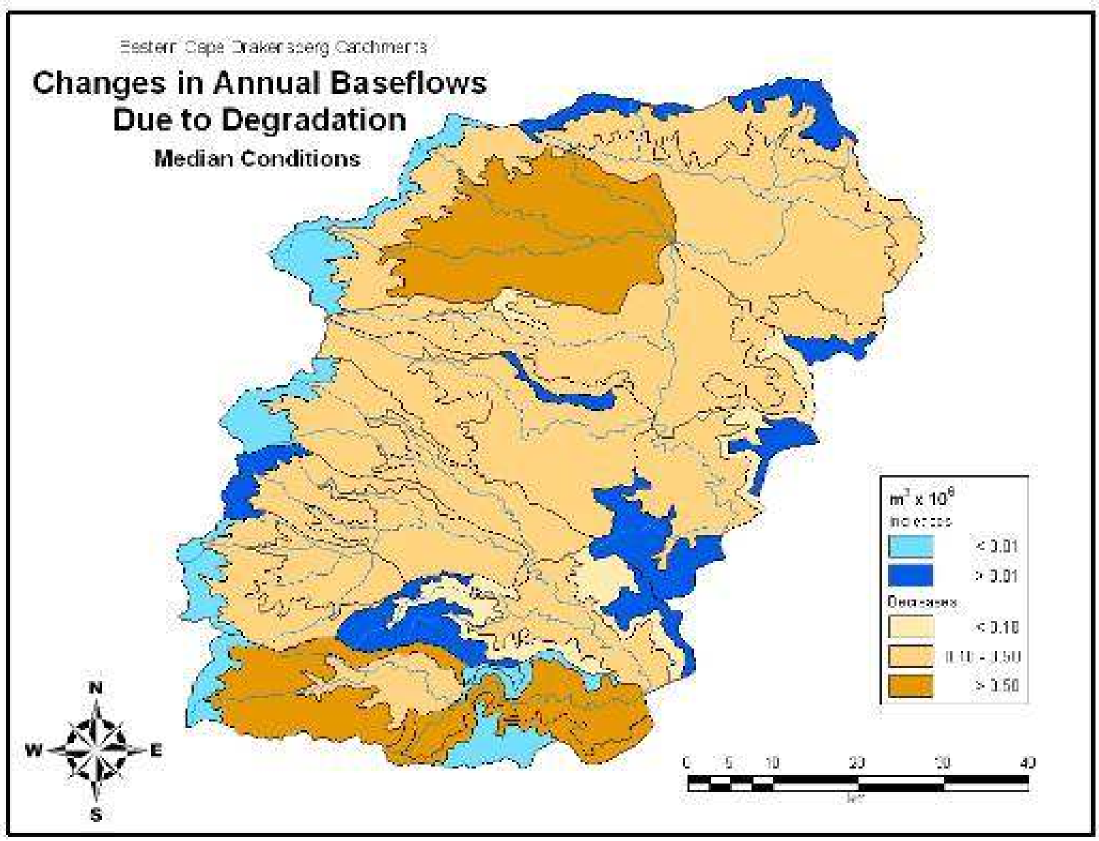

Figure 15. Changes, due to degradation, in median annual baseflows in the Umzimvubu catchments

2.8. Results 4: Changes in stormflows due to degradation

Upper Thukela

- Stormflows, in contrast to baseflows, are shown in Figures 16a and 16b to be significantly enhanced (vs diminished, as in the case of baseflows) as a consequence of degradation through annual burning and overgrazing, as would be expected with reduced canopy and ground cover.
- Again, the effects are shown to be most pronounced in the lower Quinaries where degradation is most severe, particularly when expressed as percentage changes.
- From calculations using the values in the relevant tabulated Appendices, lower Quinaries 3, 6, 9, 24 and 27, for example, show respective increases of median annual stormflows with degradation of 33%, 32%, 39%, 33% and 21%. Part of the variation in these percentage enhancements is explained by different Quinaries having different proportions of natural veld, which are the only land use assumed to be impacted by burning and overgrazing.
- In the case of the driest year in 10 the increases in stormflows are even more drastic, with the respective increases to Quinaries 3, 6, 9, 24 and 27 being 72%, 66%, 95%, 70% and 48%.
- Increased stormflows through degradation are a feature especially of the rainy summer season and this is borne out by patterns in the January map mimicking those of the annual map (cf. Figure 16a and 16b).

Umzimvubu

- While Figure 17 shows general increases in absolute values (m^3) of median annual stormflows under degraded conditions (as expected), when converted to percentage changes it is the middle Quinaries that tend to be more highly impacted than the lower ones. Thus, for example, for Quinaries 2 vs 3 the respective increases calculated from values given in the relevant appendix are 30% vs 15%, for 5 vs 6 they are 18% vs 13% and for Quinaries 17 and 18 they are 21% and12%.
- Under hydrologically dry conditions, i.e. the 1:10 dry year, impacts tend to be higher still, with the 30% increase in median stormflows from Quinary 2 changing to 44% or the 15% from Quinary 3 to 22%.
- Changes in stormflow responses to degradation are lower than in the Upper Thukela catchments as a result, inter alia, of higher percentages of non-rehabilitable degraded areas.

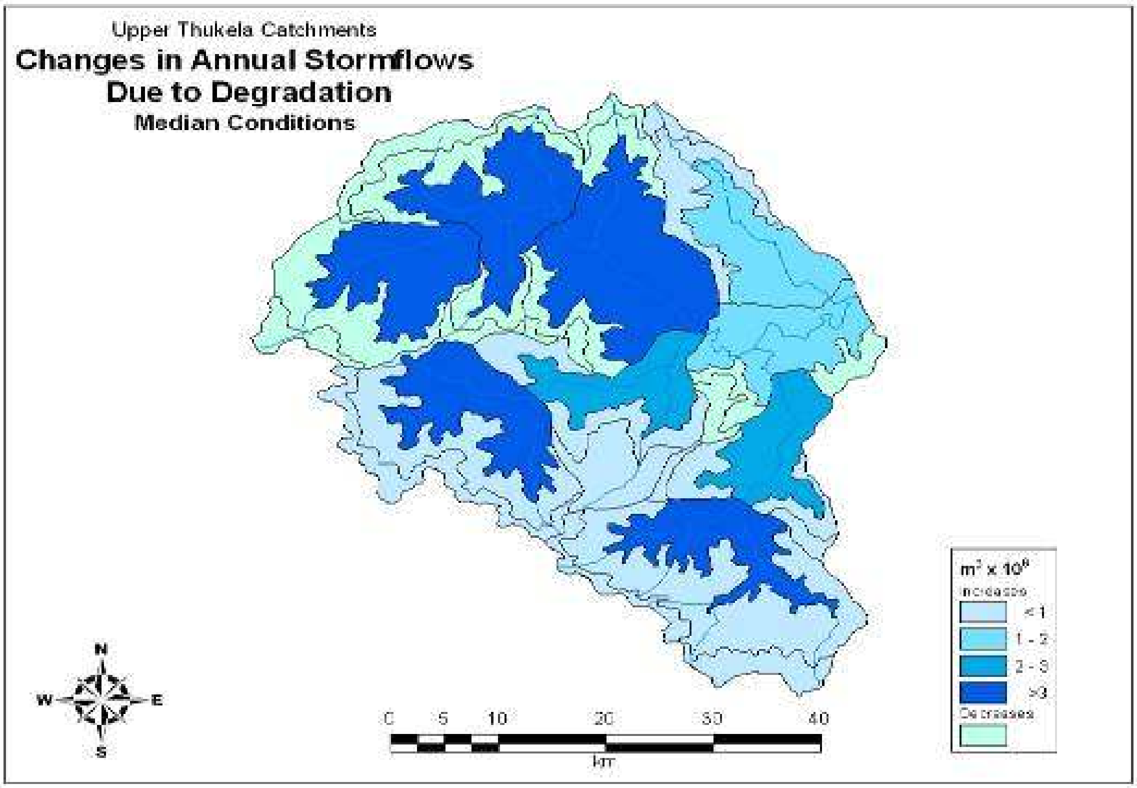

Figure 16a. Changes, due to degradation, in median annual stormflows in the Upper Thukela catchments

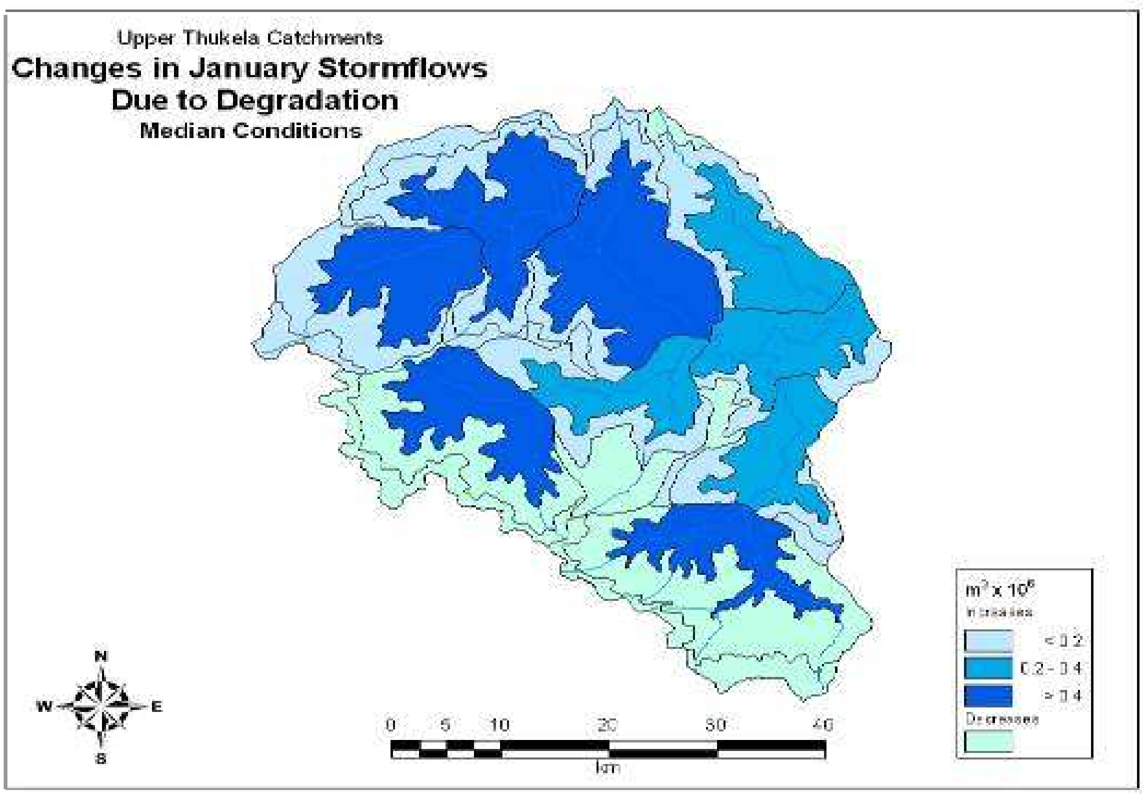

Figure 16b. Changes, due to degradation, in median January stormflows in the Upper Thukela catchments

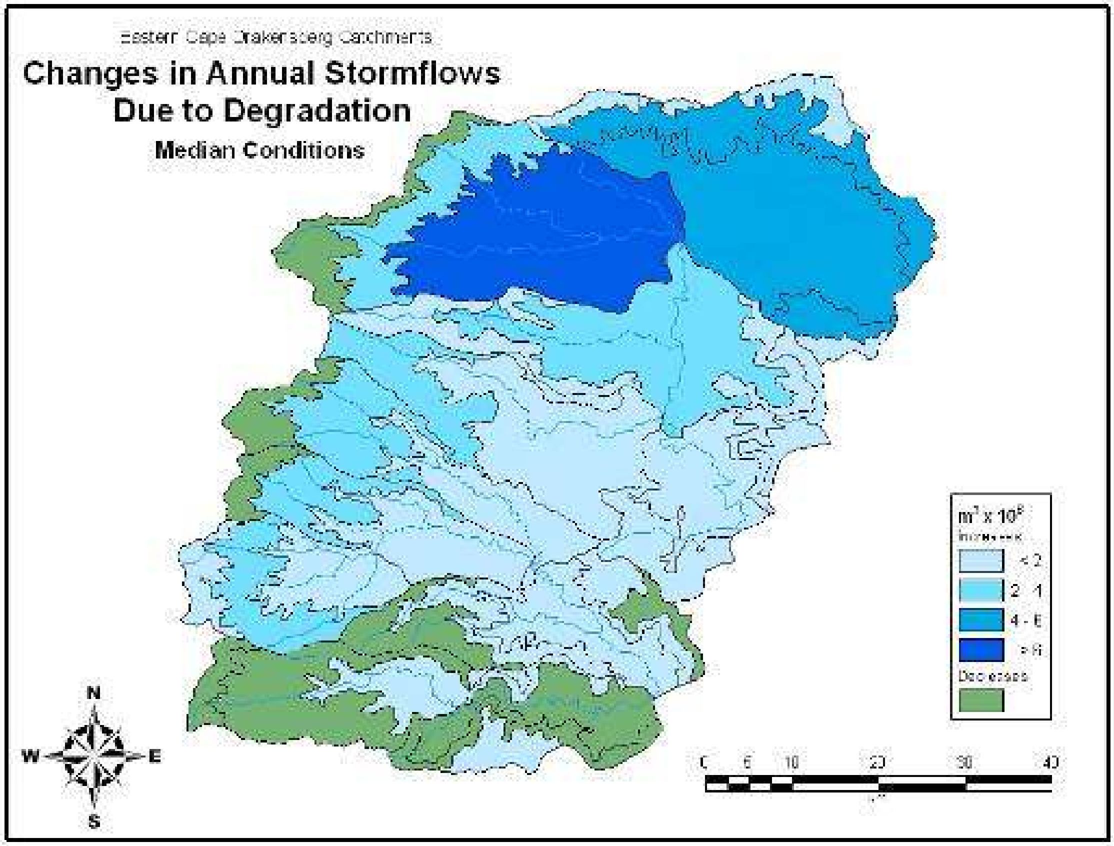

Figure 17. Changes, due to degradation, in median annual stormflows in the Umzimvubu catchments

2.9. Overall conclusions

This study has clearly shown that the management of upstream land uses can have marked influences on downstream hydrological responses, not necessarily so much in terms of changes in overall annual streamflows, but rather in changes in the components of streamflow, *viz*. baseflows and stormflows, as well as in higher order hydrological responses such as sediment yields.

However, sweeping conclusions such as those above need to be made with great caution, as marked differences in responses became evident in this study between

- the two regions, viz. the Upper Thukela and the Eastern Cape catchments, as a result primarily of different macro-climatic and land use regimes,
- the Quaternary Catchments making up the respective study areas, for the same reasons as above,

- the upper, middle and lower Quinary Catchments making up each Quaternary, each with their unique present land uses and their proposed "attainable" rehabilitated levels of land management,
- annual vs high flow season vs low flow season responses, and
- the proportions and levels of present burning and grazing management, in each Quinary, of the affected land uses for this particular study, viz. unimproved grassland and already degraded areas.

With prevailing veld burning and overgrazing regimes in the Upper Thukela, it was found that the combination of changes to the above- and ground level biomass (or basal cover) reduced baseflows significantly, particularly in the lower, more degraded Quinaries, while in the Umzimvubu the reductions were less severe. Stromflows, on the other hand, were enhanced significantly through mis-management of grassveld, with increases being relatively more pronounced in hydrologically dry years. A marked difference between the Upper Thukela and Umzimvubu catchments was, however, that in the former it was the lower Quinaries that displayed most marked increases while in the former it was the middle Quinaries. Sediment yields were found to be particularly sensitive to degradation of grasslands, with a close to doubling of annual accumulated sediment yields.

This detailed hydrological study on two contrasting catchments has set the scene for resource economists to

- assign monetary values to questions relating to downstream water beneficiaries being willing to pay/reward upstream land users for environmental stewardship in managing their land better for more sustained/cleaner water production, as well as to
- evaluate whether benefits can be sustained and trade-offs will be fair.

Furthermore, the hydrological modelling in conjunction with the grassland management optimisation evaluation, has also identified an outcome of management that can be measured – basal cover. Basal cover is a direct function of management effectiveness and is also a direct driver of hydrological processes, and therefore constitutes a potential common currency for the payment system.

3. THE ECONOMIC MODELLING OF ECOSYSTEM SERVICES TRADE

3.1. Introduction

This section provides the description and findings of an integrated hydrological, ecological restoration, and economic model for the upper Thukela and upper Umzimvubu catchments. This model offers an answer to the hypothesis that:

> *a land use management change that improves the quality and quantity of basal cover can generate job opportunities and provide a suite of ecosystem services simultaneously.*

To answer this hypothesis, the model uses and integrates the results from the ACRU-hydrological model of the University of KwaZulu-Natal, combined with an evaluation of appropriate veld management regimes to enhance basal cover - supported by evidence from an ongoing restoration project in the area (funded by Working for Water at Okhombe) - with an assessment of management and restoration costs as well as the willingness to accept compensation to change land use practices, and the economic value of the benefits of such change. This integration allows for the estimation of Unit Reference Values (URVs), which is the present value of the cost of intervention over the project life-cycle divided by the present value of the benefit of the project over the project life. This indicator is selected since it is one of the key indicators used by especially the water engineers of the Department of Water Affairs and Forestry (DWAF) in deciding the economic feasibility or not of investing in the construction of a dam. Here, however, the indicator is applied not to manufactured capital but the restoration (capital investment) and management (annual operation and maintenance) of natural capital to produce a suite of ecosystem goods and services. These services include, among others, an improvement of the baseflow during especially the winter months, additional carbon sequestration – both above and below ground – and the reduction, or avoidance, of erosion and hence sediment production. The section commences by discussing the model structure and the data required where after it provides a summary of the results followed by a section discussing the implantation pathway and recommendations.

3.2. Background

Improved land use management - which here implies land use management that improves the condition of grasslands - improves the water retention capacity of the land. A robust basal cover, together will a dense canopy, promotes greater infiltration and reduced storm flow, and increased soil water storage. Such improved water retention capacity allows for the slow release of such retained water over time. Improved land use management will reduce stormflow reduce soil erosion – and hence siltation. An additional benefit is that there would be a higher carbon sequestration capacity of the area under management. Also, the reduction in soil erosion is likely to lead to a reduction in, or avoidance of, soil-carbon loss. It goes without saying that such intervention will, per definition, combat desertification and could lead to an increase of other secondary economic activities such as tourism, as well as securing the delivery of other ecosystem services such as medicinal plants.

