

**ENVIRONMENTAL MANAGEMENT STRATEGY:  
KRANTZKLOOF NATURE RESERVE, A CASE  
STUDY.**

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of Civil Engineering, Surveying and Construction, University of Kwazulu-Natal

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## ACKNOWLEDGEMENTS

I would like to thank Dr. Cristina Trois for her invaluable assistance in providing me the opportunity to complete my MSc. Degree. I would also like to thank my son Michael for taking the photographs that appear in the text.



## **PREFACE**

This dissertation has been prepared in accordance with the Style Guide for Dissertations prepared by the Civil Engineering Program, University of Kwazulu-Natal. This dissertation has been written by Paul Seaman and it is the author's own work and has not been submitted in part, or in whole, to any other university

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**Dr C. Trois**

### ABSTRACT

KZN Nature Conservation Services budgetary cuts for the Krantzkloof Nature Reserve (KNR) has led to economic shortfalls in important areas like facilities maintenance and invader plant control. The study has found that the benefits of maintaining KNR, determined from the estimated Total Economic Value (TEV), are huge and far outweigh the budget shortfall. The shortfall has been closed by user charging, the timing of which has prevented any deterioration in the facilities and ecology of KNR due to budget cuts.

Facilities maintenance needs to be prioritized to protect the user charge funding base and alien invader control needs to be prioritized due to escalating costs and the magnitude of the problem.

The study has found that subcatchment stakeholder groups in the developing Emolweni forum, within which KNR is strategically placed, are strongly associated with local conservancies which will essentially provide the backbone for the envisaged forum. In order for stakeholder groups to be more representative, however, it is important for local conservancies to find a way to draw in community groups not normally involved in conservation work. The forum should provide networking and support for projects like environmental education, income generation and rehabilitation that will allow these community groups to participate in conservation work in a meaningful way. Delivery should occur through strategically placed community institutions like schools and clinics and should target young people and the unemployed.

Nature reserves have largely untapped resources and a *quasi- option value* project is explored that combines alien vegetation control with the development of an indigenous nursery in an ecological and economic sustainable manner. It is envisaged that income derived from the sale of horticultural plants may substitute the income derived from medicinal plants and thus reduce the pressure applied on KNR's threatened resources by the unemployed.

The study recommends that the subcatchment be divided into manageable units, based on a situational analysis, out of which particular criteria and objectives can be developed. Surveys, inventories, mapping and research activities should be carried out, with reports on the state or use of soil, water and biota submitted to the forum, which can then provide management solutions.

## **ACRONYMS USED**

CBA – Cost/Benefit Analysis  
 C & I – Criteria and Indicators  
 CEO – Chief Executive Officer?  
 CMA – Catchment Management Agency  
 CMC – Catchment Management Committee  
 CMF – Catchment Management Forum  
 CMP – Catchment Management Plan  
 CMS – Catchment Management Strategy  
 DEAT – Department of Environmental Affairs and Tourism  
 DMA – Durban Metropolitan Area  
 D'MOSS – Durban Metropolitan Open Space System  
 DOA – Department of Agriculture  
 DWAF – Department of Water Affairs and Forestry  
 ESF – Emolweni Subcatchment Forum  
 FMU – Forest Management Unit  
 FSC – Forest Stewardship Council  
 GB – Governing Body  
 GIS – Geographical Information System  
 ICM – Integrated Catchment Management  
 IWQS – Institute for Water Quality Studies  
 KNR – Krantzkloof Nature Reserve  
 KZN – Kwazulu-Natal  
 NCO – Nature Conservation Officer  
 NFA – National Forests Act  
 NFAP – National Forestry Action Program  
 NGO – Non-governmental organization  
 NWA – National Water Act  
 NWRS – National Water Resource Strategy  
 PPRI – Plant Protection Research Institute  
 RMU – Resource Management Unit  
 RQOs – Resource Quality Objectives  
 SA – South Africa  
 SAAB – South African Association of Botanists  
 SANF – South African Nature Foundation  
 SFM – Sustainable Forestry Management  
 SMF – Subcatchment Management Forum  
 SYM – Sustained Yield Management

TEV – Total Economic Value

UNCED – United Nations Conference on Environment and Development

WESSA – Wildlife and Environment Society of South Africa

WMA – Water Management Area

WMI – Water Management Institution

WQO – Water Quality Objectives

WUA – Water User Association

WWF – World Wildlife Fund for Nature

WWP – Working for Water Program

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## 1. INTRODUCTION AND CONTEXTUALISATION OF PROBLEM

### 1.1. Preamble

Kwazulu-Natal (KZN) Nature Conservation Services have faced extensive budget reductions in the past few years and were reported to say that if Krantzkloof Nature Reserve (KNR) is to continue functioning then the onus would be on the community to provide the required funding. The director of KZN Nature Conservation Services stated that the funding problem is serious and is not going to get any better (Gray, 11 March, 1999).

The environmental manager for the Durban Metro Council was reported to say that dramatic changes in the way conservation systems are funded in the future, will be seen (Gray, 11 March, 1999). The inference from the statement is that funds will be reduced

With a nearly two thirds budget cut for KNR in 1998, there was an urgent need to raise funds to supplement underfunded items and the implementation of a user charge was inevitable. The study initially investigated

- what users were prepared to pay in order to determine if the budget shortfall could be covered by user charges.
- the effect of a user charge on the frequency of visitation.
- other sources of funding.

To continue functioning (ecologically and recreationally) shortfalls in certain items of the budget allocation for KNR needed to be assessed. The study then investigated

- the item allocation changes from the 1997 to the 1998 budget associated with maintaining the integrity of KNR.
- the way these items are managed.

If the required funding target is not reached then the deterioration of KNR will occur with the resultant costs to the community. The study determined the estimated cost to the community if the nature reserve had to deteriorate and compared this with the cost of providing for the budget shortfall.

This comparison was done to highlight the extent of the problem that could occur (in economic terms) compared to the cost of providing for the budget shortfall.

The cost to the community if KNR had to deteriorate was determined by the *estimated* Total Economic Value (TEV) attached to the nature reserve. The net benefits of maintaining KNR was determined by finding the difference between the estimated TEV attributed to the nature reserve and the cost of providing for the budget shortfall.