A further benefit of such management could, if done according to conventional practices of ecological restoration, promote biodiversity and biodiversity conservation in general. The multiple benefits following the restoration of natural capital can perhaps best be understood by citing the three international Conventions (the three-Cs) that emerged from the 1992 Rio de Janeiro World Summit on Sustainable Development: The United Nations Framework Convention on Climate Change (http://unfccc.int), The Convention on Biodiversity (http://www.cbd.int), and the Convention to Combat Desertification (http://www.unccd.int). The 'three Cs' are intimately interlinked and should be seen as a cluster, or package (http://ahjwg.chem.unep.ch) (Figure 18). All three will certainly require investments in time, energy, and financing to succeed, but if one designs a programme toward achieving the objectives of one, such a programme could achieve a number of multiple objectives, including those of the other programmes. Indeed, holistic ecological restoration (Clewell and Aronson 2007) offers a unique opportunity for the "three Cs" to converge and be mutually reinforced by such a strategic alliance. It is noteworthy that striving to simultaneously address the objectives of these three conventions would take us a long way forward in contributing and ultimately achieving the United Nations' Millennium Development Goals to overcome poverty at a global scale (http://www.un.org/millenniumgoals).

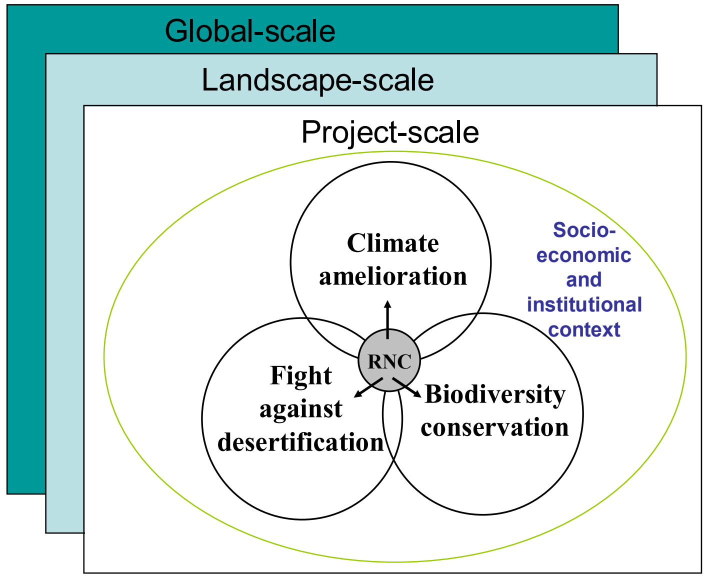

Figure 18. Schematic diagram relating objectives and strategies for ecological restoration in terms of the three Conventions of the 1992 Rio Summit as motivations in a purely conceptual space at various levels. The three arrows converging on a central area marked RNC (Restoring Natural Capital) in the centre of the figure indicate the need for integration and synergy among activities that relate to the "three Cs". The three conventions are obviously not the same in nature or in scope. The fact that all three are depicted by circles is merely for purposes of presentation. (Source: Blignaut, Aronson, Mander and Marais, in review).

Land use management intervention towards improving the state of the natural capital - the degree of basal cover in this respect - has therefore various hydrological and ecological benefits, but, additionally, also economic. The improved water retention capacity implies:

- an improvement in baseflow during the low flow (winter) months,
- a reduction in siltation - so dams can work longer,
- a potential reduction in flood damage costs due to a reduction in stormflow,
- carbon storage,
- improved biodiversity with more and better quality vegetation, and
- increased economic production through an increase in natural products, grazing and tourism.

The challenge therefore is to integrate the management intervention - with its desired ecological outcome - with the change in baseflow and with the cost and the benefits of such a change in land use management. To our knowledge such an integrated model has not yet been developed for South Africa. The rest of this report discusses the structure, assumptions, and outcome of this model as well as resulting recommendations.

3.3. The Model Structure

This integrated hydrological, ecological restoration and economic model has been developed in MS Excel, as it is a widely used and powerful software application The hydrological data originates from the University of KwaZulu-Natal's ACRU-model, research on veld management and run-off (Everson & Everson, 2007), research conducted concerning the cost of land use management (van Niekerk et.al., 2007), and the value of the respective economic benefits flowing from the intervention (Blignaut & Mander, 2007). In technical terms, the model aims to estimate a management and restoration Unit Reference Value (URV) that is the cost per R1 benefit following the implementation of a recommended management system. Unit Reference Values are one of the main criteria water planners and engineers in South Africa use when selecting the best site for developing a new dam (manufactured capital) (Blignaut, 2007). The logic behind this integrated model is that the restoration of natural capital (or the capital component of the intervention), and the maintenance of natural capital (the operation and management component of the intervention), is comparable to that of building a dam and hence it is possible to estimate a management-URV. Unit Reference Values can be, and in this case are, estimated for various catchment management options within the upper Thukela (188,000ha) and the upper Umzimvubu (397,000ha). Each catchment can be subdivided into quaternary catchments – 9 for the upper Thukela and 11 for the upper Umzimvubu – and each quaternary catchment into 3 quinaries each based on elevation. That implies that this model distinguishes geographically between 27 quinaries in the upper Thukela and 33 quinaries in the upper Umzimvubu. It is possible, and indeed was the case, to treat all 60 quinaries differently given their different geographic features.

The model structure is presented in Figure 19, indicating all the variables where the "+" and "-" signs indicate the correlation between two variables. Provided in the red circles are the management interventions, which, in this case, are assumed to be grassland restoration – the reseeding of denuded areas – donga restoration through the construction of gabions and otherwise, fire and stock management to ensure rotational grazing and a biennal spring burn. This management change will lead to a range of beneficial ecological impacts, highlighted in the light green boxes. They are an improvement in basal cover, improved grasslands and riparian ecosystem functioning and soil carbon storage through both the avoidance of top-soil loss and the increase in above ground biomass' ability to generate soil carbon – which is the most notable carbon sequestration service of grasslands (CSIR pers comm. 2007). Following the improved basal cover there are a range of beneficial hydrological impacts – indicated by the blue boxes. These are improved infiltration, and the reduction in stormflows, an improvement in baseflow during winter months and a reduction in sediment yield. These positive hydrological and ecological impacts have a range of beneficial economic implications, indicated by the black boxes. These include a reduction in flood damage, a reduction in dam sedimentation, which leads to a reduction in cost of managing the dam infrastructure. Additionally, the improvement in the baseflow leads to improved or sustained economic activity, which, in turn, leads to more or sustained jobs in the rural areas and hence income for those areas. Secondary economic activities, such as local trading (such as formal and informal sector retailing), services provision (such as herding, child minding, security, traditional healing and thatching) and additional tourism opportunities (such as guiding, accommodation and pony trekking), are also possible but not quantified in the model. These economic impacts have to be made possible through the application of a string of economic instruments, indicated in purple. These are payments for ecosystem goods and services by the beneficiaries of the respective services. In so-doing this market for ecosystem goods and services links the so-called first (formal) to the second (informal) economies of the country. To affect this market institutions are required, indicated in dark green. The main institution is that of a payment for ecosystem services (PES) implementing agency. See Section 4 for a detailed discussion about the institutional framework suggested.

3.4. Input data and assumptions

3.4.1. Landcover and Hydrology

From the national Landsat land cover database, for each of the 60 quinaries in the two case study areas, the quinary size, the area containing degraded grasslands, the area containing dongas, and the total area containing natural grasslands (or natural capital) is fed into the model. From the hydrological model the following data is used:

- the difference in the winter (April-September) baseflow between a poorly managed and a well managed grassland. Poorly managed is defined as an annual winter burning with stocking rates in excess of recommended carrying capacity whereas a well managed practice is defined as biennal spring burning with recommended stock densities and the restoration of degraded areas. The baseline scenario is the "as-is", or before intervention scenario at the median. The alternative scenario is the baseflow after management has been instituted throughout and restoration has been done in degraded areas.
- In like manner, the difference in the sediment yields (for 12 month of the year) between the baseline scenario and the post-restoration and improved land-use management scenario, also at the median. This value constitutes avoided sediment yield given the intervention.

These two values - the change in the baseflow and the change in the sediment yield per quinary as a result of improved land use management - are the two most important inputs to the model.

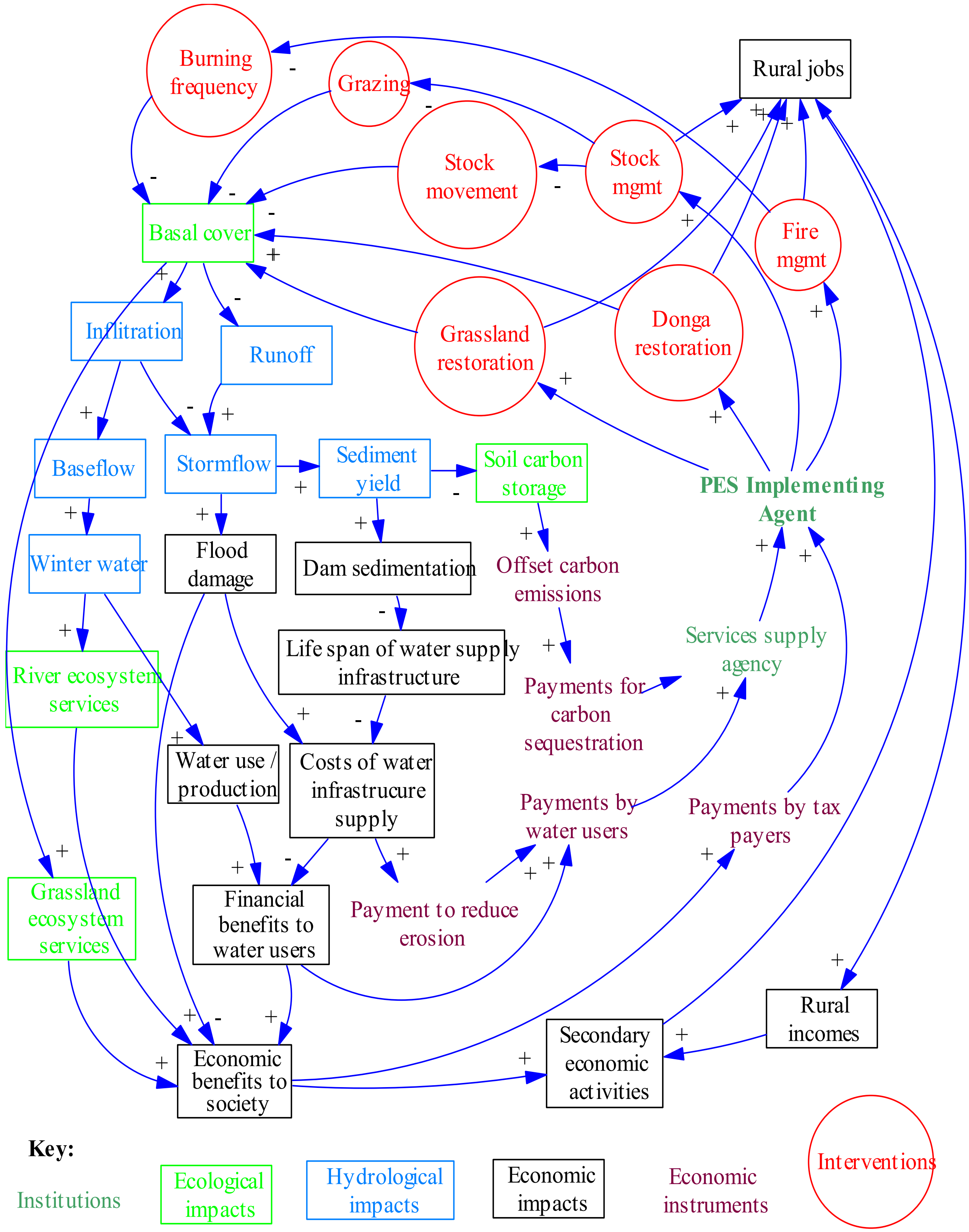

Figure 19. Overview of the model

3.4.2. Options for ecological restoration and land use management change: Assumptions and costs

A distinction is made between the restoration of natural capital – the so-called up-front capital cost component – and the required land use management change – the so-called operation and management expenditures. Restoration is considered first.

Distinction is made between two restoration activities, namely the restoration of erosion gullies (dongas) and the re-seeding of denuded areas. It has been established that it costs R55,500 to rehabilitate a hectare that comprises a condensed donga (van Niekerk et al., 2007). In other words if all the dongas per quinary were to be placed adjacent to one another (i.e. a condensed donga) it will cost R55,500/ha to rehabilitate. Likewise, it will cost R6,200/ha to re-seed areas denuded of vegetation. For the upper Thukela it has been decided that, given the typography of the area and the evidence from the landcover data that indicates no significant degradation in the higher lying quinaries, it has been accepted that for each of the 9 quaternary catchments that rehabilitation will only be required in the bottom quinary of each quaternary. For the upper Umzimvubu the situation is reversed. Given the seriousness and the intensity of degradation that occurs at the 11 bottom quinaries, it has been decided to commence with restoration only in the upper two quinaries of each quaternary unless a bottom quinary, after restoration, is likely to generate an additional baseflow of more than 200,000m^3. Such highly productive but low-lying quinaries contain valuable wetlands and should not be excluded.

The restoration cost for each quinary has been calculated using a decreasing sliding scale. In year 1, restoration cost is assumed to be 100% that of the area size requiring restoration multiplied by the unit value of restoration. Follow-up restoration is required in year 3, at 70% of the cost in year 1, followed by another restoration cycle in year 5 at 30% of the cost in year 1. Restoration is concluded in year 7 by a final level of effort estimated at 10% of the cost in year 1. This decreasing sliding scale borrows heavily on the experience of the Working-for-Water programme in terms of the restoration requirement and the need for follow-ups.

Turning to the operation and management, that is the ongoing land use management intervention required to achieve the improved landcover (which has been restored) or to maintain an existing good land cover. Two interventions are distinguished. First, a change in the fire-regime; the current practise is an annual winter burn, which is changed to a biennal spring burn. This change is brought about by making adequate provision for firebreaks and fire-fighting teams at a cost of R11.7/ha for conservation areas, R18/ha for communal land and R9/ha for land currently under commercial agriculture (van Niekerk et al., 2007). It is assumed that all quinaries, irrespective of elevation or location, need fire management. Second, the implementation of a rotational grazing system in the communal areas of the catchment is at a cost of R19,30/ha (van Niekerk et al., 2007). It is assumed, for the upper Thukela, that the top quinary of each quaternary catchment does not require grazing management due to the slope and the distance from the villages, but the bottom two quinaries do need grazing management.

An overhead cost is added as an additional 20% of all other annual costs.

3.4.3. Economic values: Assumptions and estimates

As mentioned above, restored and intact natural capital can contribute significantly to economic value. These values are, to mention a few:

- The contribution to additional baseflow in especially winter;
- The reduction in sediment, or sediment avoidance;
- Carbon sequestration through an increase in the net primary production;
- The reduction in the loss of soil-carbon;
- The reduction of damage caused by stormflow;
- The combating of desertification and hence the support of soil productivity; and
- The promotion of biodiversity and biodiversity related economic development such as tourism.

These benefits can be brought about by one integrated activity – improved land management that improves basal cover – as discussed above. It is therefore possible to bundle the suite of benefits derived from such a restoration and land use management programme to finance such a programme. The ecosystem goods and services based benefits mentioned, could be sold either in bulk or in part to either one or a number of potential parties interested in the benefits derived from such an activity.

The land owners or users are essentially becoming the sellers of a range of products that have value to a diverse range of buyers. Those keen on receiving the additional baseflow might be the Department of Water Affairs and Forestry (DWAF) and/or large water users and utilities. The water could either be used to augment the ecological reserve, be sold as additional registered water use to a third party, or be bought by a third party to offset an increase in water use or streamflow reduction activity elsewhere. The reduction in sediment is of high value to DWAF, but it has important benefits to small dam owners, such as farmers, since a reduction in silt implies a reduction in dam storage capacity. Both carbon and biodiversity have an international appeal, but in and through different markets. A multiple number of market permutations are therefore possible.

It should be noted that silt in a river without a large dam has a proportionately bigger impact on small dams, weirs, canals and pumps than would have been the case should a large dam have been in the system to capture the silt. Usually large dams are over-engineered to make provision for silt built-up, but not in smaller infrastructure. Conversely, a system with no large dam is more reliant on additional baseflow during winter months since there is no engineered storage to capture the stormflow and to regulate the flow of the water from that point going forward. Though large dams will silt up, and they can only rarely be replaced and that only at large cost. The immediate cost is for areas in which there are no large dams. This does not imply that, for example, the water from the upper Thukela is not important due to Woodstock dam and that only the additional baseflow in the Umzimvubu - where there are no large dam structures – is important. The upper Thukela water is of great significance within the context of the inter-basin transfer scheme making additional water available to Gauteng. But, since this is additional water, for which there are currently no registered water users, this water could also be used to provide the Ecological Reserve. This is an important consideration given that the lower-Thukela system is under stress as illustrated in Table 2 below.

Table 2. Reconciliation of water requirements and available water resources for the Thukela WMA for the year 2005 (million m^3/a) (Source: DWAF, 2004).

Key Area	Available water			Water requirements/allocations			Balance
	Local yield	Transfers in	Total	Local requirements	Transfers out	Total	
Upper Thukela	505	0	506	114	377+11[1]	502	4
Little Thukela	8	0	8	38	0	38	(30)
Bushmans	80	0	80	40	29[1]	69	11
Sundays	8	0	8	32	0	32	(24)
Mooi	64	0	64	52	22	74	(10)
Buffalo	174	0	174	95	55	151	23
Lower Thukela	105	40[2]	145	58	87	145	0
Total	**945**	**0**	**945**	**430**	**541**	**971**	**(26)**
Allocable							**38[3]**

Notes:

1. Releases to support the lower Thukela Key Area.
2. Supplied from Spioenkop and Wagendrift dams.
3. Since it is not feasible to supply the shortages in the Little Thukela, Sundays or Mooi Key Areas from the surpluses in the Upper Thukela, Buffalo or Bushmans Key Areas, there is at least 30 million m^3/a available for allocation in the Thukela WMA.

Figure 2 shows that the Upper Thukela had a surplus of 4 million m^3 in 2004 which could still be allocated. This implies that with effective management in the Upper Thukela, the available water could increase by 320% given that 12.8 million m^3 could be supplied under good management. Furthermore, the additional water available implies a 23% increase in total available water in the whole Thukela catchment.

It is assumed here that the additional baseflow from the upper Thukela can be sold to any of the water users at R0.30/kl, which is about 21% of the lower-bound estimate of the economic value of water, which is estimated at R1,40/kl (Blignaut & Mander, 2007). For the upper Umzimvubu a water tariff of R0.70/kl is assumed. The difference is largely linked to the difference in the raw water tariff for the two areas, which is currently R0.13/kl and R0.74/kl for the upper Thukela and upper Umzimvubu respectively (Blignaut, 2007). To determine the total value of the additional baseflow, an increasing sliding scale is used. It is assumed that not all the water benefits as a result of the restoration will materialise in year 1 (though at 100% of the restoration cost). The benefits accruing to year 1 are set at 20% of the potential, increasing proportionately to reach 100% in year 5.

Sediment is valued as the opportunity cost of water, which is estimated as the mid-value of the economic value of the water, or R3.29/kl, as determined in Blignaut and Mander (2007). The logic being that the space taken up by the silt replaces the water storage capacity of a dam, and that this space is equal to the economic value of the water. The ACRU-hydrological model provides the sediment avoidance in tonnes per ha, and this mass has been converted to m^3 using a conversion factor of 1.5t to m^3, as DWAF is concerned with the loss of water storage volumes.

Carbon is, conservatively, valued at an average of R65/t (based on 2007 market prices) and at an average sequestration rate of 2.25t/ha/y. This is the average between a low of 1.5t/ha and a high of 3t/ha and includes both above and below ground carbon (CSIR pers comm. 2007). For conservation areas it is assumed that only 15% of the carbon sequestration is additional due to improved land use management that reduces fire events linked to arson. For commercial farm lands 50% of the carbon sequestration will be additional and for communal areas 75%. The other benefits, though mentioned above, are not quantified.

3.4.4. Evaluation Criteria

Not all quinaries are equally productive and efficient in reacting to and producing additional baseflow during winter. To identify the best or more productive quinaries a quinary has to fulfil any one of three criteria, (see Table 3 below) for it to become part of the restoration and management programme. This is done to identify the so-called “low-hanging fruit” - quinaries that will provide the biggest responses to management interventions. The difference between the two catchments is ascribed to the fact that the upper Thukela is a much more productive water producing system, based on precipitation data, and one has to apply a much higher selection threshold than in the case of the upper Umzimvubu based on available precipitation data.

Table 3. Criteria used to identify productive quinaries

Criteria	Upper Thukela	Upper Umzimvubu
Volumetric: Additional baseflow > xm^3	100,000	10
Area intensity: Additional m^3/ha > xm^3	50	20
Relative importance: Additional baseflow % of MAR > x	10%	7%

Note: The answer to “x” is provided in the two columns to the right for each of the catchments

The result of applying these criteria can clearly be seen in the logical thought-process of the entire model provided in the flow diagram, Figure 20.

The main output of the model is the estimation of the URV’s, per quinary and for the catchment as a whole, using the following basic equation:

URV = {Present value of all costs in Rand incurred over the economic life span of the project} / {Present value (m^3) of the benefit over the economic life span of the project}

- where the life span of the project is 50 years;
- where the discount rate is 4%, 6%, and 8%;
- where the costs refer to the restoration and the operation and maintenance cost; and
- where the benefits refer to the value of the additional baseflow, the avoided sediment, and the carbon sequestration.

A way to interpret a URV is that a URV represents the cost in Rand to generate the value or benefit for R1.

The URV’s can and have been estimated with total cost (restoration and operation and maintenance cost) and without the restoration cost. This is done to consider the option of linking the restoration cost – the capital component – to a public works programme, but the management cost to the services yielded by the programme. Also, URV’s can and have been estimated considering the individual benefit flows as well as the total benefit flow.

A URV equal to 1 implies that the net present value of the cost and the benefits are equal. A number less than 1 implies the net present value of the benefits are bigger than that of the cost and conversely. Though no standard benchmark number exists, but most recent dams have URV's higher than 2.

Figure 20 outlines the restoration and management intervention decision flow diagram applied in the model to determine the URV's for each of the 60 quinaries in the two case study catchments. It should be noted that the URV's are only calculated for those quinaries that have passed any of the three stated selection criteria. Restoration, gully restoration valued at R55,500/ha and reseeding valued at R6,200/ha, is only applied to the portion of the quinary area either having gullies or that are denuded of vegetation, and only for the bottom quinaries in the upper Thukela and the two upper quinaries of the upper Umzimvubu. Fire management, at a cost varying between R9/ha and R18/ha, is conducted in all quinaries and grazing management, at a cost of R19.80/ha, in all but the upper quinaries of the upper Thukela. Additional baseflow for the winter months only (April-September) is valued at either R0.30/kl or R0.70/kl for the upper Thukela and upper Umzimvubu respectively. Sediment reduction is valued at R3.29/m^3 and carbon at R65/t at a sequestration rate of 2.25t/ha for above and below ground carbon combined for the areas which passes the additionality criterion. URV's are calculated as the present value of the cost of 50 years divided by the present value of the benefits over 50 years using a discount rate of 4%, 6% and 8%.

3.5. Working with the model: User input and results

The model, as stated, is developed in MS Excel in a way that allows for easy access and can be used by land and water managers to determine the feasibility of trade and management. The model has been designed to allow for a suite of variables to be changed, and for the corresponding economic impacts to be calculated. This model uses a fixed set of hydrological data – which cannot be changed unless large hydrological computations are redone. The variable inputs and the economic results of the model are discussed below. The detailed workings of the model are hidden, and cannot be altered by the user.

3.5.1. User input

Table 4 is a replica of the first sheet of the model indicating all the estimates and assumptions that are used in the model. These variables can be changed by the user and the impacts are reflected on the same sheet for easy use. A set of default values are provided for comparison of changes. Users are invited to change the entries in the white cells in the table, the grey cells are either formulas using the inputs from the white cells, or are hard input data.

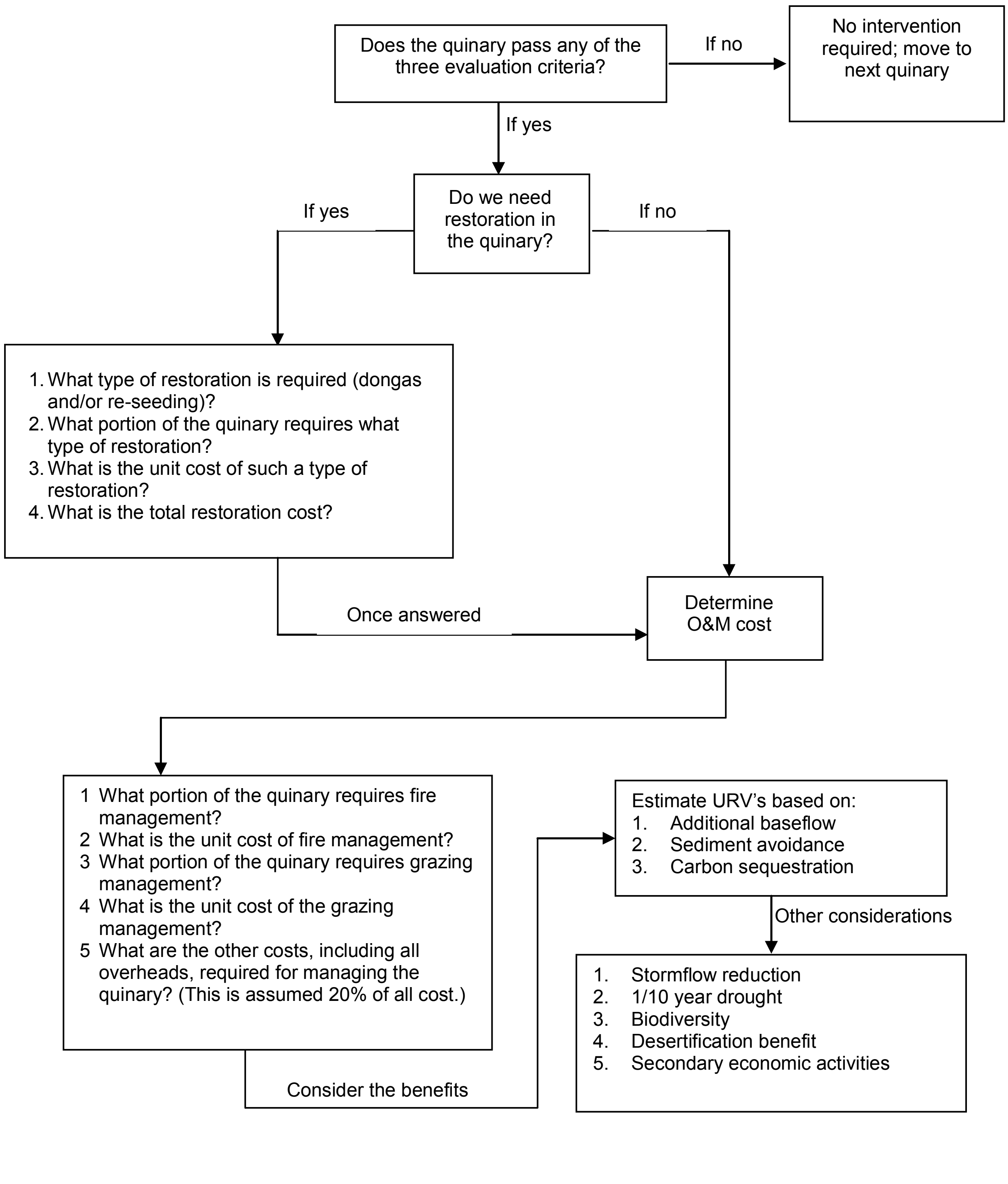

Figure 20. The restoration and management intervention decision flow diagram applied in the model to determine the URV's for each of the 60 quinaries in the two case study catchments

Table 4. Main input data

Maloti - Drakensberg Transfrontier Project: Economic Feasibility of Payment for Environmental Services Model				
Variable		**Upper-Thukela**	**Upper-Umzimvubu**	**Reference**
Cost of restoring grassland: re-seeding		R6,200	R6,200	Kate's Report
Cost of restoring dongas/erosion gullies		R55,500	R55,500	Kate's Report
Cost of Fire Operation and Management				
Commercial Farm Land		R9.00	R9.00	Kate's Report
Communal Land		R18.00	R18.00	Kate's Report
Conservation Area		R11.70	R11.70	Kate's Report
Mixed Commercial / Communal		R13.50	R13.50	Kate's Report
Mixed Commercial / Conservation		R10.35	R10.35	Kate's Report
Mixed Communal / Conservation		R14.85	R14.85	Kate's Report
Cost of grazing operation and management		R19.30	R19.30	Kate's Report
Operation and management overhead %		20%	20%	Assumption
Current raw water charge R/m3		R0.13	R0.74	DWAF Water Pricing Tarriff Book
Economic value of water: Low R/m3		R1.40	R1.45	Report 4.1.4 Table 3
Economic value of water: Medium R/m3		R3.29	R3.29	Report 4.1.4 Table 3
Economic value of water: High R/m3		R6.90	R6.90	Report 4.1.4 Table 3
Economic value of sediment R/m3		R3.29	R3.29	This can be estimated using the economic value of water or the cost of dredging estimated at R15 per cubic meter.
Price of water (Agric) R/m3		R0.30	R0.70	Report 4.1.4 Table 3
Price of water (Industry) R/m3		R0.30	R0.70	Report 4.1.4 Table 3
Price of water (Households) R/m3		R0.30	R0.70	Report 4.1.4 Table 3
Price of water (Ecol Res) R/m3		R0.30	R0.70	Report 4.1.4 Table 3
Portion of water (Agric)		0.20	0.20	Report 4.1.4 Table 3
Portion of water (Industry)		0.20	0.20	Report 4.1.4 Table 3
Portion of water (Househoulds)		0.20	0.20	Report 4.1.4 Table 3
Portion of water (Ecol Res)		0.40	0.40	Report 4.1.4 Table 3
Average water price		R0.30	R0.70	
CO2 price: Low R/t		R50.00	R50.00	www.pointcarbon.com
CO2 price: High R/t		R80.00	R80.00	www.pointcarbon.com
Average price of CO2		R65.00	R65.00	Average of low and high carbon prices
Above and below ground Carbon seq.: Low t/ha		1.5	1.5	CSIR Research into Carbon Sequestration for EKZNWild
Above and below ground Carbon seq.: High t/ha		3.0	3.0	CSIR Research into Carbon Sequestration for EKZNWild
Above and below ground Carbon seq.: Ave. t/ha		2.25	2.25	This is an estimated based on the ave. low and high estimates for Carbon Sequestration
% of area that would be additional carbon sequestration in:				
Commercial Farm Land		50%	50%	Assumption
Communal Land		75%	75%	Assumption
Conservation Area		15%	15%	Assumption
Mixed Commercial / Communal		62.5%	62.5%	Calculated
Mixed Commercial / Conservation		32.5%	32.5%	Calculated
Mixed Communal / Conservation		45.0%	45.0%	Calculated
Economically feasible if:				
Feasible	MIN URV	-100	-100	Assumption
Feasible	MAX URV	1	1	Assumption
Possible	MIN URV	1.001	1.001	Assumption
Possible	MAX URV	2.5	2.5	Assumption
Not Feasible	MIN URV	2.5001	2.5001	Assumption
Not Feasible	MAX URV	50	50	Assumption
Sediment: Conversion of tons to m3		1.5	1.5	Expert opinion
Restoration and management labour				
Cost per person per day: R/day		150	150	Working-for-Water
Number of days worked per year		200	200	Working-for-Water
Intervene in a Quinary when any of the following conditions are met				
Baseflow in m3 is more than		100,000	10	Assumption
The baseflow in m3 per ha is more than		50	20	Assumption
of intervention is more that		10.00%	7.00%	Assumption
Which quinaries should we restore				
Bottom		Y	N	Assumption
Middle		N	Y	Assumption
Top		N	Y	Assumption
Additional Baseflow in m3 is more than		1,000,000	200,000	Assumption

Variable		Upper-Thukela	Upper-Umzimvubu	Reference
Which quinaries should do grazing management in?				
Commercial Farm Land		Y	Y	Assumption
Communal Land		Y	Y	Assumption
Conservation Area		N	Y	Assumption
Mixed Commercial / Communal		Y	Y	Assumption
Mixed Commercial / Conservation		Y	Y	Assumption
Mixed Communal / Conservation		Y	Y	Assumption
High Altitude		N	Y	Assumption
Bottom		Y	Y	Assumption
Middle		Y	Y	Assumption
Top		Y	Y	Assumption
Which land use categories can we sell additional below ground carbon sequestration for?				
Commercial Farm Land		N	N	Assumption
Communal Land		N	N	Assumption
Conservation Area		N	N	Assumption
Mixed Commercial / Communal		N	N	Assumption
Mixed Commercial / Conservation		N	N	Assumption
Mixed Communal / Conservation		N	N	Assumption
What Discount Rate should be used?		6.00%	6.00%	Choose 4%, 6% or 8%
Below Ground Carbon Matrix				**Reference**
Percentage loss of Carbon				CSIR Research into Carbon Sequestration for EKZNWild
Commercial Farm Land	Top	2.13%	2.13%	
Commercial Farm Land	Middle	1.88%	1.88%	
Commercial Farm Land	Bottom	1.98%	1.98%	
Communal Land	Top	1.96%	1.96%	
Communal Land	Middle	1.35%	1.35%	
Communal Land	Bottom	1.72%	1.72%	
Conservation Area	Top	2.30%	2.30%	
Conservation Area	Middle	2.40%	2.40%	
Conservation Area	Bottom	2.24%	2.24%	
Mixed Commercial / Communal	Top	2.05%	2.05%	
Mixed Commercial / Communal	Middle	1.61%	1.61%	
Mixed Commercial / Communal	Bottom	1.85%	1.85%	
Mixed Commercial / Conservation	Top	2.22%	2.22%	
Mixed Commercial / Conservation	Middle	2.14%	2.14%	
Mixed Commercial / Conservation	Bottom	2.11%	2.11%	
Mixed Communal / Conservation	Top	2.13%	2.13%	
Mixed Communal / Conservation	Middle	1.88%	1.88%	
Mixed Communal / Conservation	Bottom	1.98%	1.98%	
Probability of Recouping Value				Default Value/Assumption
Commercial Farm Land	Top	40.00%	40.00%	
Commercial Farm Land	Middle	40.00%	40.00%	
Commercial Farm Land	Bottom	40.00%	40.00%	
Communal Land	Top	40.00%	40.00%	
Communal Land	Middle	40.00%	40.00%	
Communal Land	Bottom	40.00%	40.00%	
Conservation Area	Top	40.00%	40.00%	
Conservation Area	Middle	40.00%	40.00%	
Conservation Area	Bottom	40.00%	40.00%	
Mixed Commercial / Communal	Top	40.00%	40.00%	
Mixed Commercial / Communal	Middle	40.00%	40.00%	
Mixed Commercial / Communal	Bottom	40.00%	40.00%	
Mixed Commercial / Conservation	Top	40.00%	40.00%	
Mixed Commercial / Conservation	Middle	40.00%	40.00%	
Mixed Commercial / Conservation	Bottom	40.00%	40.00%	
Mixed Communal / Conservation	Top	40.00%	40.00%	
Mixed Communal / Conservation	Middle	40.00%	40.00%	
Mixed Communal / Conservation	Bottom	40.00%	40.00%	

3.5.2. Main output

Table 5 indicates that the URV for water only in the Upper Thukela, at a discount rate of 6% over 50 years, is 1.13. That implies that each R1 of water sale will cost R1.13 to produce, excluding restoration costs. Once restoration is considered, each R1 benefit will cost R1.66 to produce. This changes dramatically once the value of sales of sediment reduction and carbon is added. When including restoration costs, each R1 benefit will cost only R0.31. In the case of the upper Umzimvubu, which is not a major water producing system relative to the upper Thukela, but a system that generates a significant amount of sediment and carbon sequestration value due to the high degree of degradation, the URV for water alone is a high 8.28, but with all the other benefits added it is 0.48, is an attractive investment option. The net present value of the intervention for both systems is estimated to be approximately R1,000/y/ha.

The implications of these findings are that it is financially feasible to trade specific ecosystem services, as discussed above, from a number of quinaries. The more services that are traded, the greater the returns to the producers, and the more quinaries become viable sites for management and restoration.

Apart from the financial feasibility, investment in management is beneficial for the local economy, especially in these economically depressed remote rural areas. The trade in ecosystem services has the potential to generate 1 800 restoration-related jobs per year for the first seven years of the intervention and almost 500 permanent jobs in veld management, both in addition and thereafter.

3.5.3. Catchment output

The outputs of the quaternary catchments are summarised in Table 6. This table outlines the key information for the catchments as a whole, especially the quantities of the services supplied, the numbers of quinaries wherein management is feasible from an eco-hydrological perspective, the costs of management, and the returns from such management. The management cost varies between almost R4million and R10million per year for the two systems. The economic value of the water produced at this cost is between R18million and R89million for the upper Thukela and R5million and R27million for the upper Umzimvubu. This value is not the value of the water sales, it is the economic value added due to the availability and use of the additional dry season water. In other words, for the upper Thukela as an example, a total management investment of approximately R4million will generate an additional baseflow of 12million m^3, which has an economic value of at least R18million.