- Climax riverine forest on the valley floor
- Aquatic systems associated with the streams and rivers



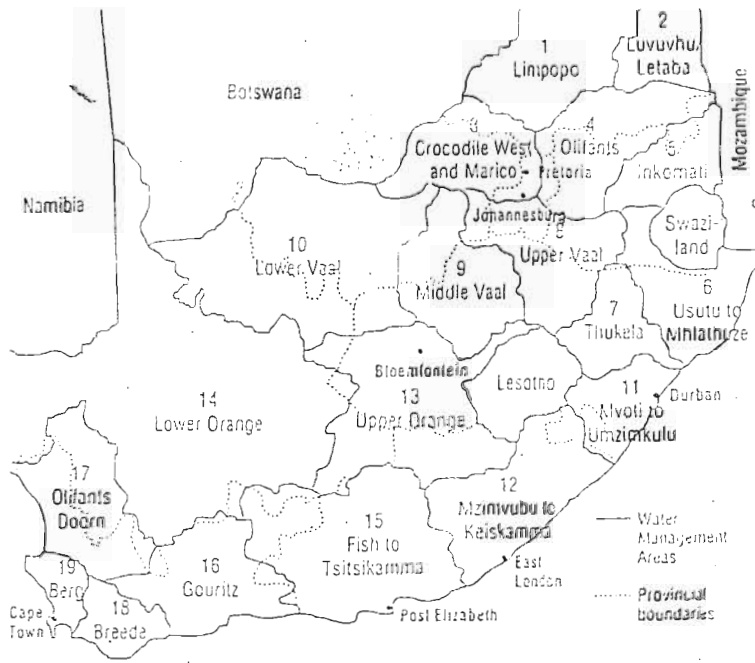


Figure 2-2 – Water Management Areas of S.A. – National Water Act News, November, 1999

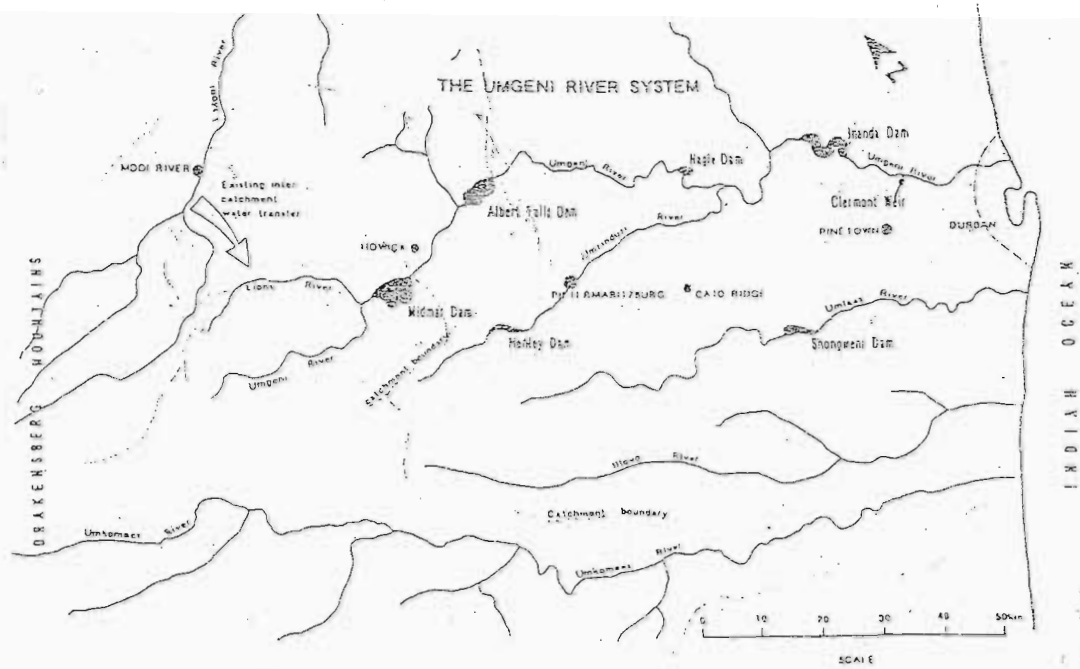


Figure 2-3 – The Umgeni River System – source unknown

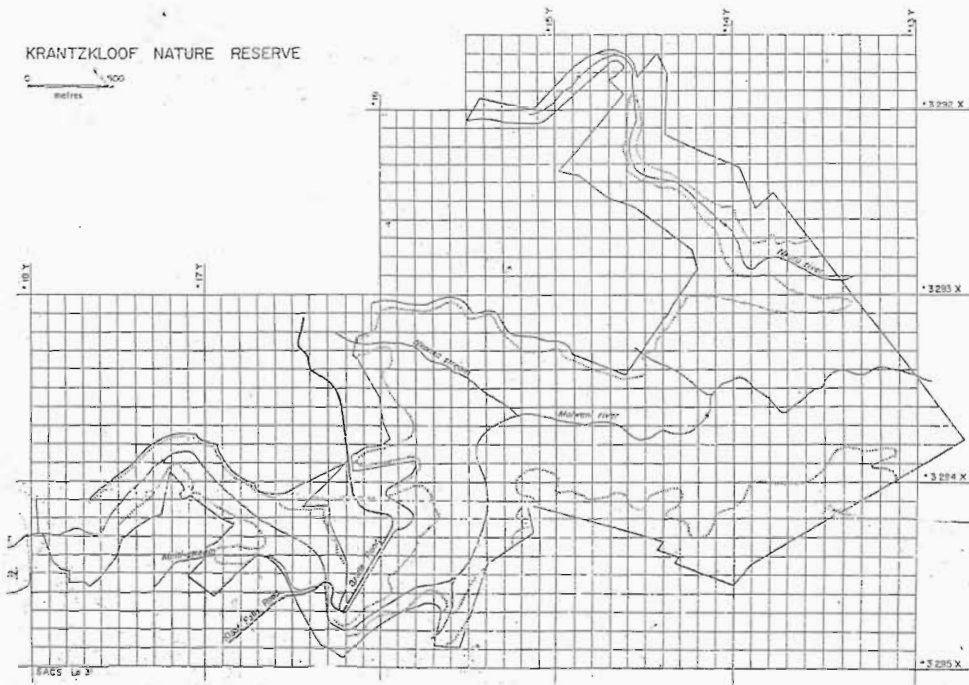


Figure 2-4 – Passage of the Emolweni and Nkutu rivers through KNR – source KNR NCO  
 \* 3 FORMAL ENTRANCES TO KNR