Table 5. Maloti - Drakensberg Transfrontier Project: Economic Feasibility of PES - Summary of Key Results

Economic Unit Reference Values for the Two Catchments		
	Upper Thukela	**Upper Umzimvubu**
Water only, no restoration costs	1.13	3.24
Water only, total cost	1.66	8.28
Total benefits, no restoration costs	0.21	0.19
Total benefits, total cost	0.31	0.48
	Upper Thukela	**Upper Umzimvubu**
Total additional baseflow: m^3	12,869,204	3,936,842
Sediment reduction: t/y	1,884,379	7,381,437
Sediment reduction: m^3/y	1,256,252	4,920,958
Carbon sequestrian: t/y	134,352	337,718
Value of water sales: R/ha/y for 50 years	R20.12	R8.06
Value of all benefits: R/ha/y for 50 years	R97.57	R123.82
Restoration cost: Total cost over 7 years/ha	R170.27	R655.28
Management cost: R/ha/y for 50 years	R20.23	R23.14
Net present value of water: R/ha/y for 50 years	-R185.33	-R820.50
Net present value of all benefits: R/ha/y	R1,035.50	R1,004.18
Number of jobs: During restoration	279	1,548
Number of jobs: During maintenance	127	307
Total Management Costs: R/y	R3,795,061	R9,202,899
Total Restoration Costs over 7 years R/y	R31,945,410	R260,652,840
Total Water Sales R/y (year 5 and onward)	R3,860,761	R2,755,789
Economic Value of Water Low R/y	R18,016,886	R5,708,421
Economic Value of Water Medium R/y	R42,339,681	R12,952,210
Economic Value of Water High R/y	R88,797,508	R27,164,210
Percentage of feasible quinaries	55.56%	54.55%

Table 6. Outputs of quaternary catchments

Maloti - Drakensberg Transfrontier Project: Economic Feasibility of Payment for Environmental Services Model

Thukela - Summary Page

General Statistics	
Total Number of Quinaries	27
Total Size in ha	187619

Eco-Hydrology Feasibility	
Feasible Quinaries	16
Not Feasible Quinaries	11

Economic Feasibility	Feasible	Possible	Not Feasible
Water Sales (Management Only)	5	5	6
Water Sales (Man & Restore)	4	5	7
Sediment (Management Only)	6	5	5
Sediment (Man & Restore)	5	3	8
Carbon (Management Only)	16	0	0
Carbon (Man & Restore)	14	2	0
Combined (Management Only)	16	0	0
Combined (Man & Restore)	15	1	0

Value of Improved Land Management	
Increase in Baseflow During Winter m3	12,869,204
Sediment Reduction tons	1,884,379
Sediment Reduction m3	1,256,252
Carbon Sequestration ton/annum	134,352

Annual Returns to Land Owners	Water	Sediment	Carbon	Combined
Max return per ha (in a quinary)	R86.26	R167.35	R118.63	R350.16
Min return per ha (in a quinary)	R3.64	R3.07	R16.42	R50.67
Ave return per Ha	R20.12	R31.58	R46.55	R97.57
Ave per Quinary per ha	R24.78	R38.64	R62.88	R125.45

Management Costs	
Restoration Costs over 7 Years	R31,945,410
Operation & Management Costs per annum	R3,795,061

Job Creation	
Restoration jobs per year	152
Operation and Management jobs per year	127
Total jobs per year	279

Economic Value of the Water	
Low	R18,016,886
Middle	R42,339,681
High	R88,797,508

Maloti - Drakensberg Transfrontier Project: Economic Feasibility of Payment for Environmental Services Model

Umzimvubu - Summary Page

General Statistics	
Total Number of Quinaries	33
Total Size in ha	397771

Eco-Hydrology Feasibility	
Feasible Quinaries	24
Not Feasible Quinaries	9

Economic Feasibility	**Feasible**	**Possible**	**Not Feasible**
Water Sales (Management Only)	2	2	20
Water Sales (Man & Restore)	0	2	22
Sediment (Management Only)	22	0	2
Sediment (Man & Restore)	15	3	6
Carbon (Management Only)	24	0	0
Carbon (Man & Restore)	16	3	5
Combined (Management Only)	24	0	0
Combined (Man & Restore)	18	5	1

Value of Improved Land Management	
Increase in Baseflow During Winter m3	3,936,842
Sediment Reduction tons	7,381,437
Sediment Reduction m3	4,920,958
Carbon Sequestration ton/annum	337,718

Annual Returns to Land Owners	**Water**	**Sediment**	**Carbon**	**Combined**
Max return per ha (in a quinary)	R53.64	R140.71	R107.60	R252.96
Min return per ha (in a quinary)	R0.58	-R0.20	R22.05	R32.31
Ave return per Ha	R8.06	R60.58	R55.19	R123.82
Ave per Quinary per ha	R11.19	R72.82	R70.37	R154.38

Management Costs	
Restoration Costs over 7 Years	R260,652,840
Operation & Management Costs per annum	R9,202,899

Job Creation	
Restoration jobs per year	1,241
Operation and Management jobs per year	307
Total jobs per year	1,548

Economic Value of the Water	
Low	R5,708,421
Middle	R12,952,210
High	R27,164,210

3.5.4. Quinary output

The outputs of the quinary catchments are summarised in Table 7. This table outlines all the relevant information which would direct interventions for each discrete quinary. The tables outline the location, suitability for restoration and management, potential returns to each quinary, and importantly, the prerequisite trades (i.e. water sales, sediment reduction sales and carbon sequestration sales) necessary to make restoration and management feasible. These tables also show which quinaries require restoration before management will delivered the desired services.

Table 7. These tables provide one more layer of detail, namely the outputs and results per quinary. Here the results for both the upper Thukela and Umzimvubu are presented

General Information			
Quinary	**Status**	**Height in Catchment**	**Size**
Quinary1	Conservation Area	Top	2047
Quinary2	Communal Land	Middle	7344
Quinary3	Communal Land	Bottom	11304
Quinary4	Conservation Area	Top	4944
Quinary5	Communal Land	Middle	9149
Quinary6	Communal Land	Bottom	11184
Quinary7	Commercial Farm Land	Top	4925
Quinary8	Commercial Farm Land	Middle	7745
Quinary9	Commercial Farm Land	Bottom	12294
Quinary10	Commercial Farm Land	Top	2156
Quinary11	Commercial Farm Land	Middle	5378
Quinary12	Mixed Commercial / Communa	Bottom	16430
Quinary13	Communal Land	Top	5254
Quinary14	Communal Land	Middle	6257
Quinary15	Communal Land	Bottom	6896
Quinary16	Commercial Farm Land	Top	988
Quinary17	Commercial Farm Land	Middle	5217
Quinary18	Commercial Farm Land	Bottom	9571
Quinary19	Conservation Area	Top	5367
Quinary20	Conservation Area	Middle	16930
Quinary21	Conservation Area	Bottom	9075
Quinary22	Communal Land	Top	1544
Quinary23	Communal Land	Middle	3755
Quinary24	Communal Land	Bottom	7933
Quinary25	Communal Land	Top	1547
Quinary26	Mixed Commercial / Communa	Middle	3314
Quinary27	Commercial Farm Land	Bottom	9071

Feasibility									
Quinary	Eco-Hydrological	Water Sales	Water Sales	Sediment Reduction	Sediment Reduction	Carbon	Carbon	Combined	Combined
		M Only	M & R	M Only	M & R	M Only	M & R	M Only	M & R
Quinary1	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary2	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary3	Y	Feasible	Possible	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible
Quinary4	Y	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible
Quinary5	Y	Possible	Possible	Not Feasible	Not Feasible	Feasible	Feasible	Feasible	Feasible
Quinary6	Y	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible
Quinary7	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary8	Y	Not Feasible	Not Feasible	Not Feasible	Not Feasible	Feasible	Feasible	Feasible	Feasible
Quinary9	Y	Possible	Possible	Possible	Possible	Feasible	Feasible	Feasible	Feasible
Quinary10	Y	Not Feasible	Not Feasible	Not Feasible	Not Feasible	Feasible	Feasible	Feasible	Feasible
Quinary11	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary12	Y	Not Feasible	Not Feasible	Possible	Not Feasible	Feasible	Feasible	Feasible	Feasible
Quinary13	Y	Not Feasible	Not Feasible	Not Feasible	Not Feasible	Feasible	Feasible	Feasible	Feasible
Quinary14	Y	Not Feasible	Not Feasible	Not Feasible	Not Feasible	Feasible	Feasible	Feasible	Feasible
Quinary15	Y	Possible	Possible	Feasible	Possible	Feasible	Feasible	Feasible	Feasible
Quinary16	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary17	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary18	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary19	Y	Possible	Possible	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible
Quinary20	Y	Feasible	Feasible	Possible	Possible	Feasible	Feasible	Feasible	Feasible
Quinary21	Y	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible
Quinary22	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary23	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary24	Y	Possible	Not Feasible	Possible	Not Feasible	Feasible	Possible	Feasible	Feasible
Quinary25	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary26	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary27	Y	Not Feasible	Not Feasible	Possible	Not Feasible	Feasible	Possible	Feasible	Possible

Feasibility									
Quinary	**Eco-Hydrological**	**Water Sales**	**Water Sales**	**Sediment Reduction**	**Sediment Reduction**	**Carbon**	**Carbon**	**Combined**	**Combined**
		M Only	**M & R**	**M Only**	**M & R**	**M Only**	**M & R**	**M Only**	**M & R**
Quinary1	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary2	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary3	Y	0.99	1.86	0.46	0.87	0.41	0.77	0.18	0.33
Quinary4	Y	0.85	0.85	0.35	0.35	0.64	0.64	0.18	0.18
Quinary5	Y	2.21	2.21	3.13	3.13	0.41	0.41	0.31	0.31
Quinary6	Y	0.55	0.55	0.26	0.26	0.41	0.41	0.12	0.12
Quinary7	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary8	Y	3.65	3.65	9.74	9.74	0.46	0.46	0.40	0.40
Quinary9	Y	1.64	2.01	1.39	1.71	0.46	0.57	0.29	0.35
Quinary10	Y	3.04	3.04	9.42	9.42	0.46	0.46	0.39	0.39
Quinary11	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary12	Y	7.33	8.99	2.42	2.96	0.43	0.53	0.35	0.43
Quinary13	Y	3.82	3.82	6.58	6.58	0.41	0.41	0.35	0.35
Quinary14	Y	4.81	4.81	4.81	4.81	0.41	0.41	0.35	0.35
Quinary15	Y	1.08	2.02	0.79	1.48	0.41	0.77	0.22	0.40
Quinary16	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary17	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary18	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary19	Y	1.32	1.32	0.36	0.36	0.64	0.64	0.19	0.19
Quinary20	Y	0.74	0.77	1.32	1.37	0.64	0.66	0.27	0.28
Quinary21	Y	0.16	0.17	0.07	0.08	0.64	0.69	0.05	0.05
Quinary22	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary23	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary24	Y	1.85	4.76	1.07	2.75	0.41	1.05	0.25	0.66
Quinary25	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary26	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary27	Y	3.27	16.58	1.76	8.94	0.46	2.35	0.33	1.67
Total		**1.13**	**1.66**	**0.64**	**0.94**	**0.44**	**0.65**	**0.21**	**0.31**

Annual Returns to Land Owners								
Quinary	**Water Sales**	**Water Sales**	**Sediment Avoidance**	**Sediment Avoidance**	**Carbon Sequestration**	**Carbon Sequestration**	**All Combined**	**All Combined**
	After 5 Years	**Per ha after 5 Years**	**After 5 Years**	**Per ha after 5 years**	**After 5 years**	**Per ha after 5 years**	**After 5 years**	**Per ha after 5 years**
Quinary1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary3	R480,369.00	R42.50	R915,778.08	R81.01	R1,033,146.56	R91.40	R2,429,293.64	R214.91
Quinary4	R78,975.60	R15.97	R167,950.55	R33.97	R93,146.63	R18.84	R340,072.78	R68.78
Quinary5	R199,568.40	R21.81	R125,244.71	R13.69	R1,085,339.39	R118.63	R1,284,907.79	R140.44
Quinary6	R953,155.50	R85.22	R1,820,401.74	R162.77	R1,142,614.69	R102.17	R3,916,171.93	R350.16
Quinary7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary8	R71,725.50	R9.26	R23,805.12	R3.07	R499,516.88	R64.50	R595,047.50	R76.83
Quinary9	R233,181.00	R18.97	R243,709.71	R19.82	R728,690.63	R59.27	R1,205,581.34	R98.06
Quinary10	R25,174.80	R11.68	R7,202.80	R3.34	R146,103.75	R67.77	R178,481.35	R82.78
Quinary11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary12	R59,819.40	R3.64	R160,928.38	R9.79	R903,276.56	R54.98	R1,124,024.34	R68.41
Quinary13	R69,273.60	R13.18	R35,705.38	R6.80	R575,640.00	R109.56	R680,618.98	R129.54
Quinary14	R54,505.50	R8.71	R48,314.64	R7.72	R569,387.81	R91.00	R672,207.95	R107.43
Quinary15	R185,468.40	R26.90	R225,466.00	R32.70	R434,691.56	R63.04	R845,625.97	R122.63
Quinary16	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary17	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary18	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary19	R48,192.00	R8.98	R158,464.50	R29.53	R88,101.00	R16.42	R294,757.50	R54.92
Quinary20	R339,117.30	R20.03	R169,457.37	R10.01	R349,266.94	R20.63	R857,841.61	R50.67
Quinary21	R782,791.20	R86.26	R1,518,737.70	R167.35	R175,587.75	R19.35	R2,477,116.65	R272.96
Quinary22	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary23	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary24	R133,360.50	R16.81	R204,941.34	R25.83	R535,823.44	R67.54	R874,125.28	R110.19
Quinary25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary26	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary27	R59,611.50	R6.57	R98,099.25	R10.81	R372,571.88	R41.07	R530,282.62	R58.46

Restoration Costs				
Quinary	Restoration Costs	Restoration Costs	Management Costs	Management Costs
	Over 7 Years	Per Ha over 7 years	Per year	Per ha Per year
Quinary1	R0.00	R0.00	R0.00	R0.00
Quinary2	R0.00	R0.00	R0.00	R0.00
Quinary3	R6,744,360.00	R596.63	R421,594.44	R37.30
Quinary4	R0.00	R0.00	R59,613.84	R12.06
Quinary5	R0.00	R0.00	R391,784.28	R42.82
Quinary6	R0.00	R0.00	R466,264.92	R41.69
Quinary7	R0.00	R0.00	R0.00	R0.00
Quinary8	R0.00	R0.00	R231,980.76	R29.95
Quinary9	R1,419,180.00	R115.44	R338,411.40	R27.53
Quinary10	R0.00	R0.00	R67,852.08	R31.47
Quinary11	R0.00	R0.00	R0.00	R0.00
Quinary12	R1,598,310.00	R97.28	R388,955.52	R23.67
Quinary13	R0.00	R0.00	R234,900.48	R44.71
Quinary14	R0.00	R0.00	R232,349.16	R37.13
Quinary15	R2,825,340.00	R409.71	R177,383.88	R25.72
Quinary16	R0.00	R0.00	R0.00	R0.00
Quinary17	R0.00	R0.00	R0.00	R0.00
Quinary18	R0.00	R0.00	R0.00	R0.00
Quinary19	R0.00	R0.00	R56,384.64	R10.51
Quinary20	R156,240.00	R9.23	R223,530.84	R13.20
Quinary21	R156,240.00	R17.22	R112,376.16	R12.38
Quinary22	R0.00	R0.00	R0.00	R0.00
Quinary23	R0.00	R0.00	R0.00	R0.00
Quinary24	R6,259,890.00	R789.09	R218,652.60	R27.56
Quinary25	R0.00	R0.00	R0.00	R0.00
Quinary26	R0.00	R0.00	R0.00	R0.00
Quinary27	R12,785,850.00	R1,409.53	R173,026.20	R19.07

Number of Jobs		
Quinary	For Restoration	For Management
	Per Year	Per Year
Quinary1	0	0
Quinary2	0	0
Quinary3	32	14
Quinary4	0	2
Quinary5	0	13
Quinary6	0	16
Quinary7	0	0
Quinary8	0	8
Quinary9	7	11
Quinary10	0	2
Quinary11	0	0
Quinary12	8	13
Quinary13	0	8
Quinary14	0	8
Quinary15	13	6
Quinary16	0	0
Quinary17	0	0
Quinary18	0	0
Quinary19	0	2
Quinary20	1	7
Quinary21	1	4
Quinary22	0	0
Quinary23	0	0
Quinary24	30	7
Quinary25	0	0
Quinary26	0	0
Quinary27	61	6

Table 75 continued. Outputs for the Umzimvubu

General Information			
Quinary	**Status**	**Height in Catchment**	**Size**
Quinary1	Communal Land	Top	8290
Quinary2	Communal Land	Middle	19898
Quinary3	Communal Land	Bottom	38756
Quinary4	Mixed Communal / Conservation	Top	7948
Quinary5	Mixed Communal / Conservation	Middle	13942
Quinary6	Mixed Commercial / Communal	Bottom	38016
Quinary7	Communal Land	Top	1509
Quinary8	Communal Land	Middle	10754
Quinary9	Communal Land	Bottom	24434
Quinary10	Communal Land	Top	3389
Quinary11	Communal Land	Middle	12268
Quinary12	Communal Land	Bottom	30407
Quinary13	Communal Land	Top	10929
Quinary14	Communal Land	Middle	2578
Quinary15	Communal Land	Bottom	13168
Quinary16	Communal Land	Top	3930
Quinary17	Communal Land	Middle	10533
Quinary18	Communal Land	Bottom	9601
Quinary19	Communal Land	Top	3143
Quinary20	Communal Land	Middle	8458
Quinary21	Communal Land	Bottom	12991
Quinary22	Communal Land	Top	5098
Quinary23	Communal Land	Middle	11877
Quinary24	Communal Land	Bottom	11185
Quinary25	Communal Land	Top	10306
Quinary26	Communal Land	Middle	11522
Quinary27	Communal Land	Bottom	12314
Quinary28	Communal Land	Top	2860
Quinary29	Communal Land	Middle	16621
Quinary30	Communal Land	Bottom	7298
Quinary31	Communal Land	Top	6800
Quinary32	Communal Land	Middle	5314
Quinary33	Communal Land	Bottom	11634