MOLWENI

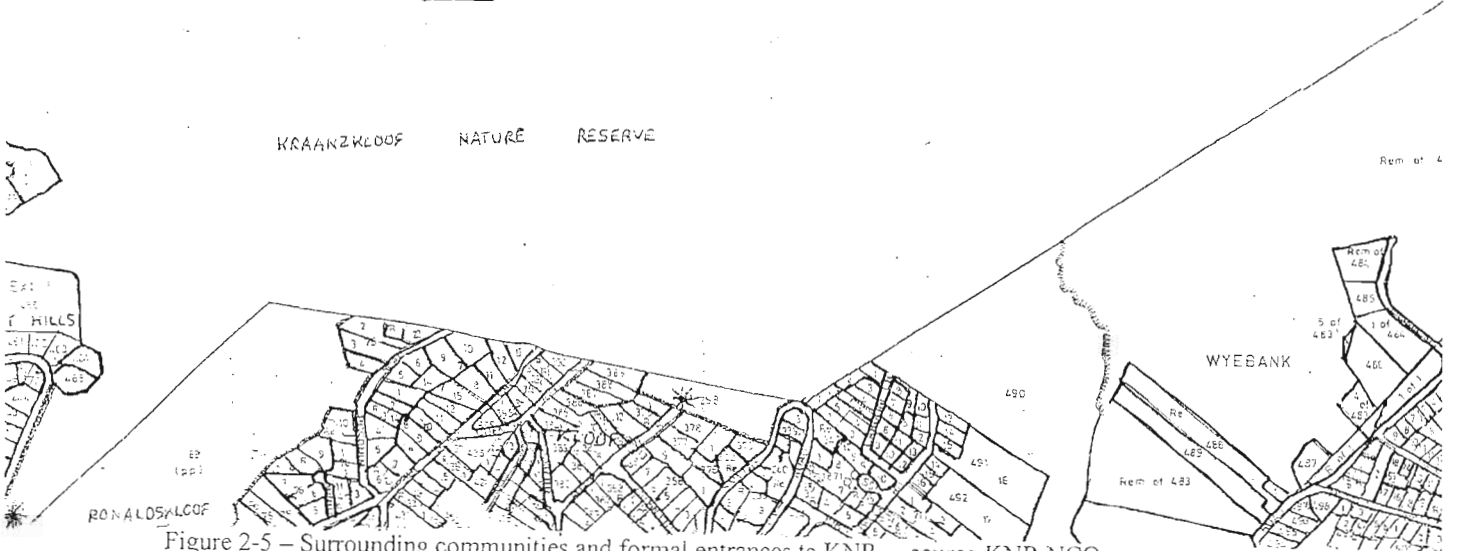


Figure 2-5 – Surrounding communities and formal entrances to KNR. – source KNR NCO

### 2.3. Privately owned land in the vicinity of KNR

The plot consists of 0.8 ha of sloped, south-facing land alongside an indigenous forest located approximately 1 km from KNR and approximately 1 km from a major shopping centre.. Plate 2-1 indicates the position of the area (sub 335 marked by a white cross) relative to KNR. A forest corridor extending towards KNR can be seen.



Plate 2-1 - Aerial map of privately owned land relative to KNR

The Nkonka stream, (Figure 2-4), that feeds the Emolweni River in KNR, flows underground through the bottom of the property. The area was originally developed as a pine and gum tree plantation. Clearfelling took place approximately 20 years ago (owner of adjoining property, pers. comm., 2004).

Plate 2-2 shows the remains of a felled pine stump.

Plate 2-3 shows one of the last standing pines at the edge of the study site.



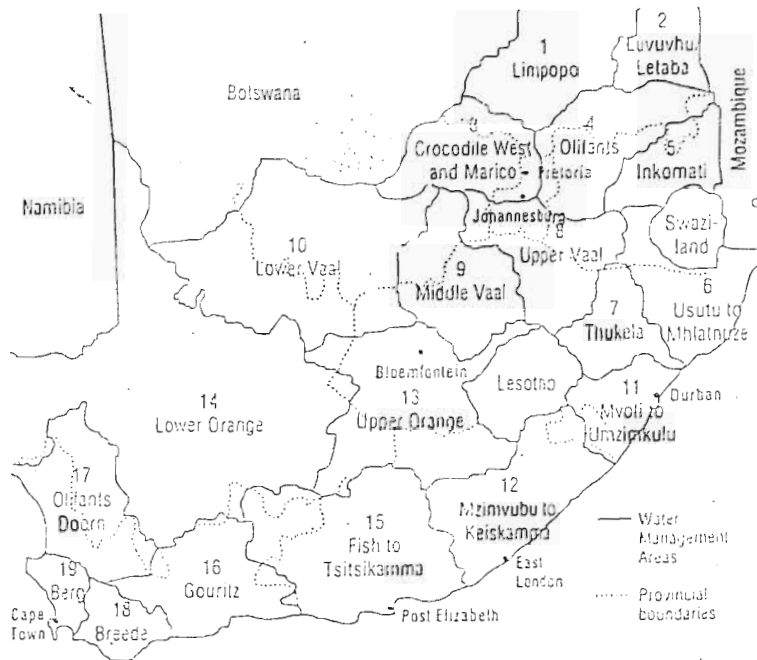


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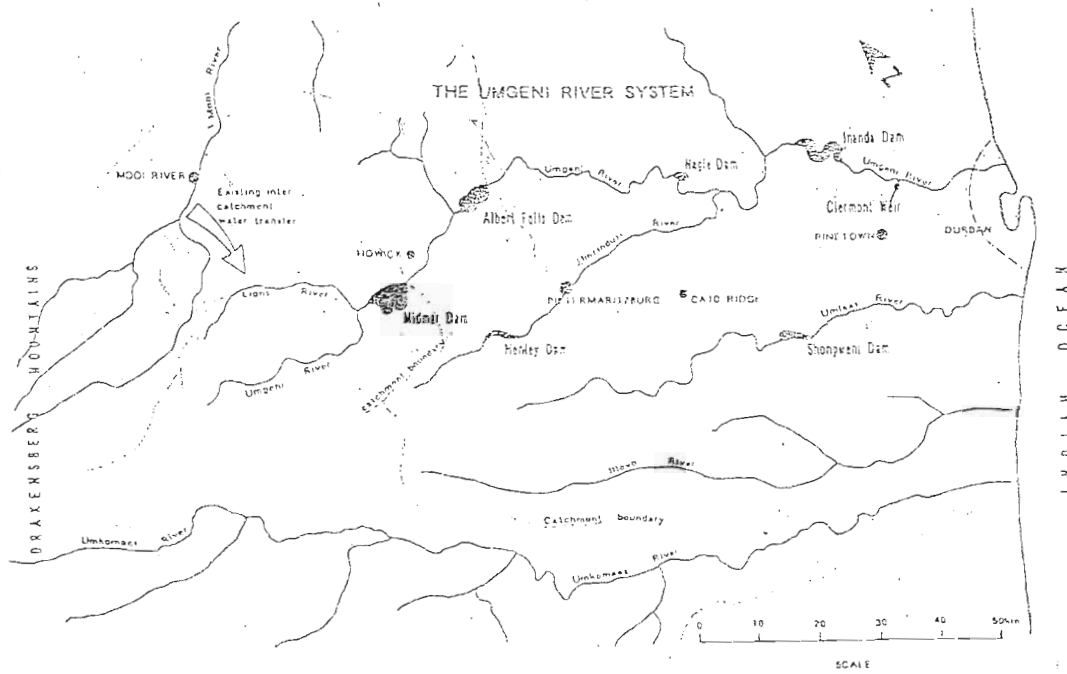