Feasibility									
Quinary	**Eco-Hydrological**	**Water Sales**	**Water Sales**	**Sediment Reduction**	**Sediment Reduction**	**Carbon**	**Carbon**	**Combined**	**Combined**
		M Only	**M & R**	**M Only**	**M & R**	**M Only**	**M & R**	**M Only**	**M & R**
Quinary1	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary2	Y	Not Feasible	Not Feasible	Feasible	Possible	Feasible	Possible	Feasible	Feasible
Quinary3	Y	Not Feasible	Not Feasible	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible
Quinary4	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary5	Y	Not Feasible	Not Feasible	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible
Quinary6	Y	Not Feasible	Not Feasible	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible
Quinary7	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary8	Y	Not Feasible	Not Feasible	Feasible	Possible	Feasible	Possible	Feasible	Feasible
Quinary9	Y	Not Feasible	Not Feasible	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible
Quinary10	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary11	Y	Not Feasible	Not Feasible	Feasible	Not Feasible	Feasible	Not Feasible	Feasible	Possible
Quinary12	Y	Not Feasible	Not Feasible	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible
Quinary13	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary14	Y	Not Feasible	Not Feasible	Feasible	Not Feasible	Feasible	Not Feasible	Feasible	Possible
Quinary15	Y	Not Feasible	Not Feasible	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible
Quinary16	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary17	Y	Not Feasible	Not Feasible	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible
Quinary18	Y	Not Feasible	Not Feasible	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible
Quinary19	Y	Not Feasible	Not Feasible	Not Feasible	Not Feasible	Feasible	Feasible	Feasible	Feasible
Quinary20	Y	Not Feasible	Not Feasible	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible
Quinary21	Y	Not Feasible	Not Feasible	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible
Quinary22	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary23	Y	Not Feasible	Not Feasible	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible
Quinary24	Y	Not Feasible	Not Feasible	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible
Quinary25	Y	Not Feasible	Not Feasible	Not Feasible	Not Feasible	Feasible	Possible	Feasible	Possible
Quinary26	Y	Not Feasible	Not Feasible	Feasible	Not Feasible	Feasible	Not Feasible	Feasible	Not Feasible
Quinary27	Y	Not Feasible	Not Feasible	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible
Quinary28	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary29	Y	Possible	Possible	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible
Quinary30	Y	Possible	Possible	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible
Quinary31	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary32	Y	Feasible	Not Feasible	Feasible	Possible	Feasible	Not Feasible	Feasible	Possible
Quinary33	Y	Feasible	Not Feasible	Feasible	Not Feasible	Feasible	Not Feasible	Feasible	Possible

Feasibility									
Quinary	Eco-Hydrological	Water Sales	Water Sales	Sediment Reduction	Sediment Reduction	Carbon	Carbon	Combined	Combined
		M Only	M & R	M Only	M & R	M Only	M & R	M Only	M & R
Quinary1	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary2	Y	12.02	38.46	0.52	1.67	0.41	1.31	0.22	0.72
Quinary3	Y	12.02	12.02	0.52	0.52	0.41	0.41	0.23	0.23
Quinary4	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary5	Y	4.40	4.40	0.28	0.28	0.62	0.62	0.19	0.19
Quinary6	Y	4.23	7.98	0.28	0.54	0.43	0.81	0.16	0.31
Quinary7	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary8	Y	4.01	19.83	0.27	1.35	0.41	2.02	0.16	0.78
Quinary9	Y	4.01	4.01	0.26	0.26	0.41	0.41	0.15	0.15
Quinary10	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary11	Y	4.24	44.49	0.28	2.98	0.41	4.28	0.16	1.69
Quinary12	Y	4.24	4.24	0.29	0.29	0.41	0.41	0.16	0.16
Quinary13	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary14	Y	8.01	90.91	0.31	3.47	0.41	4.63	0.17	1.94
Quinary15	Y	8.01	8.01	0.34	0.34	0.41	0.41	0.18	0.18
Quinary16	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary17	Y	4.24	4.24	0.37	0.37	0.41	0.41	0.18	0.18
Quinary18	Y	4.24	4.24	0.35	0.35	0.41	0.41	0.18	0.18
Quinary19	Y	36.05	36.05	4.38	4.38	0.41	0.41	0.37	0.37
Quinary20	Y	4.24	6.43	0.33	0.49	0.41	0.62	0.17	0.26
Quinary21	Y	4.24	4.24	-76.24	-76.24	0.41	0.41	0.37	0.37
Quinary22	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary23	Y	4.24	4.68	0.31	0.34	0.41	0.45	0.17	0.19
Quinary24	Y	4.24	4.24	-82.69	-82.69	0.41	0.41	0.37	0.37
Quinary25	Y	72.10	225.98	5.60	17.57	0.41	1.28	0.38	1.19
Quinary26	Y	12.02	183.63	0.35	5.42	0.41	6.24	0.19	2.86
Quinary27	Y	12.02	12.02	0.39	0.39	0.41	0.41	0.20	0.20
Quinary28	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary29	Y	1.27	1.27	0.44	0.44	0.41	0.41	0.18	0.18
Quinary30	Y	2.33	2.33	0.41	0.41	0.41	0.41	0.19	0.19
Quinary31	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary32	Y	0.68	4.77	0.35	2.48	0.41	2.87	0.15	1.04
Quinary33	Y	0.56	4.19	0.37	2.77	0.41	3.04	0.14	1.08
TOTAL		**3.24**	**8.28**	**0.38**	**0.98**	**0.42**	**1.07**	**0.19**	**0.48**

Annual Returns to Land Owners								
Quinary	Water Sales	Water Sales	Sediment Avoidance	Sediment Avoidance	Carbon Sequestration	Carbon Sequestration	All Combined	All Combined
	After 5 Years	Per ha after 5 Years	After 5 Years	Per ha after 5 years	After 5 years	Per ha after 5 years	After 5 years	Per ha after 5 years
Quinary1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary2	R68,027.40	R3.42	R1,390,563.90	R69.88	R1,776,608.44	R89.29	R3,235,199.74	R162.59
Quinary3	R73,243.80	R1.89	R1,489,647.85	R38.44	R1,912,840.31	R49.36	R3,475,731.96	R89.68
Quinary4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary5	R141,004.50	R10.11	R1,961,820.42	R140.71	R883,796.06	R63.39	R2,986,620.98	R214.22
Quinary6	R282,639.00	R7.43	R3,730,902.44	R98.14	R2,460,473.44	R64.72	R6,474,014.88	R170.30
Quinary7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary8	R102,249.00	R9.51	R1,329,377.80	R123.62	R890,114.06	R82.77	R2,321,740.86	R215.90
Quinary9	R61,891.20	R2.53	R836,550.60	R34.24	R538,785.00	R22.05	R1,437,226.80	R58.82
Quinary10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary11	R81,241.30	R6.62	R1,074,476.17	R87.58	R748,836.56	R61.04	R1,904,554.03	R155.25
Quinary12	R97,294.40	R3.20	R1,269,736.02	R41.76	R896,805.00	R29.49	R2,263,835.42	R74.45
Quinary13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary14	R10,067.40	R3.91	R234,257.87	R90.87	R175,280.63	R67.99	R419,605.90	R162.76
Quinary15	R38,133.90	R2.90	R802,298.08	R60.93	R663,938.44	R50.42	R1,504,370.42	R114.24
Quinary16	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary17	R122,665.20	R11.65	R1,255,327.79	R119.18	R1,130,658.75	R107.34	R2,508,651.74	R238.17
Quinary18	R70,281.40	R7.32	R755,837.69	R78.72	R647,814.38	R67.47	R1,473,933.47	R153.52
Quinary19	R4,207.00	R1.34	R30,734.19	R9.78	R329,610.94	R104.87	R364,552.13	R115.99
Quinary20	R94,152.80	R11.13	R1,085,220.98	R128.31	R867,847.50	R102.61	R2,047,221.28	R242.05
Quinary21	R41,281.10	R3.18	-R2,036.51	-R0.16	R380,505.94	R29.29	R419,750.53	R32.31
Quinary22	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary23	R134,862.70	R11.35	R1,626,489.80	R136.94	R1,243,088.44	R104.66	R3,004,440.94	R252.96
Quinary24	R48,242.60	R4.31	-R2,194.43	-R0.20	R444,673.13	R39.76	R490,721.30	R43.87
Quinary25	R5,980.80	R0.58	R68,231.64	R6.62	R937,170.00	R90.93	R1,011,382.44	R98.14
Quinary26	R17,967.60	R1.56	R539,720.22	R46.84	R469,243.13	R40.73	R1,026,930.95	R89.13
Quinary27	R32,793.60	R2.66	R906,545.68	R73.62	R856,440.00	R69.55	R1,795,779.28	R145.83
Quinary28	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary29	R640,147.90	R38.51	R1,649,117.76	R99.22	R1,768,820.63	R106.42	R4,058,086.29	R244.15
Quinary30	R154,920.50	R21.23	R786,461.34	R107.76	R785,252.81	R107.60	R1,726,634.65	R236.59
Quinary31	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quinary32	R258,134.80	R48.58	R440,183.91	R82.83	R380,615.63	R71.63	R1,078,934.33	R203.04
Quinary33	R624,082.90	R53.64	R837,110.56	R71.95	R762,437.81	R65.54	R2,223,631.27	R191.13

Restoration Costs				
Quinary	Restoration Costs	Restoration Costs	Management Costs	Management Costs
	Over 7 Years	er Ha over 7 yeai	Per year	Per ha Per year
Quinary1	R0.00	R0.00	R0.00	R0.00
Quinary2	R28,986,090.00	R1,456.73	R724,977.72	R36.43
Quinary3	R0.00	R0.00	R780,569.64	R20.14
Quinary4	R0.00	R0.00	R0.00	R0.00
Quinary5	R0.00	R0.00	R550,320.42	R39.47
Quinary6	R17,113,110.00	R450.16	R1,059,492.48	R27.87
Quinary7	R0.00	R0.00	R0.00	R0.00
Quinary8	R26,079,060.00	R2,425.06	R363,227.40	R33.78
Quinary9	R0.00	R0.00	R219,861.12	R9.00
Quinary10	R0.00	R0.00	R0.00	R0.00
Quinary11	R52,690,050.00	R4,294.92	R305,576.52	R24.91
Quinary12	R0.00	R0.00	R365,957.76	R12.04
Quinary13	R0.00	R0.00	R0.00	R0.00
Quinary14	R13,448,610.00	R5,216.68	R71,526.48	R27.74
Quinary15	R0.00	R0.00	R270,932.28	R20.58
Quinary16	R0.00	R0.00	R0.00	R0.00
Quinary17	R0.00	R0.00	R461,386.08	R43.80
Quinary18	R0.00	R0.00	R264,352.56	R27.53
Quinary19	R0.00	R0.00	R134,503.80	R42.79
Quinary20	R3,320,100.00	R392.54	R354,141.12	R41.87
Quinary21	R0.00	R0.00	R155,272.44	R11.95
Quinary22	R0.00	R0.00	R0.00	R0.00
Quinary23	R950,460.00	R80.03	R507,265.08	R42.71
Quinary24	R0.00	R0.00	R181,457.04	R16.22
Quinary25	R14,829,780.00	R1,438.95	R382,429.44	R37.11
Quinary26	R49,684,320.00	R4,312.13	R191,483.28	R16.62
Quinary27	R0.00	R0.00	R349,486.08	R28.38
Quinary28	R0.00	R0.00	R0.00	R0.00
Quinary29	R0.00	R0.00	R721,799.76	R43.43
Quinary30	R0.00	R0.00	R320,436.84	R43.91
Quinary31	R0.00	R0.00	R0.00	R0.00
Quinary32	R17,030,160.00	R3,204.77	R155,317.20	R29.23
Quinary33	R36,521,100.00	R3,139.17	R311,126.76	R26.74

Number of Jobs		
Quinary	For Restoration	For Management
	Per Year	Per Year
Quinary1	0	0
Quinary2	138	24
Quinary3	0	26
Quinary4	0	0
Quinary5	0	18
Quinary6	81	35
Quinary7	0	0
Quinary8	124	12
Quinary9	0	7
Quinary10	0	0
Quinary11	251	10
Quinary12	0	12
Quinary13	0	0
Quinary14	64	2
Quinary15	0	9
Quinary16	0	0
Quinary17	0	15
Quinary18	0	9
Quinary19	0	4
Quinary20	16	12
Quinary21	0	5
Quinary22	0	0
Quinary23	5	17
Quinary24	0	6
Quinary25	71	13
Quinary26	237	6
Quinary27	0	12
Quinary28	0	0
Quinary29	0	24
Quinary30	0	11
Quinary31	0	0
Quinary32	81	5
Quinary33	174	10

3.5.5. Conclusions of the model outputs

The water retention and slow release capacity of the Drakensberg grasslands and wetlands have long been postulated and intuitively managed for and conserved in certain areas such as the Ukhahlamba Drakensberg Park. A model has now been developed which provides the clearest indications of the capacity of the vegetation in the two study areas to supply water related goods and services. Importantly, the model shows that best practice livestock and fire management are good for enhancing baseflows, sediment reduction and carbon sequestration. The model estimates the quantity and value of management improvements to these three services. A fourth service, stormflow reduction, has also been quantified but not valued, due to the lack of a ready buyer. The management actions required to enhance the supply of the above services, also supplies a wider suite of ecosystem goods and services such as reducing water vulnerability, diluting pollution, assimilating discharged phosphates and nitrates, disease reduction, increasing grazing quality and quantity and thus livestock productivity, increase access to thatching grass, increase tourism opportunities and improved biodiversity conservation amongst others. These services have not been valued but are of immense value to user communities, either within the Maloti Drakensberg bioregion or further afield. The resulting economic benefits can be converted to both financial and economic flows by selling the benefits, which, in turn, can pay for the restoration and maintenance of the natural capital or catchments.

However, the magnitude of the restoration and the concomitant costs has broader implications than just trade. As much of the restoration is necessary on communal lands – state land, there needs to be state funding for this intervention. The model clearly shows that the market or consumers could pay for management, but the income from water is generally not sufficient to pay for restoration. This implies, that the state has a role to play in using state funds to implement restoration of its own lands, and then it becomes feasible to charge the users for the upkeep of those lands. The results of the model show that there is a need for a combination of both market based trade in ecosystem services and state funded natural capital restoration programmes.

In summary, the value accruing from ecosystem goods and services as a result of the restoration and maintenance of natural capital are sufficient to be converted into incentives to induce land use management change for the better, for both land users, and for water and carbon buyers. While financially feasible, implementation will require significant institutional buy-in and commitment and accepting significant transaction costs associated with engaging the communal land-users. The following chapter explores these requirements and makes recommendations for implementation.

4. INSTITUTIONAL OPTIONS FOR IMPLEMENTING A PAYMENT FOR ECOSYSTEM SERVICES SYSTEM

4.1. Introduction

Having shown that it is financially feasible and economically desirable to trade ecosystem services from the two study sites, this particular section focuses on the institutional options and models recommended for implementing such a system. It addresses very much what one might call "the business end" of the initiative, in other words, looking at how one would, in practice, implement these large scale management and rehabilitation programmes.

This section primarily addresses what institutional models and options there are to achieve successful implementation of such a programme; and to give effect to this, what resources, skills and other key aspects would be needed for implementation.

In addition to the institutional models and options, this section also discusses the governance arrangements for such a programme. This is critical because the institutional environment for a programme such as this is complex with a large range of stakeholders involved, in addition to the very large community participation element, which is fundamental for such work. The roles of key stakeholders and how they will be kept informed are just as critical as the more technocratic and bureaucratic management aspects.

At this stage in this analysis and study, the focus is tending to be on establishing certain principals and concepts. For this reason, it is not appropriate to delve into great detail in terms of the implementation arrangements and the approach adopted here has rather been on looking at a number of possible options that could be pursued. In addition, these options and recommendations are viewed as those best suited to apply the findings of the economic model.

4.2. Scope of the rehabilitation work to be undertaken

The modeling analysis undertaken has identified catchments where the financial feasibility for rehabilitation is favourable. In this regard, a number of mountain catchments of the upper Thukela in the Mnweni area and also the upper Umzimvubu, have been identified. Further details on the scope of the work in these two areas is very briefly outlined below. In general, the work will focus on the following key elements:

- Fire management
- Grassland rehabilitation
- Donga and related wetland rehabilitation.
- Livestock control and grazing management.

4.2.1. Upper Thukela

The estimated budget to rehabilitate this area is R32 million over a period of seven years. This implies a budget of between four to five million Rands per annum, including escalation. Management would address an area of approximately 180 000 hectares.

This area is also dominated by rural subsistence communities. A large part of it is extremely remote. The environment is heavily degraded due to the carrying capacity of the land, for livestock, being significantly exceeded in settled areas. In addition, the soils in this area are sensitive and susceptible to degradation.

There are no significant urban settlements within the area and the closest is Bergville. There is a significant commercial farming component in this area, estimated to be approximately 20%. This is a potential resource that could be employed to assist the other 80%.

4.2.2. Umzimvubu

It has been estimated that the indicative budget for rehabilitation of the Umzimvubu catchment will be of the order of R260 million. It is postulated that a realistic programme for implementation would be of the order of seven years. This would therefore represent an annual expenditure budget of some R30 - R40 million, including escalation. Management would cover an area of approximately 290 000 hectares. The most significant settlements in the area are Matatiele and Mount Fletcher.

The area is primarily rural subsistence in nature with scattered development and small villages. There is a small proportion of commercial farming estimated at approximately 5% by area.

The level of environmental degradation in this area is extremely serious, far worse both in size and severity, than the upper Thukela area.

4.2.3. Key Challenges

There are a range of challenges for this type of work in this area that are important to recognise in terms of considering the most appropriate overall management arrangements for such a project. A number of these are listed below and are considered in the subsequent discussion.

- These areas are primarily traditionally tribal in nature and it will be important for strong interaction with tribal authorities to occur.
- Local authority capacity is typically weak and capacity building is critical.
- Community participation is fundamental and will require significant resources. While these costs have been factored into the financial model there are several agencies that may accept responsibility for these costs.
- When it comes to aspects such as livestock management there are deeply ingrained cultural practices in place that will not be easy to change. This may result in participants converting their incentive payments into additional livestock and this will have to be negotiated upfront.
- If successful, then the project will permit significant resources and employment opportunities to be channelled into the areas. This is clearly an opportunity, but this process will nevertheless need to be conducted in a very transparent manner as the opportunities created will not be able to fully meet the needs on the ground.
- There is a large range of potential stakeholders that will need to be involved and kept informed of progress on the project.
- Although this may initially be viewed as an additional burden on Government, such an initiative will in effect provide related Departments with an efficient and effective vehicle to carry out their existing legal mandates.
- Catchment Management Agencies, although ultimately being a logical "home" for such a programme, are not yet well established. In the Eastern Cape they are probably at least five years away from having a significant presence. In KwaZulu Natal the situation is more advanced with the process to set up the Advisory Committee for the Governing Board for the Thukela CMA currently underway. It is nevertheless likely to be several years before it has significant capacity. An initiative such as this may however be a catalyst to move these processes along.
- Poverty, unemployment and low education levels are endemic in these areas.
- The prevalence of HIV Aids is likely to be high.
- Infrastructure is generally underdeveloped and the difficult topography exacerbates this situation. Access roads can therefore often be problematic.

- Similarly, communications in such areas can also be a challenge.

4.3. Potential Funding Streams

Significant benefits emerged from the modeling exercise relating to water use and water quality lower down in the catchment area. This means that the most appropriate institution in terms of accessing funding would be the Department of Water Affairs and Forestry. With this in mind, they have been approached initially regarding the results of the model and have expressed interest in exploring the matter further. Carbon trading and biodiversity trading also show some significant benefits, but these markets and opportunities are still in the developmental stage, albeit currently evolving at quite a rapid rate. It would therefore seem that, in the short term at least, DWAF would be the most likely potential source of funding and the biggest state "beneficiary" of the programme. As carbon trading can help to increase the numbers of quinaries where management interventions become financially feasible, a number of strategic partnerships with other relevant agencies will need to be developed. These partnerships could include public sector (local, district, provincial and national government departments) and private sector actors.

As was noted earlier, this work would fall logically into the remit of Catchment Management Agencies when they are established. Until this occurs, the National Water Act allows for the Department of Water Affairs to play that role. The Act also allows for Catchment Management Charges to be levied by CMAs to undertake their work in catchments, specifically around the protection and allocation of water resources. Furthermore the Act also allows the Raw Water Charges to cover the costs of water supply schemes, and associated action necessary to augment the water supply. The likely revenue stream however would certainly not be sufficient to address the large upfront costs needed for rehabilitation. This should rather be targeted at the ongoing maintenance function that is crucial thereafter. A case therefore will have to be made for grant funding by DWAF and other strategic partners to the National Treasury. In specific catchments the financial benefits would appear to be significant and thus a sound case can be put to Treasury in that the expenditure will result in a net saving to the country as a whole. This case stands on its financial merits alone however there are clearly other very significant spin-offs in terms of job creation, upliftment of rural communities and poverty alleviation in areas where the need is particularly acute.

Once DWAF has been successful in motivating such funding, it would then administer those funds in the normal manner and would have a range of options in terms of how it would address implementation in terms of the use of the private sector, NGOs, parastatals etc. These are discussed in more detail in section 4.6.

It is worth noting that the potential benefits identified in the model in terms of carbon trading and biodiversity trading could be very significant. Although this is still a developing market, it is something that should certainly be considered in future and makes the whole logic for the intervention more compelling. It is not explored in detail here. However, provincial conservation agencies, provincial agriculture departments and National Treasury could benefit significantly by partnering with DWAF in implementation as the implementation of a payment for ecosystem services system would significantly promote the attainment of their respective mandates.

4.4. Governance Arrangements

As was noted earlier, the governance arrangements for such an important intervention are critical. This would be the case for any large intervention but this case is particularly key because of the nature of the areas and the complexity of the institutional environment. The governance arrangements seek to spell out the roles and responsibilities of the key players, which is a very important aspect of the programme as a whole. Suggested governance arrangements for the programme are illustrated in Figure 21. The different structures illustrated are discussed in more detail below.

4.4.1. Programme Management Steering Committee (PMSC)

The role of the PMSC is to play the role of oversight for the whole programme for the two implementation areas. Key areas of responsibility would include the following:

- Overall approach – identifying the appropriate objectives, resources and takes to achieve the desired outcomes
- Funding – securing funds for different sources for water and carbon related services
- Overall performance - oversight of the programme ensuing that stated objectives are being met for both implementation areas
- Scope of work – ensuring that the appropriate tasks are identified and implemented
- Lesson learning – reviewing experiences and internalising and sharing lessons emerging in implementation
- Relevant policy matters – ensuring compliance of implementation with relevant legal obligations and institutional policies
- Relevant strategy matters – designing and reviewing implementation strategy

- Guidance to the Umzimvubu Project Management Team and the Upper Thukela Project Management Team – Steering the implementation of the two area projects
- Audit – monitoring and evaluating the outcomes of the implementation for services trading

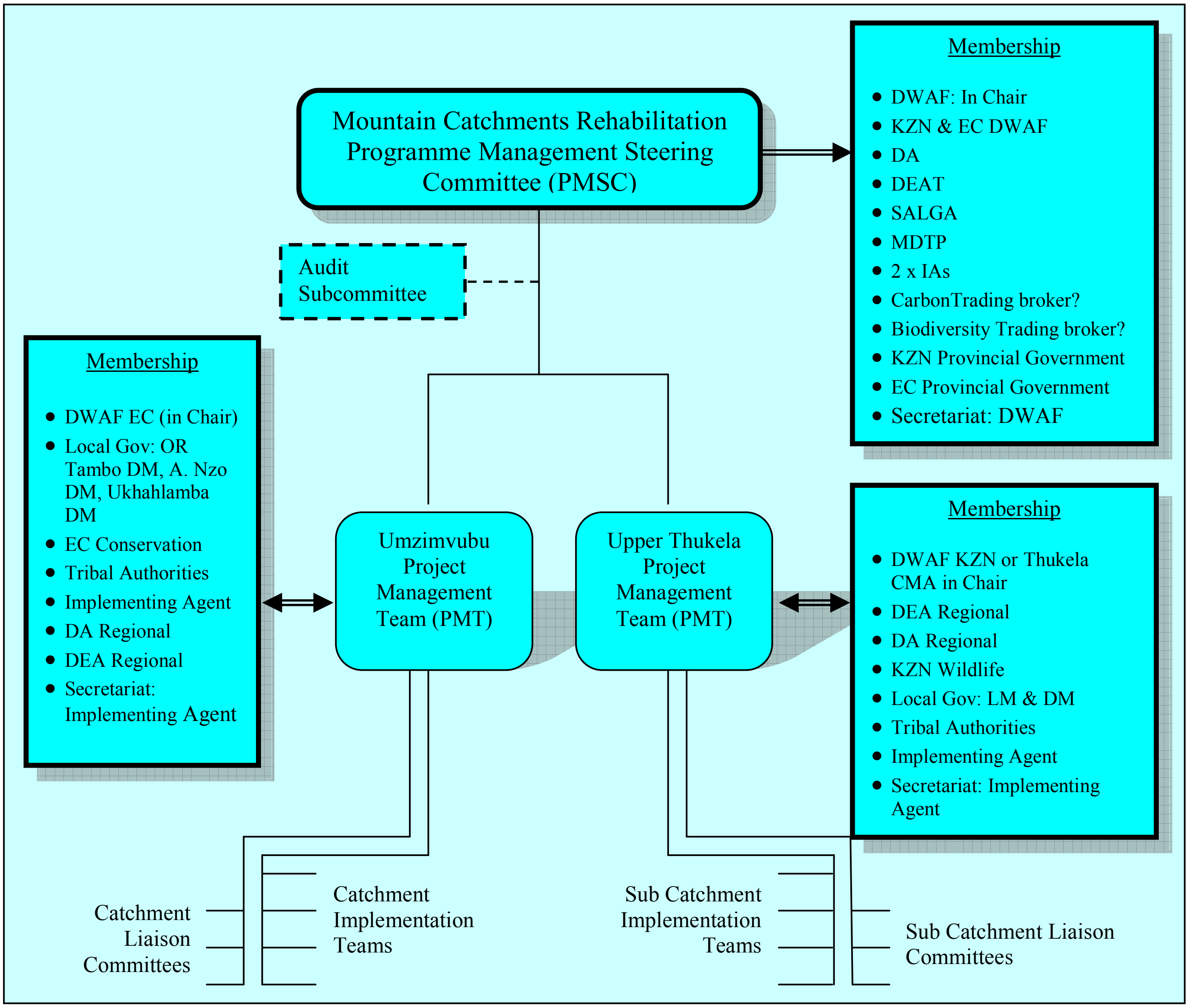

Figure 21. Possible Programme Governance Arrangements

Due to the strategic nature of the programme - the enhancement of water supply and the provision of jobs in a rural area with major implications for numerous government departments – a steering committee of a wide range of stakeholders (as illustrated in Figure 21) will need to be established to ensure sound governance of the programme. It is important to emphasise in view of the range of stakeholders involved, particularly at a government level, that an Inter-

Governmental Relations (IGR) type of initiative will be necessary. In terms of the Chair for such a structure, a case can certainly be made for the Department of Water Affairs and Forestry, Department of Environmental Affairs and Tourism and Department of Agriculture, however, as was noted earlier, at this stage the Department of Water Affairs is seen as the main beneficiary/shareholder (or the 'anchor tenant' for the initiative) and potentially the main funding source. In addition, the Department does have a good track record in terms of implementing significant programmes of capital expenditure so they therefore become the most logical choice to lead such an initiative. In addition to the national government departments, a number of provincial and local government agencies would also need to be involved. The steering committee would also need to be represented by the two project management teams implementing management in the catchments.

It is suggested that the PMSC should meet on a two to three monthly basis. An audit subcommittee of the PMSC is shown as a possible option in Figure 21. This is likely to be a critical requirement if the carbon and biodiversity trading becomes a significant source of income to the programme as "client" organisations will require an independent audit of work undertaken. This is also likely to necessitate the appointment of an independent specialist team, reporting to the PMSC, to assist with carrying out the audits.

4.4.2. Project Management Teams

Two project management teams would be required to implement the management action in the two sites. Key areas of responsibility for these structures would be as follows:

- Implementation of the project/programme – the oversight of the implementation activities in the catchments
- Monitoring progress – monitoring and evaluation of project outcomes in relation to the programme objectives and set tasks
- Budgets – oversee management of finances and monitoring expenditure
- Liaison with water services suppliers and carbon brokerages – communicating with the buyers of services on a regular basis
- Procurement – oversee purchase of materials and services necessary for implementation
- Community liaison matters – ensuring that adequate levels of communication are taking place at the local level to ensure the necessary levels of participation and local leadership buy-in
- Quality assurance – ensuring that local level management is taking place at the required standard

- Oversight of the Catchment Liaison Committees and Catchment Implementation Teams – managing the management implementation within the quinary catchments

It is proposed that these Teams should meet on a monthly basis and as with the programme steering committee, a broad range of stakeholders should be involved to direct management and secure buy-in.

4.4.3. Catchment Liaison Committees and Sub-catchment Liaison Committees

These structures would address the critical area of community liaison at a local level and would be lead by the relevant people from the Catchment Implementation Teams. Key responsibilities would include:

- Keeping local communities and stakeholders informed on progress
- Employment aspects – setting guidelines for employment and performance criteria
- Capacity building – identifying skills requirements and implementing training
- Scheduling of work – planning management activities schedules

It is proposed that this meets on a one to two monthly basis.

4.4.4. Catchment Implementation Teams and Sub-catchment Implementation Teams

This again is very much a practical implementation structure that would consist almost exclusively of the team responsible for implementing projects in particular areas. They are therefore likely to be small groups. Key responsibilities would include:

- Implementation – implementing the recommended management activities
- Labour matters – payment, work discipline, task allocation, performance assessment
- Budgets – identifying budgets for labour and materials for tasks required
- Progress – monitoring work performance and management task implemented
- Quality control – setting work standards and monitoring compliance
- Problem solving – addressing local level problems as they emerge

It is proposed that these would meet on a weekly or two weekly basis.

4.4.5. Criteria for Payments

In addition to the above responsibilities, the system of payments at the local level would need to developed, including the criteria for payments. Payment for ecosystem services systems can be based on either the management undertaken (the most common approach), or the results of that management (an intermediate result – such as basal cover), or 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. The current levels of under-development in the mountain communities implies that self-organisation and management implementation for supplying improved basal cover is unlikely to occur spontaneously. Therefore, in the short term the payment system will need to focus on paying for piece-meal management work, with the potential to shift to broader contract for service delivery in the longer term as local management capacity increases. In addition, the monitoring of ecosystem services will need to confirm whether the desired services are in fact being delivered by the management actions.

Herewith is a set of such payment criteria, and procedures and controls which could form the basis of discussions with participating communities:

Criteria:

- Payments should be based on contractual arrangements between at least two legal entities. These legal entities should represent the demand for water catchment services and the supply of water catchment services.

- The payments system should allow for the fact that the demand-side could constitute, either individually or in combination, government departments, private companies, local and/or international donors, NGO's, research institutions, etc.

- The supply side constitutes rural communities who have opted to change their land use practices in order to supply, enhance, and augment the services required.

- The measurable deliverable should be one that allows for events outside human control. The suppliers of water catchment services should not, for example, be held responsible if it does not rain or if above average events supersede restoration efforts.

- The contract between the parties should stipulate the actions and payments that underpin the transaction. Parties should therefore agree about the type of activity that has to be undertaken and, based on the agreed-upon outcome, the level and schedule of payments.

- The size of the payment, though a negotiated outcome, should be of the order of magnitude that provides sufficient incentive to induce the required land use change and therefore be higher than the opportunity cost (both direct and indirect) of not changing the land use practices, but it should also not be so high as to distort other local markets. In other words, wages should be comparable to those paid in other industries, e.g., agriculture.

- Payments should be sustainable over a long period of time. Contracts should therefore be rather longer term than shorter term. The start-stop cycles of Research and Development (R&D) and consultancy projects are not conducive to the development of social capital or to achieve any long-term objective, such as water catchment service or biodiversity conservation.

- Should the project be one of R&D or consultancy, i.e. pilot project, then it must be clearly communicated and motivated as such, and the longer-term objective be stated as well.

- Communities are, by definition, in a weak bargaining position and utmost care should be taken to consider their welfare, especially at the outset of the project. The development of social capital is as important, if not more, than restoring the natural capital.

- When dealing with communities, care should be taken to work, as far as possible, with existing structures and initiatives. In this way the project will support local action and help gain broad-based community buy-in. Such structures could include the tribal authority, the livestock farmers' network, tourism trusts, or other relevant co-operatives. The principle is: collaborate, consolidate, and strengthen rather than establishing new structures.

- If the project could lead to an improved link between the first and second economies of the country, so much the better.

- If the project can lead to improved relationships among the various stakeholders, i.e. commercial farmers, communities, and conservation agencies, so much the better.

- Given that any water catchment services project has a wide-ranging and far-reaching bearing on land use, broad-based support for the project is necessary. Insofar as far as possible, all the members of the community should, directly (financially) or indirectly (non-financially), benefit from the project.

- Agreements must include a clause that ensures that communities do not invest income in activities that will compromise the agreement e.g. more livestock.

The following procedures and controls will need to established:

- Transactions will take place between two legal entities, based on a contract, and payments shall be linked to clear and unambiguous, that is measurable and quantifiable deliverables.

- Payment schedules linked to both monitoring and evaluation activities and outcomes, should be drafted.

- Once payments have been made, the receiving entity, i.e., the supplier of the services, takes responsibility for managing the funds. In accordance with eco- and ethical labelling practices, however, the party making the payment can discuss the guidelines, upfront as to how the monies will be managed. Such guidelines could be made part of the contract as an annex. Such guidelines could include:

    - That payment to individuals shall be made based on their relative contribution to the project. In this regard, distinction can be made between both the level and the type of effort when considering the individuals' relative contributions;

    - That the expected level and type of effort be communicated in advance and that a payment schedule, and level of payment (rate) linked to each activity, be drafted upfront;

    - That an agreed-upon portion of the funds be set aside for overheads (including accounting fees and auditing), contingencies, and on-going expenditures;

    - That the receiving party's financial statements be audited according to the SA law as and when required by law;

    - That all surplus money be transferred to an agreed-upon, legally registered, broad-based community venture. The use of the monies are to be defined within the MoU between the management group and the broad-based community venture or trust;

- The entity in the community responsible for the restoration and management of the natural capital could be a co-operative, whereas the broad-based community venture could be something like a community trust, or something similar.

- There should be a contract between the restoration entity and the broad-based community venture describing the relationship between them and the basis upon which payments will be made.

In general:

- Arguably the best place to start such a programme of payments for ecosystem goods and services is to have a land use management plan – call it a master plan – and then to manage towards such a plan and its stated long-term objectives.

- Such a master plan should be drafted in collaboration with, and support from, the community members.

While this framework was complied with explicit focus on payments for water catchment services, a large number of these principles apply for other ecosystem goods and services as well. It is therefore not impossible to visualise the supplier of ecosystem goods and services, i.e., the implementing agency, to enter into a multiple number of contracts with a range of institutions regarding payments for ecosystem goods and services. These services could include carbon sequestration and biodiversity conservation. When entering into such a bundle of contracts offering a range of services, care should be taken that the different objectives of these contracts do not lead to contradictory land management practices. This reinforces the need to have an integrative land use management plan and here MDTP could play a major role in such planning.

4.5. Management Arrangements, Skills and Key Resources

This section addresses the management agreements, skills and key resources that are likely to be needed to implement these interventions. This would tend to a large extent, to be a matter that would be common to any of the institutional arrangements and therefore it is appropriate to discuss it here before the discussion on potential institutions. It is also necessary to differentiate between the rehabilitation phase and the maintenance phase since the resources required and skills needed are significantly different.

4.5.1. Upper Thukela Management Team

A possible (indicative) organogram is outlined in Figure 22 below. The Upper Thukela requires a relatively small management team to implement the desired management action. As in standard practice, a manager with general assistants would be required, with a finance officer. Importantly, a community liaison officer would be required given the high levels of community interaction necessary. Other specialist services would be required as specific problems arise.