Figure 2-3 – The Umgeni River System – source unknown

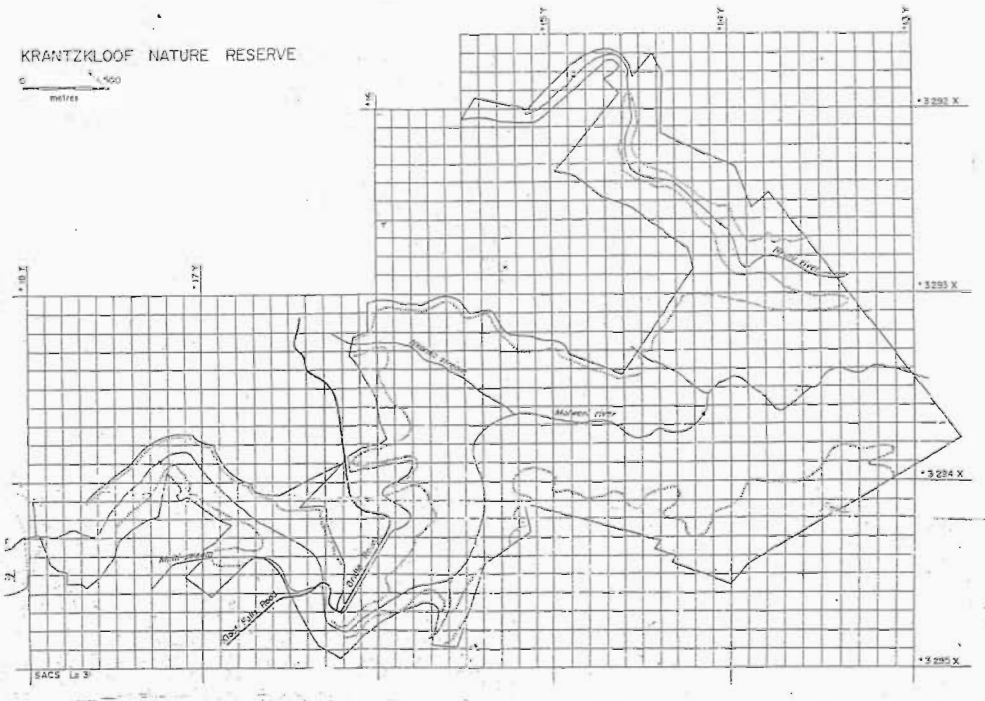


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MOLWENI

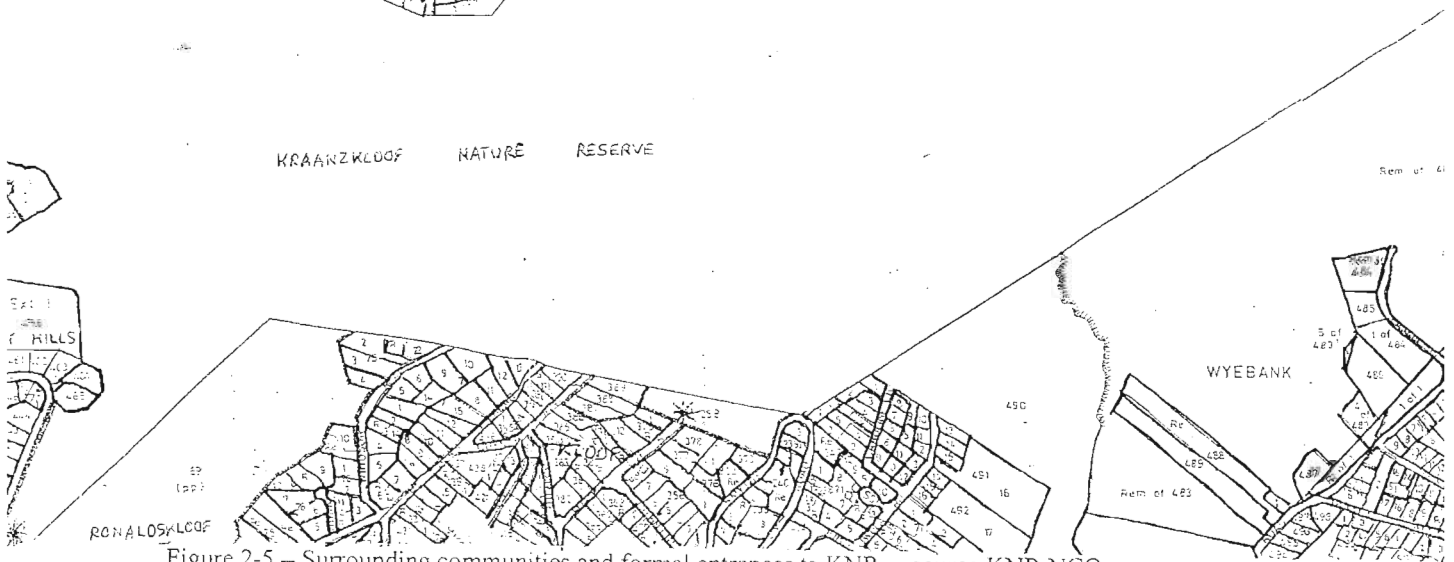


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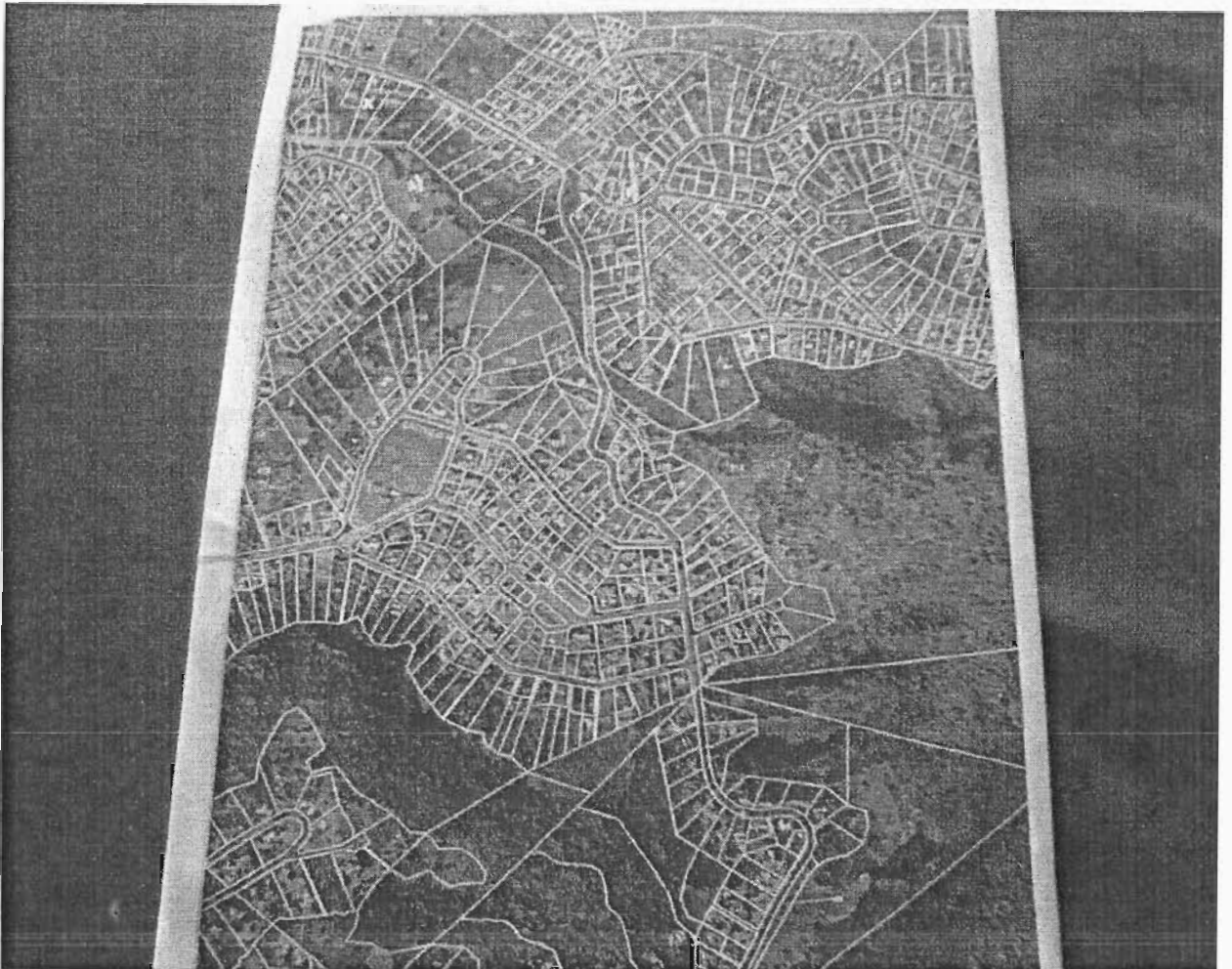


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Plate 2-2 shows the remains of a felled pine stump.

Plate 2-3 shows one of the last standing pines at the edge of the study site.



Plate 2-2 – Rotting pine stump



Plate 2-3 – Last standing pine, rotting from the top.

The dominating mature indigenous trees initially found at the site (1993) are:

- 3 *Protorhus longifolia* (red beech) – Plate 2-4
- 2 *Bridelia micrantha* (mitzeeri) – Plate 2-5
- 1 *Croton sylvaticus* (forest fever-berry) – Plate 2-6
- 2 *Halleria lucida* (tree fuscia) – Plate 2-7
- 1 *Burchellia bubalina* (wild pomegranate) – Plate 2-8
- 1 *Trema orientalis* (pigeonwood) – Plate 2-9
- 1 *Harpephyllum cafrum* (wild plum) – Plate 2-10



Plate 2-4 – Red Beech (*Protorhus longifolia*), dominating the study site.



Plate 2-5 –Mitzeeri (*Bridelia micrantha*)



Plate 2-6 - Forest Fever-berry (*Croton sylvaticus*)



Plate 2-7 - Tree Fuschia (*Halleria lucida*)



Plate 2-8 – Wild Pomegranate (*Burchellia bubalina*)



Plate 2-9 - Pigeonwood (*Trema orientalis*)



Plate 2-10 –Wild Plum (*Harpephyllum cafrum*)

Dense infestations of *Lantana camara* (tickberry), Plate 2-11, was observed, in 1993, to have invaded and dominated the area after clearfelling. *Solanum mauritianum* (bugweed), Plate 2-12, was the other main invader, which dominated shaded areas. Guava varieties, *Syringa*, mulberry, sword fern, Brazil pepper, trifid weed, canna, Kahili ginger lily, rambling cassia and napier grass were some of the exotics seen to have invaded over the period of regeneration, but to a lesser degree.



Plate 2-11 Tickberry (*Lantana camara*) dominated sunny and semi-shady areas after clearfelling.



Plate 2-12 – Bugweed (*Solanum mauritianum*) dominated shady areas after clearfelling.

Removal of these invaders by handpicking started in 1994 with subsequent follow-up operations. The regrowth and subsequent forest development has attracted various herbivores including bushbuck, duiker, dassie and bushpig.

#### 2.4. Conclusion

The responsibility of promoting the extension of the natural environment lies, to a large extent, outside KNR where domestic gardens need to be transformed from sources of alien invader plants to pockets of urban conservation promoting the corridor concept. The concept works well for bird and insect life and for climbing herbivores like dassies and monkeys, but generally excludes buck due to fencing. On the other hand, fences play a role in keeping in one of the main threats to the buck, that is, dogs.

There is a need for an extensive educational drive to promote the extension of the natural environment. This need is partially fulfilled by the media through local community newspapers and the work of the organized conservancies. However, these sources of information do not reach certain community groups bordering on KNR and more innovative methods (based on social, environmental and economic principles) are needed to promote the extension of natural vegetation and the associated herbivores.

Many role players are needed to achieve this goal since the success relies on the management of areas not only within KNR, but within the broader Emolwemi catchment. This requires extensive networking and co-operation amongst governmental and non-governmental organizations and the local community.

### 3. RESEARCH METHODOLOGY

#### 3.1. Introduction

Since the community was expected to pay for the conservation of KNR, the question was how much would be needed to cover for the budget shortfall. Thus the first step was to analyze the budget change and to determine what the underfunded items were. The second step involved informal interviews with users of KNR to determine whether they would be able to cover the shortfall. Since, at that stage, the NCO of KNR stated that there were logistical problems in charging a gate fee, an alternative method of fee collection, i.e. at picnic sites, was decided on and those using the sites (at no cost) were approached for interview. Fifty individuals were interviewed informally, after which the process was terminated as the management of KNR managed to charge a gate fee. The collection of charges was then monitored to determine if the amount collected would provide for the underfunded items. Further interviews among users took place to determine if the charge would affect the frequency of visitation. This information was then used to predict any decline in visitor numbers. The amount collected from users and the travel cost per annum was then incorporated into the calculation of the TEV.

Role players in environmental management were informally interviewed (including the NCO of KNR) and documents collected pertaining to their vision and strategy. This was done since major problems within KNR stemmed from the built environment and the management of these areas impacted on the management of KNR. Some of these role players were also considered as a possible source of funds for maintaining KNR and a source of support in project development.

The result of the budget analysis revealed that no funds had been allocated for alien invader control and the study then focused on the nature of the problem. Since the NCO particularly blamed surrounding properties for the invasion, the study then looked at the type of invasion that might occur at the interface of the built and natural environment (second study site). Subsequently the alien plants were removed by the process of handpicking (disturbing the ground) with follow-up operations. This was in contrast to the herbicidal / fire approach (minimizing ground disturbance) followed by the management of KNR. Handpicking was considered a preferred approach since it is a labor intensive practice (unemployment levels high) and results in dense regeneration of indigenous plants that have a potential horticultural value which could then be linked to the TEV of KNR, assuming that similar regeneration patterns would occur there and regenerated plants may be made available for sale at the KNR nursery outlet.

Included in the TEV were other ecological roles played by KNR, and the possible impact of a reduced budget on the value ascribed to KNR was considered. From there the estimated net benefits of maintaining KNR was determined (cost of deterioration compared to budget shortfall).

### 3.2. Budget analysis

A comparison of the budgets for 1997, 1998 and 1999/2000 was done to determine what the underfunded items in 1998 and 1999/2000 were and to what extent they were underfunded. A survey was done to determine what alternative sources of funding were available to make up for the budget shortfalls.

### 3.3. Interviews

Interviews were conducted with the Nature Conservation Officers (NCOs) of KNR (1999 – Ian Patrick , 2003 – Johan Vermeulen), with the then Deputy Regional Director of DWAF (Ash Seetal), the horticulturists that run the KNR nursery, members of the Kloof Conservancy, the owner of the property bordering the private land, the general public and recreational and educational users of the reserve.

The NCO in 1999 was asked the following questions:

- How has the budget cut impacted on the carrying out of management duties?
- Why was no user charge implemented when the first budget cut took place in 1988?
- Which management functions in particular are most affected by the budget cut and how are these management functions carried out?
- What is the approximate number of people visiting KNR over a monthly period?
- Have any surveys been done to determine whether recreational users are prepared to pay an entrance fee?
- Are there any management plans to integrate communities in the activities relating to KNR?
- What impact do informal users of KNR have on the vegetation?