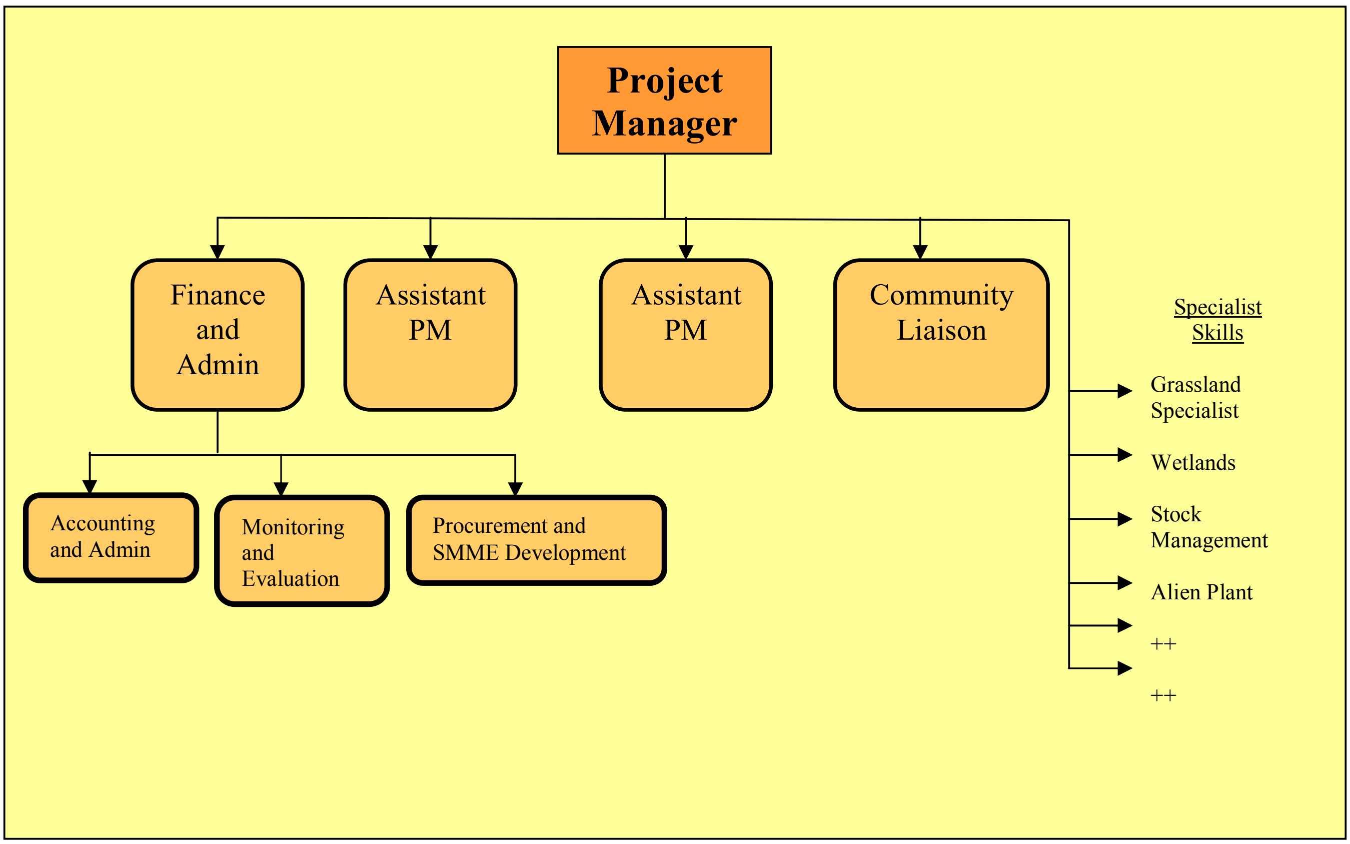

Figure 22. A possible organogram for Mnweni

4.5.2. Umzimvubu Management Team

A possible (indicative) organogram for this is illustrated in Figure 23 below. The Umzimvubu management team is a large team given the level of investment required in restoration. A number of catchment based managers will need to be established to enable sufficient hands-on management. As with the Upper Thukela team, the specialist services of a fiancé officer and community liaison officers will be necessary. Additional specialist scientific services will be required at times to address site specific problems.

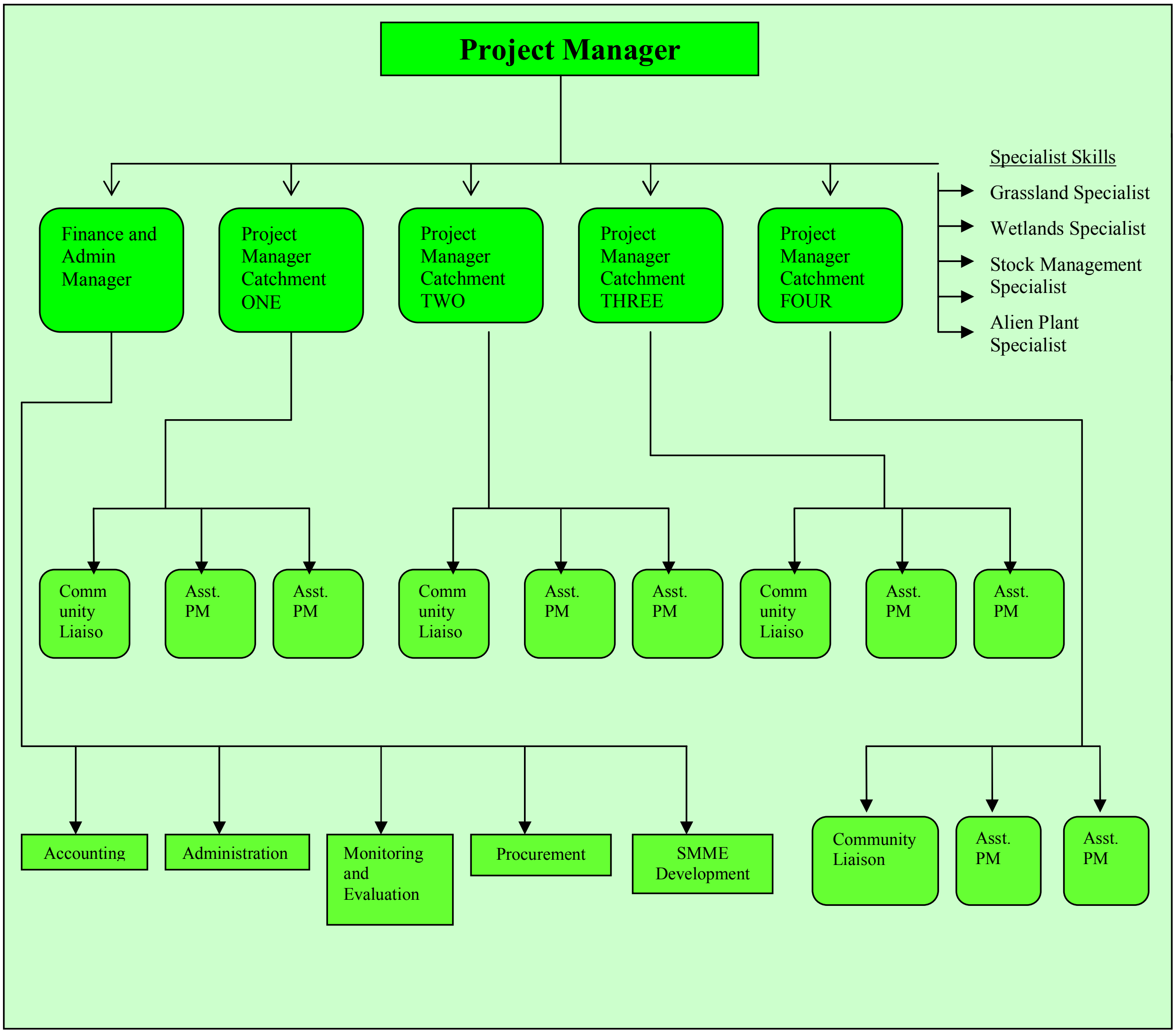

Figure 23. A possible organogram for Umzimvubu

The core management team identified would consist of about 20 to 30 people. In terms of costing (see 4.5.4) it is assumed that a specialist resource would be needed for approximately eight to ten days per month. The number of Catchment Project Manager "legs" is illustrative only and would be up to the Implementing Agency (IA) to determine (the same comment applies to the upper Thukela organogram).

If the local implementation model relies primarily on the use of SMMEs (as we suggest later) then there is a case for SMME development to be carried out within each catchment team as it is likely to be quite time consuming (the same applies to Figure 22).

There are a number of options for implementation of such projects at a local level. Examples would include the following:

- The use of established contractors of different types.
- An Expanded Public Works Programme/Working for Water model of payment on a daily basis.
- Development of SMMEs.
- Use of local established farmers that have capacity.

These are just some examples and often the responsible institution at the helm of such an intervention would express their preference to the Implementing Agent in terms of how they would like it carried out. Given that this project, in concept, has the potential for a significant lifetime, not only in the rehabilitation phase but also in the maintenance phase, our preference would be for the SMME route. This would require more work initially in terms of capacity building etc. but has much more potential benefits in terms of sustainability since the SMMEs, once developed, would have the ability to continue to tender for not only this work but also for work of a similar nature in the area, or indeed in other areas. This is therefore a more sustainable route in terms of local job creation and income generation. It would also have the advantage that the management would be via small contracts that could be paid on specific measurable outcomes within a competitive environment.

4.5.3. Skills needed

Under this heading, it is important to differentiate between the core skills that will be needed for implementing the programme and certain specialist skills that would be needed on a draw-down basis which would necessarily be less intensive. The former would therefore be full-time employees, whereas the latter could be accessed on an hourly basis.

Core skills would include the following:

- Project Management
- Procurement
- Financial Management
- Community liaison
- Administration
- Capacity building
- SMME development (see discussion later)
- Monitoring and evaluation

Specialist skills needed would include:

- Grassland specialist
- Wetlands specialist
- Stock management specialist
- Alien plants specialist
- Social anthropologist
- Hydrologist
- Unspecified others (It probably makes sense with a new intervention such as this to make a contingency allowance for other specialists of some sort.)

4.5.4. Indicative costs

While the costs of management of this programme have been built into the financial model, a discussion of management costs is provided below in order to indicate the magnitude of costs for different components of management. Costs are obviously a key element to be considered although somewhat difficult to estimate at this conceptual stage. There are a number of ways of calculating this.

The staffing and costs are different for the rehabilitation and maintenance phases. For this reason, four tables of costs are set out below, outlining the percentage of each management component cost relative to the total management cost and the Rand value. These should be regarded as indicative. In practice, work on catchments will be carried out in a phased manner and thus the costs would evolve over time. The annual budgets for each scenario were provided from the modelling work referred to earlier.

For a programme of this nature, establishment or the Preliminary and General (P&G) costs will be substantial and could include, establishment of office(s), purchase of vehicles and equipment, etc. This has not been identified as a separate item and it is assumed that it is included in the project management item.

Table 8. Umzimvubu Rehabilitation Cost Breakdown

Indicative Annual Costing for Implementing Agent for Mountain Catchments Rehabilitation Programme

Annual Expenditure Budget assumed to be R30M per annum (escalation excluded)

Item	Unit	Unit Cost	Quantity	Cost	Notes/comments
Project Management	Percentage	NA	15	R 3,947,368	The proportion for project management can vary depending on the scope/TOR. This figure represents to some extent the average in the range. This would include aspects such as community liaison and capacity building and SMME development.
Materials	Percentage	NA	26	R 6,842,105	
Labour	Percentage	NA	45	R 11,842,105	As an SMME implementation model is foreseen at the local level, this figure includes payment to the contractor and his labour.
Tools, transport, logistics	Percentage	NA	10	R 2,631,579	
Access to Specialists	Days	R6,000	150	R900,000	Rate includes for disbursements
Subtotal				R 26,163,157	
VAT				R 3,662,842	
Totals				**R 29,825,999**	

Table 9. Umzimvubu Maintenance Cost Breakdown

Indicative Annual Costing for Implementing Agent for Mountain Catchments Rehabilitation Programme

Annual Expenditure Budget assumed to be R9,2M per annum (escalation excluded)

Item	Unit	Unit Cost	Quantity	Cost	Notes/comments
Project Management	Percentage	NA	14	R1,129,825	The proportion for project management can very dramatically depending on the scope/TOR. This figure represents to some extent the average in the range. This would include aspects such as community liaison and capacity building and SMME development.
Materials	Percentage	NA	13	R1,049,123	Assumes some degree of rehabilitation and other work will be needed on an ongoing basis during the maintenance phase.
Labour	Percentage	NA	29	R2,340,351	Assumes some degree of rehabilitation and other work will be needed on an ongoing basis during the maintenance phase. As an SMME implementation model is foreseen at the local level, this figure includes payment to the contractor and his labour.
Tools, transport, logistics	Percentage	NA	7	R564,912	Assumes some degree of rehabilitation and other work will be needed on an ongoing basis during the maintenance phase.
Access to Specialists	Days	R6,000	50	R300,000	Rate includes for disbursements
Community stipends	Percentage	NA	33	R2,663,158	Herders, indunas, etc., etc.
Subtotal				R8,047,368	
VAT				R1,126,632	
Totals				**R9,174,000**	

Table 10. Upper Thukela Rehabilitation Cost Breakdown

Indicative Annual Costing for Implementing Agent for Mountain Catchments Rehabilitation Programme

Annual Expenditure Budget assumed to be R5M per annum (escalation excluded)

Item	Unit	Unit Cost	Quantity	Cost	Notes/comments
Project Management	Percentage	NA	15	R657,895	The proportion for project management can very dramatically depending on the scope/TOR. This figure represents to some extent the average in the range. This would include aspects such as community liaison and capacity building and SMME development.
Materials	Percentage	NA	23	R1,008,772	
Labour	Percentage	NA	45	R1,973,684	As an SMME implementation model is foreseen at the local level, this figure includes payment to the contractor and his labour.
Tools, transport, logistics	Percentage	NA	10	R438,597	
Access to Specialists	Days	R6,000	60	R360,000	Rate includes for disbursements
Subtotal				R4,438,947	
VAT				R621,453	
Totals				**R5,060,400**	

Table 11. Upper Thukela Maintenance Cost Breakdown

Indicative Annual Costing for Implementing Agent for Mountain Catchments Rehabilitation Programme

Annual Expenditure Budget assumed to be R3,7M per annum (escalation excluded)

Item	Unit	Unit Cost	Quantity	Cost	Notes/comments
Project Management	Percentage	NA	14	R454,386	The proportion for project management can very dramatically depending on the scope/TOR. This figure represents to some extent the average in the range. This would include aspects such as community liaison and capacity building and SMME development.
Materials	Percentage	NA	12	R389,474	Assumes some degree of rehabilitation and other work will be needed on an ongoing basis during the maintenance phase.
Labour	Percentage	NA	29	R941,228	Assumes some degree of rehabilitation and other work will be needed on an ongoing basis during the maintenance phase. As an SMME implementation model is foreseen at the local level, this figure includes payment to the contractor and his labour.
Tools, transport, logistics	Percentage	NA	7	R227,193	Assumes some degree of rehabilitation and other work will be needed on an ongoing basis during the maintenance phase.
Access to Specialists	Days	R6,000	25	R150,000	Rate includes for disbursements
Community stipends	Percentage	NA	33	R1,071,053	Herders, indunas, etc., etc.
Subtotal				R3,233,333	
VAT				R452,667	
Totals				**R3,686,000**	

4.6. Institutional Options

When considering the possible options in terms of institutions that would be suitable to implement such a programme, there are, in theory, a range of possibilities available across the spectrum of government, private sector, parastatals and civil society. Of utmost importance however is whether they have the requisite skill sets and do they have available capacity to undertake the work? In general, it is believed that government institutions are under resourced and would struggle. As was noted earlier, it has been suggested that their role is much more valuable in the programme governance arena (see section 4.4). The capacity of local government is particularly stretched as they continue to struggle to assimilate a range of new responsibilities. While there are certainly municipalities in South Africa who are coping well, this is unlikely to be the case in the two areas in question. In general therefore, it is postulated that the best options lie in the private sector, parastatals or NGOs.

Of course the best and most logical option is with Catchment Management Agencies however these are still in the formative stages of development in South Africa. In the Eastern Cape, the CMA establishment process has not even started and the establishment of a viable institution with significant capacity for the Umzimvubu to Keiskamma WMA area is probably, at best, 5 years away. From experience in other parts of the country, it is apparent that even the process of development of the Proposal to establish the CMA, as required in the National Water Act, can take 2 to 3 years. Much of this is due to the fact that the stakeholder participation processes are onerous, and probably rightly so.

The process to establish the Thukela CMA is better advanced with the Proposal for the establishment of the CMA having been approved by the Minister of Water Affairs. The process to establish the Advisory Committee for the Governing Board is currently underway. It is important to emphasise that at this stage they have no capacity at all to implement. It would therefore be unwise at this stage to allocate them responsibility for a large new programme where there would be significant risks and uncertainties. By the same token however it would also be very unwise not to delegate this task to them as soon as they have the capacity because it is clearly a core responsibility for them in the future.

4.6.1. Implementation Model Options

As was noted earlier, it is assumed that the core buyer of services will be DWAF. In terms of implementation models or modalities, possible options include the following:

- The Implementing Agent route
- Working for Water Programme (enlarged remit)

- Private sector tender
- NGO tender

The Implementing Agent route would utilise a mechanism that was established some while ago to allow DWAF (and other government institutions) to utilise credible, capacitated institutions to assist them with implementation of projects and programmes. Its big advantage is that it negates the requirement of a lengthy tendering process. It is a well-understood process with specific percentages agreed for work to be undertaken and proforma agreements and documentation in place. Once the key agreements have been negotiated, then funds can be transferred and work can commence immediately thereafter. A number of Water Boards have IA status as does the NGO; Mvula Trust. Its main disadvantage is that it is not a competitive tendering process so if there is a major concern about value for money one may want to consider other mechanisms.

The Working for Water Programme has established a very good track record in terms of work on alien plant removal. In the process, they have been able to deal with many of the challenges inherent in the programme proposed here such as handling large budgets, extensive community liaison and procurement. As a result, Working for Water should certainly be considered as an option in terms of an implementation model. Their terms of reference will need to be expanded substantially as alien plant removal is only one of 4 or 5 major aspects needed for successful catchment rehabilitation. Another new aspect is the maintenance phase. This will to some extent require new skills and maybe a new approach but will bring a sustainability aspect to WFW.

Another potential route is that of a private sector competitive tender. This is again a process that is well understood by government agencies, however for large projects this can be a lengthy process. It should result in fair value for money although for a new concept such as this PES system, there, may be pricing risks for both parties. This also makes compiling contractual documentation difficult. Value for money concerns can also apply if there are few tenderers.

NGOs can also tender in the competitive process outlined above but civil society have complained on occasions that current government tender adjudication methodologies discriminate unfairly against them on aspects such as equity of PDIs (previously disadvantaged individuals). NGOs will also argue that the fact that they are driven by “principle rather than profit” makes them a better choice for such work in largely impoverished communities. Another factor to consider is that some funders, the European Union for example, will sometimes set targets for civil society participation that could include benchmarks for expenditure routed through them. This could be a factor if the programme engages with voluntary markets for biodiversity and carbon offsets.

4.6.2. Options for the Umzimvubu Catchment

It is clearly not appropriate in a document such as this to play some kind of marketing role for organisations that may be considered for a programme/project of this nature. Nevertheless, it is the author's belief that, in order to move out of the realms of an academic discussion into practical considerations around implementation, it is important to mention some options that can be considered. In this regard, we list a number of what we believe are credible organisations but this is certainly not intended to be exhaustive. It may very well be that the ultimate solution will use a combination of agencies and of course if a competitive tendering process is followed, then any organisation tendering will have to stand on its own merits at that stage.

In the Umzimvubu Catchment, the following should have the capacity and ability to undertake the work:

- Lima
- Amatole Water
- Umgeni Water
- Amanzabantu

Lima is an NGO that focuses primarily on the agricultural sector. They have extensive experience of working in these catchments and have undertaken a lot of work on donga and grassland rehabilitation. They are very experienced in community-based projects. Of the four organisations listed here, the work required is probably the most closely aligned to their core areas of expertise but they are the smallest which could prove limiting in such a large and diverse catchment.

Amatole Water is a medium size Water Board based in East London. They have a good track record with projects undertaken for DWAF, Department of Education and Department of Public Works. They have also had hands-on experience of work on the Working for Water Programme. They have a lot of experience of projects requiring extensive community participation and would generally partner with Mvula Trust for that component. Amatole Water has Implementing Agent status with DWAF.