The horticulturists at the nursery were asked (2002) ...

- What techniques are used to grow the plants for sale?
- What size of income does the nursery generate, on average, over a monthly period?
- What plants were mostly sought after by purchasers?

The NCO in 2003 was asked the following questions:

- Has there been a decline in the number of visitors to KNR since user charges were implemented?
- What is the current funding situation and what social development activities have occurred?

The Regional Deputy Director of DWAF was asked the following questions.

- Where is the Emolweni River Catchment placed in terms of the overall management of the Umgeni River system?
- What are the fundamental characteristics of the Umgeni River system?
- What management structures involving local communities does DWAF plan to use in the management of the Umgeni River System?

### 3.3.1 Recreational users

Initially the researcher was informed by the NCO that there was logistical problems in charging a gate fee so an initial survey was done at the Azalea Place and Kloof Falls Rd entrances to determine whether or what amount picnickers would be prepared to pay for a picnic site

The following survey was done among 20 groups of picnickers (50 adults interviewed) between January, 1999 and June, 1999 to determine whether they were aware of the budget predicament and how much they would be prepared to pay towards the maintenance of recreational facilities.

#### 3.3.1.1. Picnickers

The questions informally posed to the picnickers were:

- How many times a year do you visit the picnic sites at KNR and where do you come from? This question was posed to determine travel cost.
- If you had to be charged for the use of this picnic site, how much do you think is a fair price to pay?
- The budget for maintaining these picnic facilities has been slashed. Would you pay any more now that you know KNR management is short of money? How much more?
- What would you pay if you knew that the funds raised were allocated specifically for picnic site maintenance compared to the amount you would pay if you knew that the funds were being placed in a general fund.
- Have you ever placed money in the Conservation Trust donation box and do you know what it is for? If you have given, how many times compared to the number of times you have visited here have you put money in and how much, on average, do you put in?

During this period of research, however, the management of KNR managed to find a way to collect user charges and began implementing a user charge of R5 per person on 1st November, 1999 in order to maintain the under funded projects (Gray, 15 October, 1999). The focus of the study then had to change and it was decided to investigate any impact of a recreational fee on the number of visitors or number of visiting times and the potential user charge contribution towards maintaining KNR.

After 1st November, 1999 the questions changed to...

- Do you think that R5 per person is a fair price to pay?
- Will you come here any less than normal now that you are required to pay R5?
- Will you place less in the donation box? How much less?

### 3.3.1.2. Hikers

The following questions were put to the hikers informally interviewed.

- How many times a year do you go for casual walks within the Emolweni River catchment area and how many times a year do you attend organized hikes?
- What do you think is a reasonable price to pay per organized hike?
- Did you know that the budget for alien vegetation control and path maintenance in KNR has been slashed to nothing? If you were not aware of this, how much more would you be prepared to pay per organized hike, now that you know?
- What percentage of your payment would you like to see being allocated to: (i) path maintenance and development (ii) alien vegetation control (iii) trail guides? (Did you know that the management of KNR is looking at training unemployed people from Molweni to act as trail guides?)
- What difference will there be in the amount you are prepared to pay if you knew that the funds would be allocated to a general fund or if the funds were to be allocated specifically to path maintenance and alien vegetation control?

### 3.3.2. Educational users

The conservation/education value that educationists currently place on KNR was investigated by approaching schools in the highway area to determine how often they used KNR for educational excursions (per annum). Local conservancies and the Wildlife Society were also approached to determine their frequency of use of KNR for educational purposes.

### 3.3.3. General public

To determine a non-use value twenty members of the local community were approached at Kloof and Waterfall shopping centres during 1999 to determine what they would be prepared to pay for the existence of the nature reserve, that is, what they would be prepared to pay for the protection of the Emolweni river catchment area and the associated ecosystem. People who visited KNR less than twice a year were considered to provide an existence valuation. Even though they do not regard visiting KNR for recreational activities as important, their conservation, aesthetic and property valuations were measured as an important existence value.

### 3.3.4. Conservancy members

Informal interviews were held with members of the Kloof Conservancy on matters of alien infestation and control in the Outer West.

### 3.3.5. Owner of property bordering private land

The neighbour, who had lived in the area for 35 years, was approached to determine the extent of the plantation and approximately when clearfelling of the pine forest had taken place.

### 3.4. Valuation study

Values arrived at in these valuation studies are estimates. The emphasis in this study is *qualitative*, and not quantitative, and focuses on *the type* of factors that may be used in a valuation study and suggests ways in which they may be assessed in economic terms. The purpose is to highlight the net benefits to be derived from KNR in order to emphasize the necessity of continuing with the maintenance projects that will ensure the integrity of the nature reserve remains intact. Thus this analysis is not meant to be mathematically accurate, but a means to highlight the dangers of allowing the deterioration of KNR.

In this study environmental values are regarded as benefits and the costs are determined from the budget shortfall, that is, the cost to KZN Conservation Services to make up the budget shortfall. This cost has been compared with the costs that will occur (or benefits lost) due to the deterioration of KNR.

The estimated net benefits of maintaining the ecological integrity of KNR is determined by subtracting the costs of providing for the budget shortfall from the Total Economic Value (TEV) associated with KNR.

Since members of the Molweni community abstract their drinking water from the Emolweni River, the costs to the community of consuming toxic drinking water or the costs of being unable to drink water due to increased sediment load were estimated. The costs to cure resultant sicknesses from drinking toxic water and the loss of income and transport costs to the clinic were used to determine a monetary figure associated with the consumption of toxic water that might result due to the deterioration of wetlands in KNR that effectively purifies the water. The cost to the community due to the deterioration in water quality by an increase in sediment load due to accelerated erosion was estimated by the need to travel to obtain pure water or the cost of building settlement tanks. Soil conservation value was taken into account in the costs resulting from increased sediment load.

Flood damage estimates from erosion and other factors occurring were determined by assessing the cost to the community during times of flooding. A small percentage of the cost due to flooding in the Inner West, where the effective open space to act as a sponge is smaller than in the Outer West, (year 2000), was taken as a bench mark to estimate possible costs due to flooding that might occur in the Outer West due to the deterioration of KNR. An estimate of the damage that could result from fire due to the deterioration of KNR was also done.

The TEV estimate is essentially a very conservative estimate since it excludes many other environmental benefits, like carbon sequestration as an example, of which an estimate of the value was not done. Many other benefits are to be obtained from open spaces like KNR and these are explored further in the literature survey.

### 3.5. Catchment Community structures

To determine the type of community structures that will assist in the management of natural resources at local level (Emolweni River Catchment), a forum was initiated by calling a meeting of interested and affected parties. A list of guests to be invited was supplied by the NCO and the meeting was made public through the local newspaper.

The then Regional Deputy Director of DWAF (1999) addressed the audience on the formation and function of a catchment forum. Those that attended were given a questionnaire to determine the type of developmental activities they were involved in and to find out what they thought management priorities were for the Emolweni River Catchment.

### 3.6. Alien invader control and nursery development

The study looked at how the development of an indigenous nursery may be integrated with an invader control program. Invasion at the forest fringe and under canopy was investigated. The main invading plants found, i.e. *Lantana camara* (tickberry) and *Solanum mauritianum* (bugweed) were removed by hand where possible and spades were used for larger plants. "Rocking" large bugweed when the soil was wet allowed them to be uprooted.

Hand picking alien vegetation (mechanical disturbance) in and around the sampling area resulted in dense populations of young indigenous trees and the expansion of indigenous herbs/shrubs. These plants were investigated for number and type. Slashers and bushcutters were deliberately excluded from the clearing operation. Fire was excluded from the harvesting area for at least 10 years to promote the growth of the woody component and to allow regeneration to reach ecological climax.

Certain plants were removed sustainably and tested for wholesale saleability at plant nurseries. Initially plants found in abundance resulting from the handpicking alien control program were removed directly from the ground, bagged, allowed to settle for a short recuperation period, and tested for their marketability. Once their marketability was established, to ensure sustainability some of these plants were then cultivated from seed. Soil for the bags was obtained from making steps for sloped areas for path development.

Plants were sold over the period 2000 to 2003 to six outlets in the Outer West, in the suburbs of Kloof, Waterfall, Hillcrest and Assegai. To get into these markets, plants were initially left on consignment.

Consignment goods were fitted with a label that emphasised the value of the plant. Most of the trees removed were taken when they were fairly large (between 1 and 2 metres in length) and when the ground was wet to ensure their survival and marketability within a short recovery period. Mature herbs were bagged in time to recover before being sold in their flowering stage.

Handpicking was used to reduce the destruction of indigenous plants. This would ensure that the density of the regenerating indigenous plants provided competition to keep out invaders. Young indigenous trees that had invaded the grassland area were targeted for sale to maintain the status of the grassland, thus reducing alien invasion.

By excluding bushcutters and slashers, the problem of regenerating invader plant fragments was avoided. The roots of the invader were removed completely from the ground to prevent regrowth and whole plants were stacked to localise any re-infestation that might occur. Fire was also avoided since burnt vegetation also offers establishment sites for some invaders, including Tickberry, the dominating invader identified on the private land.

The wholesale market value of the plants sold was considered as a way in which natural areas may be valued, specifically KNR, whose flora resembles that of the private land nursery area. The plants sold from the private land nursery was compared with those available for sale at the KNR nursery. Also, the possibility of extending the alien invader/indigenous nursery integrated project to benefit low income communities was explored. Disabling and enabling factors, for example, access, infrastructural support and legislation pertaining to the controlled use of indigenous plants, were identified and assessed and the supporting structures necessary for the sustainable development of the project was investigated.

The role of public education, training and employment in tackling the alien invader control problem is explored as well as social and environmental benefits that could arise. The potential of forums to provide networking and support is investigated for the envisaged project.

### 3.7. Conclusion

The results of the methodological approach led to an analysis of the situation on the ground and what was required for the ongoing maintenance and development of KNR as a core conservation cell. From this analysis recommendations on how to achieve the goal of natural area development in the Outer West / Emolweni subcatchment were put forward.

#### 4. “Management of Nature Reserves: A theoretical Review”

##### 4.1. Introduction

The management of nature reserves involves an approach that considers social, economic and ecological factors. Where possible all of these factors should be integrated simultaneously into project development. To ensure that the environmental / ecological component is included, resources should be used in a sustainable manner, i.e. similar types and amounts of natural resources should be available for future generations. Strategic intervention is required, but in a manner that can lead to the educational development of communities rather than follow a “policing” approach. This leaves managers with the need to acquire negotiation and facilitation skills and the need to build manpower capacity to conduct surveys in areas and to monitor these areas on an on-going basis. To develop this capacity, managers will require the assistance of other role players involved in environmental management and / or accumulate funding for the training and employment of extra personnel.

The management of KNR is dependant on the broader management of the Emolweni subcatchment within which KNR falls where the policies and the procedures of other environmental management organizations are relevant. The case study therefore looks at KNR in the context of broader forums and the overall environmental management strategy. The literature review therefore considers national and international policies as guidelines for implementation at local level. A discussion of the relevance to KNR of the policies and procedures adopted by various environmental management role players, as described in the literature review, takes place in the next chapter (Results & Discussion).

##### 4.2. Funding “crisis”

The 1997 KNR budget allocation of R108 000 was slashed to R32 667 in 1998. There was a slight improvement in 1999/2000 with a budget of R57 408 being granted. News of the budget slash was made public when it was given headline news in *The Hilltop*, a local community newspaper, in March, 1999. The article reported that no provision had been made for soil erosion prevention or alien vegetation control and that building maintenance allocation had been reduced from R16 000 to only R144 (Gray, 11 March, 1999).

The larger share of the overall reduced budget of KZN Nature Conservation Services has been given to sites that are preferred tourist destinations e.g. the newly acclaimed World Heritage Site, St Lucia, also Umfolose, Hluhluwe, Ndumu and the Drakensberg (Gray, 11 March, 1999).

##### 4.2.1. User charge:

KNR is visited by between two and a half and three thousand people a month (KNR NCO, pers. comm., 1999), from which a user charge may be obtained. Visitors are mainly picnickers and hikers with the picnickers being the vast majority. A 1997 summer/winter study by KNR management involved asking picnickers whether they would be prepared to pay an entrance fee of R2,50 and an overwhelming majority said they would (KNR NCO pers. comm., 1999).

When asked why the user charge was not implemented during 1998, the year when the budget cut occurred, the NCO explained that entrances to picnic sites were from main roads and a gate fee would disrupt traffic.

The collection of user charges from picnic sites was then considered as an alternative to a gate fee and the study first investigated what picnickers were prepared to pay for the use of the picnic site (January, 1999 to June, 1999). During this investigation, an entrance fee of R5 per person was implemented by the management of KNR. The collection of charges took place by approaching cars in the parking area. Thus, when the study continued the next interviewees were asked if having to pay the R5 will influence the number of times they visit the site (November 1999 to March, 2000).

Charges were raised to R7 (2004) and are currently (2006) at R10 per person.

#### 4.2.2. Other sources of funding

Income for KNR is gained by hiring out the Interpretative centre which nets approximately R5400 in a seven month period (calculated from November, 1998 to July, 1999), that is, approximately R9000 per annum (KNR NCO pers. comm., 1999).

KNR runs a small nursery which is non-competitive, low key and not well signposted. Approximately R50 a month (R600 per annum) is netted (NCO pers. comm., 2002).

Fundraising for KNR occurs through the Kloof Conservancy in an Open Gardens Project. In 1998 a total of R18 000 for the one Open Gardens was raised and the Highway Mail Reporter (April, 16<sup>th</sup>, 1999) reported that more than 2000 people visited indigenous gardens in the Kloof area. In 2004, R50 000 was raised which is being used to provide alien control work for unemployed locals (KNR NCO, pers. comm., 2004). The funds raised are administered by the NCO of KNR, who undergoes a regular audit by the Kloof Conservancy.

Donation boxes are provided at all three entrances in order to collect money for the Conservation Trust. The Conservation Trust was set up a few years ago since it was anticipated that funding difficulties for conservation would arise. Although the money (+/- R1000 / month before user charges were implemented) may not be used directly by KNR, interest on the capital amount is to be used for funding emergencies which may be applied for (KNR NCO, pers. comm., 1999). The affect of user charges on the Conservation Trust Fund income was investigated by survey amongst users.