Umgeni Water are a large Water Board based in Pietermaritzburg. They have a long track record of undertaking work for a number of clients including DWAF and a number of municipalities. They also have hands-on experience on alien plant removal programmes. They have a lot of experience of projects requiring extensive community participation. Umgeni Water have Implementing Agent status with DWAF.

Amanzabantu are a private sector consortium/company that was formed to bid (successfully) for the Build-Operation-Train-and-Transfer (BOTT) programme for DWAF in the Eastern Cape. The BOTT programme was very large, ran for a period of more than 3 years and covered a large range of water projects, including planning, implementation and operation. Since the completion of that project they have been involved in a range of water sector and other projects. They have also had hands-on experience of the Working for Water programme. They have a lot of experience of projects requiring extensive community participation.

One other important point to note for the upper Thukela catchment is the recent formation of a “special purpose vehicle” to drive Accelerated Shared Growth Initiative of South Africa (ASGISA) in the Eastern Cape. A key priority for this mechanism will be the development of the Mzimvubu basin. There are very likely to be some good synergy opportunities here and these need to be explored further.

4.6.3. Options for the upper Thukela Catchment

In general, KwaZulu Natal is blessed with more institutional capacity than the Eastern Cape. Credible options would include:

- Lima (see discussion under 4.6.2)
- Umgeni Water (see discussion under 4.6.2)
- KZN Wildlife
- Rand Water
- Thukela CMA

KZN Wildlife have a Projects Division, which could undertake work of this nature on a commercial basis. They have a good track record in this regard and have undertaken extensive work on the Working for Water Programme. It is understood that they also have Implementing Agent status but this could not be verified within the time constraints of this study.

Rand Water, like Umgeni Water are a very large Water Board with Implementing Agent status and a lot of institutional capacity. They are based in Gauteng and for this reason may not be interested in this work however, because of the Thukela Vaal transfer scheme, they have a very real interest in protecting the water resources in this catchment and have already been involved in a number of land rehabilitation projects as well as the establishment of the Rand Water Mnweni Trust.

As was noted in the discussion earlier, as soon as the Thukela CMA has the capacity, serious consideration should be given to handing the project over to them.

4.7. Carbon and Biodiversity Trading

As was noted earlier, carbon trading is still an emerging market with significant uncertainly. Biodiversity trading is even less developed but clearly an area that has great potential considering the international biodiversity importance of the area as a whole, and the emerging global markets in biodiversity offsets. The modelling work has indicated that the financial viability of rehabilitation in a number of catchment is attractive purely from a water resources perspective. Where carbon and biodiversity trading are key are that, not only do they make these catchments even more attractive, they also make rehabilitation of more catchments feasible.

What institutional arrangement would be appropriate and most effective to access funding from carbon and biodiversity trading? Clearly a key role will need to be played by a "carbon and/or biodiversity broker". As the name implies, they will act as a middle man/woman between the programme and potential "clients" looking for projects which can yield "carbon or biodiversity offsets". In view of the potentially key role the brokers can play in terms of raising funding we have shown them as sitting on the PMSC for the project. With the information available at this stage it is not clear whether this is appropriate or not.

Also critical will be the relationship between the brokers and IAs. The reason for this is that it will probably be necessary for projects (in this case catchments or sub catchments) to be "packaged" for presentation to potential carbon and biodiversity clients. The brokers will have to guide this process but IAs will need to generate the documentation. It is important that this function is written into the terms of reference of the IAs.

This is such a new area that there may be a range of other innovative mechanisms and options that can be considered for implementation. The whole area of building/facilitating a market for trading ecosystem services is one that lends itself to more of a private sector input. It has even been suggested that some sort of public private partnership should be explored. The Trans Caledon Tunnel Authority, as a key player in terms of raising commercial funding for major water resource projects, may even be able to pay some sort of role. The big attraction of course is that the more funding that can be generated, the more will be available for rehabilitation and for payments to poor rural communities.

4.8. Conclusions on implementing institutions

This section sets out some high-level ideas and options around the institutional arrangements that are likely to be necessary for successful implementation of rehabilitation of mountain catchments in the upper Thukela and upper Umzimvubu basins. The key proposals relate to governance arrangements (which are always mission critical for a large programme of this nature), indicative staffing/organograms and institutional options. With regard to the latter, there are a number of “layers” to be considered which include the type of implementation mechanism chosen, the type of institution and implementation modalities at a local level.

5. CONCLUSIONS

Within South Africa, the Maloti Drakensberg mountains are the most strategic water source in the region, supplying much of the sub-continent through rivers, and national and international inter- basin transfers. The natural vegetation in these mountains is the main engine for maintaining a regular and quality water flow. However, the vegetation outside of protected areas is being transformed through inappropriate land use.

The application of regulations relating to fire management and stocking rates has been largely unsuccessful, with large areas of landscape becoming seriously degraded. In addition, previously well managed areas are coming under increasing pressure from arson, excessive grazing and land use transformation.

The costs of such degradation or transformation are significant. Stream flow in the dry season is reduced or may cease to flow, while summer flows are exacerbated, resulting in flooding, soil erosion, reduced veld productivity, water scarcity, poor water quality and increased water vulnerability. Water storage and abstraction infrastructure is impaired through sedimentation leading to increases in the costs of water supply.

Due to the high value of the water resource supplied from the Maloti Drakensberg, and the growing scarcity of water in South Africa, there is an emerging need to incentivise mountain catchment management by paying mountain communities to supply ecosystem services, and in particular, water related services.

Many mountain catchments have been managed for water on an intuitive basis for the last 100 years in South Africa. This study has developed an ecology-hydrology-economic model which has for the first time shown:

- what best practice veld management is required for enhanced basal cover, and the concomitant ecosystem services including enhanced baseflows, reduced storm flows, reduced sediment erosion and improved carbon sequestration,
- the quantities of the changes (or enhancement) in the services supplied,
- the costs of the management required to enhance the supply of services,
- the values of enhanced services supplied,
- the financial and economic feasibility (and prerequisites) for implementing management, and
- the exact location of the area or sub-catchment where management is required.

Two priority case study areas were assessed using the model, namely:

- Upper Thukela and
- Umzimvubu

Within these areas, the hydrological modelling confirmed that biennal spring burning, grazing at recommended stocking rates, and restoration of degraded grasslands could make significant impacts on reducing run-off, increasing infiltration, reducing summer river baseflows and increasing winter base flows. This would further result in significant reductions in soil erosion and increases in soil carbon content. In essence, good cattle farming practices are good for producing water, soil protection and carbon sequestration services. And conversely, poor stock farming generates significant costs to society.

In the Thukela, good management practice results in an additional 12.8 million m^3 in winter river baseflows, with a sales value of R3.8 million per annum and it adds value to the economy by between R18 million and R88.7 million per year. With only 4 million m^3 surplus in the upper Thukela, the additional water represents a 320% increase in surplus or allocable water. In terms of the whole Thukela basin, the additional water represents a 23% increase in allocable water. The same action reduces sediment yields by 1.2 million m^3, with a value of R4.1 million per annum in cost savings, while carbon sequestration is worth R8.7 million per annum. In total, the sales of services from the upper Thukela could generate R16.7 million per annum. The costs of management on the other hand are R3.8 million per annum and restoration would cost R31.9 million over the first 7 years.

In the Umzimvubu, good management practice will result in an additional 3.9 million m^3 in winter river baseflows, with a sales value of R2.7 million per annum. The additional water adds value to the economy by between R5.7 and R27.1 million per annum. Importantly, access to water in periods of scarcity reduces rural household vulnerability, especially in the Eastern Cape where many households rely on river water as their primary water source. In terms of erosion, the reduction in sediment is 4.9 million m^3 per annum and this has a value of R16.2 million per year. Carbon sequestration is worth R21.9 million per annum. In total, potential sales of services could amount to R40.7 million per year. Management costs are estimated to be R9.2 million per annum, with restoration costs reaching a high of R260 million for a 7 year period.

Between the two upper catchments, the trade in ecosystem services has the potential to generate 1800 restoration-related jobs per year for the first seven years of the intervention and almost 500 permanent jobs in veld management.

Furthermore, by improving baseflows and vegetation cover, a wide range of ecosystem services associated with healthy rivers and grasslands are enhanced, for the benefit of both the local and more remote users. In addition, the intervention in the Thukela, apart from increasing the baseflow in winter also increases the mean annual runoff. In contrast, the mean annual runoff in the Umzimvubu catchment is dramatically reduced, through the addition of improved basal cover. There is immense value in this, as the runoff is converted to green water - plant biomass - which has considerable value to the local residents in areas of expanding desertification. This also has significant implications for biodiversity conservation, as the reduced MAR is converted to plant biodiversity. The reduction in soil yields are also significant, as this reduction in soil loss will convert to higher grassland productivity, better water quality and reduced water infrastructure maintenance costs.

The above estimates imply that there is a significant suite of benefits for both local ecosystem services producers (the farmers and mountain communities) and for the broader user or catchment community. However, costs are varied, with some areas, notably the Thukela, showing that payments for ecosystem services as a market based mechanism are feasible, while other areas, largely the Umzimvubu, would require public works programmes to restore the grasslands before it was possible to institute a market-based payment-for-management system. In addition, for many of the areas, trade only becomes feasible when more than one of the ecosystem services is traded.

The magnitude of the restoration costs has broader implications for an ecosystem services trading system. As much of the restoration necessary is on communal lands – state land - there needs to be state funding for this intervention. The feasibility assessment shows that consumers could pay for management, but the income from water is generally not sufficient to pay for restoration actions. This implies that the state should use state funds to implement restoration of state lands, and then it becomes feasible to charge the ensuing service users for the upkeep of those lands. The results of the assessment shows that there is a need for a combination of both market based trade in ecosystem services and state funded natural capital restoration programmes.

In essence, improved management and restoration can shift destructive summer flows in periods of water abundance or excess, to the winter months when water is scarce and when value can be added to the water. The reduced storm flows also reduces soil erosion, reducing the sedimentation of water infrastructure, and improving productivity of the associated land. Importantly, a trade in ecosystem services will result in large positive externalities, with more ecosystem services, less water vulnerability, more jobs in the region, and improved land quality that can stimulate the development of a host of other economic options, such as tourism, game farming, improved grazing and natural products harvesting.

The eco-hydrological/economic assessment has shown conclusively that it is feasible and indeed economically desirable for a payment for ecosystem services system to be established in the Maloti Drakensberg. The model developed in this process is 'live' and can be used by stakeholders to inform project implementation activities. A set of variables can be changed and the outputs used to inform decision making.

The question then arises, what is the institutional system required to establish and implement such a trade system?

An assessment of the trade requirements, the scale and nature of the management required and the existing institutional context, has pointed to the need for two key processes in implementation. The implementation process requires both an implementing agent and a governance system. As the trade will engage with a nationally strategic resource (water), in an ecologically sensitive area, on agricultural lands in association with vulnerable communities, in association with a World Heritage Site, and with a need to use public monies for the restoration of natural capital before the market can be engaged to maintain the assets, an oversight mechanism or governance mechanism is required.

It is recommended that a steering committee is developed to play the oversight role, and should be driven by DWAF as the 'anchor tenant' or key partner in the programme. This committee would need to have subcommittees for both the Thukela and Umzimvubu systems, and an audit committee particularly when carbon offsets are traded. These committees will then need to direct an implementing agent in each of the two regions. The steering committee would also need to play a strong role in securing 'deals' for the supply of services, especially carbon and biodiversity. This committee would also need to have a strong relationship with brokers of these services.

The implementing agent would ensure that management action is implemented on the ground by catchment implementation teams at the right costs, standard, time, location, frequency, etc. The implementing agents would need to be effective project managers, with strong administration, financial and delivery skills. The implementing agent would need to work closely with catchment liaison committees, consisting of tribal authorities, stakeholders and implementing teams, who would help direct implementation of restoration and management actions on the land.

The implementing agent/s for market development and the associated management and restoration implementation, could be sourced in a number of ways:

- Working for water could be agent to implement this initiative with their existing expertise,
- An agency with official 'Implementing Agent' status with DWAF, such as KZN Wildlife and large water boards,
- A tender could be offered to private and NGO agencies with the requisite skills.

In the long term, the implementing agents should be the Catchment Management Agencies, but as they are either developing or proposed at this point in time, they should be involved but are not in a position to implement.

Lastly, it is important to note that there are no legal impediments to the implementation of a trade system for water related services or management, as the National Water Act makes provision for either levies to be charged for catchment management or for raw water charges to include the costs of a water supply scheme, that can include both the management and restoration of water supply assets – and in this case natural assets.

Institutionally, the systems, laws and resources are available in South Africa to implement a payment for ecosystem services system.

The demand to implement such a system has been made clear during the course of this investigation. The producers of ecosystem goods and services – the communal farmers, commercial farmers and conservation agencies have clearly articulated the need for new income streams, the willingness to engage in management actions (albeit with various degrees of effectiveness), and the desire to restore their land to former high value. Linked to these producers are numerous local and district municipalities which have identified a payment for ecosystem services as a means to promote local economic development in remote rural areas, and to help improve municipal environment management (a mandate of local government).

The demand for payment for ecosystem services from consumers and buyers was more mixed, with large strategic agencies like DWAF and Rand Water being optimistic regarding the possibility of identifying new and cost effective water augmentation options. Smaller water utilities had concerns about who would pay for additional costs. However, the assessment has shown that appropriate veld management could represent one of the cheaper water augmentation strategies available, and therefore payment for ecosystem services is in fact a cost savings option for consumers in future water supply augementation.

This assessment shows that a payment for water and carbon services is ecologically, hydrologically, economically and institutionally feasible. It is also desirable from a development and social equity perspective, rewarding those who maintain a water supply engine but who are spatially and economically marginalised.

The broader implications of this assessment (in two case study areas of high and low rainfall) is that the Maloti Drakensberg as a whole must generate a similar range of economic benefits in all other catchments, and therefore a similar assessment should be undertaken to identify the need and opportunity for enhancing further veld management and restoration, enhanced services supply and generating greater economic benefits in mountain communities. This opportunity could equally apply to all mountain communities in high rainfall regions in southern Africa.

With the availability of quality water predicted to be the single greatest development constraint facing South Africa, and virtually all surface waters in South Africa already allocated to users, the adoption of new supply enhancement strategies is urgent. An efficient way to invest in water security is to protect it at its source through prudent land management. In this way, investing in land management becomes a water augmentation and an economic development intervention.

6. REFERENCES

Acocks, J.P.H. 1988. Veld Types of southern Africa. Botanical Research Institute, Pretoria, RSA. Botanical Survey of South Africa Memoirs, 57. pp 146.

Aylward, B., Bandyopadhyay, J. and Belausteguigotia, J.C. 2005. Freshwater ecosystem services. Ch 7 in: Ecosystems and Human Well-Being: Policy Responses, Vol 3. Millennium Ecosystem Assessment, Island Press, Washington DC, USA.

Blignaut, B.J & M. Mander (2007) Benefits of the Drakensberg: Developing the range of incentives for improved management In Maloti Drakensberg Transfrontier Project (2007) Payment for Ecosystem Services: Developing an Ecosystem Services Trading Model for the Mnweni/Cathedral Peak and Eastern Cape Drakensberg Areas. Mander (Ed) INR Report IR281. Development Bank of Southern Africa, Department of Water Affairs and Forestry, Department of Environment Affairs and Tourism, Ezemvelo KZN Wildlife, South Africa.

Blignaut, B.J & M. Mander (2007) Understanding the catchment services, producers and their economics In Maloti Drakensberg Transfrontier Project (2007) Payment for Ecosystem Services: Developing an Ecosystem Services Trading Model for the Mnweni/Cathedral Peak and Eastern Cape Drakensberg Areas. Mander (Ed) INR Report IR281. Development Bank of Southern Africa, Department of Water Affairs and Forestry, Department of Environment Affairs and Tourism, Ezemvelo KZN Wildlife, South Africa.

Blignaut, B.J. (2007) Estimate of finances available for the purchase of activities to improve the delivery of water related ecosystem services In Maloti Drakensberg Transfrontier Project (2007) Payment for Ecosystem Services: Developing an Ecosystem Services Trading Model for the Mnweni/Cathedral Peak and Eastern Cape Drakensberg Areas. Mander (Ed) INR Report IR281. Development Bank of Southern Africa, Department of Water Affairs and Forestry, Department of Environment Affairs and Tourism, Ezemvelo KZN Wildlife, South Africa.

Blignaut, J., Aronson, J., Mander, M., & C. Marais (In Prep.) Investing in natural capital and economic development: South Africa's Drakensberg mountains.

Clewell, A.F. and J. Aronson 2007. Ecological restoration: Principles, values, and structure of an emerging profession. Washington, D.C.: Island Press.

Department of Water Affairs and Forestry. 2004. Internal Strategic Perspective: Thukela Water Management Area. Prepared by Tlou & Matji (Pty) Ltd, WRP (Pty) Ltd, and DMM cc on behalf of the Directorate: National Water Resource Planning (East). DWAF Report No. P WMA 07/000/00/0304.

Everson, C.S. and Everson, T. 2007. Respectively CSIR and University of KwaZulu-Natal, Pietermaritzburg, RSA. Personal communication.

IIED, 2007. Water Ecosystem Services and Poverty Reduction under Climate Change. International Institute for Environment and Development, London, UK. pp 33.

Mr. Craig Thompson of Amatole Water regarding how to implement the rehabilitation programme and the possible role of Amatole Water: personal communication

Mr. Duncan Stewart of Lima regarding how to implement the rehabilitation programme the possible role of Lima: personal communication

Mr. Graham von Maltitz of the CSIR: personal communication (November 2007)

Mr. Oliver Ive of Amanzabantu regarding how to implement the rehabilitation programme and the possible role of Amanzabantu Water: personal communication

NLC, 2005. National Land Cover satellite imagery. CSIR and ARC Consortium, Pretoria, RSA.

Scholes, R. 2001. Global Terrestrial Observing System: Regional Implementation Plan for Southern Africa. GTOS-21. CSIR, Pretoria.

Schulze, R.E. 1995. Hydrology and Agrohydrology: A Text to Accompany the ACRU 3.00 Agrohydrological Modelling System. Water Research Commission, Pretoria, RSA, Report TT 69/9/95. pp 552.

van Niekerk, K. Mahlangu, I, Mavundla, K and M. Mander (2007) Identification of current land use management practices and associated costs influencing water related services in the Ukhahlamba region In Maloti Drakensberg Transfrontier Project (2007) Payment for Ecosystem Services: Developing an Ecosystem Services Trading Model for the Mnweni/Cathedral Peak and Eastern Cape Drakensberg Areas. Mander (Ed) INR Report IR281. Development Bank of

Southern Africa, Department of Water Affairs and Forestry, Department of Environment Affairs and Tourism, Ezemvelo KZN Wildlife, South Africa.