Ninety percent of the community levy obtained from user charges is retained for local community development, while 10 % goes to a central fund (KNR NCO pers. comm., 2004). Funds may be applied for locally from the central fund depending on the community needs analysis. The advantage is that economically stronger, larger nature reserves with high tourist potential also contribute 10 % to the central

fund, thus indirectly supporting economically weaker nature reserves. Income from the nursery also goes to the central fund.

#### 4.2.3. Underfunded items

##### 4.2.3.1. Facilities maintenance

The use value for picnickers will diminish if the facilities are not maintained and the use value for hikers will diminish if alien invaders are not controlled and the hiking paths are not maintained or developed.

25 barbecue areas are available to the public, there are various marked trails and a large grassed open area for picnicking. Grass cutting, removal of rubbish and structural repairs of buildings (toilets) and roads all go into maintaining the entertainment areas. The NCO in charge of KNR was quoted to say that, with the huge cuts in building maintenance, if the toilets are vandalized, they will not be able to be repaired (Gray, March 11, 1999).

Secondly there is the task of maintaining the marked hiking trails. Materials for path maintenance and development are needed and there is the labour cost of laying the poles.

The interpretative centre and staff housing also need maintaining. Any broken fences that would allow unauthorised access to the reserve would need repair.

##### 4.2.3.2.. Alien invader control

A local environmental consultant was reported to say that if the alien invader problem in KNR is neglected, within a short space of time the problem will escalate. It is false economy to do nothing (Gray, March, 11<sup>th</sup> 1999).

The invasion into KNR happens where openings in the canopy forest occur, for example, due to the falling of trees. Much of the alien invasion at forest fringes and in the grasslands comes from private properties surrounding KNR, contributing to the problem (KNR NCO pers. comm., 1999).

The KNR alien control project involves a herbicide programme that has been in operation for the past 20 years with an estimated cost of R8 400 per annum (KNR NCO pers. comm, 1999). Regular monitoring takes place and a further precaution is taken by burning the grassland once a year to destroy any invader plant seed that might have accumulated. The herbicidal programme that is in place involves the placing of the herbicide on the foliage of the invader. The poison eventually reaches the roots and the plant dies. The groundcover/grass then grows over the place where the exotic plant has died. Foot patrols through the nature reserve are followed over a four to five kilometer trail to identify and combat any new infestations that occur. Vehicle use for these patrols is limited due to the difficulty of accessing the nature reserve owing to the presence of steep cliffs.

The control of alien invaders in KNR will be backed up by the following (KNR Management Plan, 2003).

- An inventory and distribution map of each alien species showing priority areas.
- Division of problem areas into management blocks for control and recording purposes.

Goal achievement, cost effectiveness and long term maintenance requirements will be reviewed.

Alien invader plants are species of plants which have been introduced into a country from other areas, and are capable of invading even stable indigenous vegetation. They can cause major changes in the composition of the flora and fauna in a region and the landscape as a whole. Alien invaders promote erosion on river banks and in grasslands and largely destroy wetlands.

A co-ordinated programme to contain the spread of invader plants and weeds, as well as for their eradication should be introduced. Not enough funds and personnel have been allocated for the control and eradication of weeds and invader plants (Fuggle & Rabie, 1991).

The importation of alien plants into South Africa was not controlled prior to 1937, and invasive aliens are today on the increase, causing dramatic and difficult-to-reverse changes to the plant cover of the country (Davis, August 13<sup>th</sup>, 1999).

According to Cronk & Fuller, 1995, an invasive plant may be defined as:

“an alien plant spreading naturally (without the direct assistance of people) in natural or semi-natural habitats, to produce a significant change in terms of composition, structure or ecosystem processes”.

This definition excludes plants that invade highly disturbed man-made or agricultural habitats.

Natural or semi-natural habitats are defined as (Cronk & Fuller, 1995):

“communities of plants and animals with some conservation significance, either where direct human influence is minimal or where human disturbance serves to encourage communities of wild species of interest to conservation”.

One hundred and ninety-eight species of dangerous alien plants have been identified as having invaded almost 10 percent of South African land (Alien Busters, 2001). In SA, invading aliens affect almost 10 million hectares (8.28 percent) of the country. About 750 tree species and 8000 shrubs have been introduced to SA and of these 161 are regarded as invaders and 44 are legally declared noxious weeds whose removal is required by law (The Teacher, 2000). Ten species are seriously invasive in KZN and at least another 20 more are identified as potentially serious invaders (Kluge and Erasmus, 1991).

KZN has the climate that some alien vegetation thrive in and, together with the lack of natural enemies, quickly overtake and choke the natural vegetation. Attention was first drawn to the threat of alien invader plants in Natal in the 1950s and in the 1960s research into their chemical and mechanical control was undertaken by the Department of Agriculture (DOA) Technical Services (Kluge and Erasmus, 1991).

In 1981 a field station was set up by the Plant Protection Research Institute (PPRI) at the Cedara Experimental Farm to promote further research. By 1991 there had been little progress with the control of invaders and some of the reasons cited (Kluge and Erasmus, 1991) are:

- the complexity of the problem in Natal
- chemical and mechanical control
- the attitude towards the control of invader plants
- biological control

The control of alien invader plants in KZN is complex because of the number of species involved and the many situations in which they occur. The fact that different invaders commonly grow together further complicates the logistics of control.

Different complexes of these invaders are found in each of the three eco-climatic zones in KZN, that is coastal, midland and inland zones. Within these zones the invaders occur in different land-use types, that is agricultural grazing land, nature conservation estates, utility areas, silvicultural estates and urban open space which require different control approaches. Because of the steeply sloping topography of KZN, which is transected by deeply incised river valleys, the infestations commonly occur in difficult terrain (Kluge & Erasmus, 1991). Some 8000 km<sup>2</sup> of the lowland forest biome of KZN is invaded by triffid weed, *Chromolaena odorata* (Fuggle & Rabie, 1991).

The *Western Mail Options* produced a series of successive articles dealing with the alien invader problem, with a description of the “more troublesome alien plants infesting the Outer West and the means to their eradication.” The source of this information is “Alien plants - a threat to natural fauna and flora” published by the National DO A. A list of common invaders in the Outer West of DMA targeted under the Agricultural Resources Act is given in the *Western Mail Options* (Davis, August, 13<sup>th</sup>, 1999). They are:

Mauritius Thorn (*Caesalpinia decapetala*), Inkberry (*Cestrum laevigatum*), Triffid Weed (*Chromolaena odorata*), Sour prickly pear (*Opuntia stricta*), Tickberry (*Lantana camara*), Barbados gooseberry (*Pereskia aculeata*), American Bramble (*Rubus cuneifolias*), Sesbania (*Sesbania punicea*), Bugweed (*Solanum mauritianum*), Silver Wattle (*Acacia longifolia*), Black Wattle (*Acacia mearnsli*) and Pines (*Pinus* spp.)

Other common invaders include: Balloon Vine (*Cardiospermum grandiflorum*), Leucaena (*Leucaena leucocephala*), Syringa (*Melia azedarach*), guava (*Psidium guajava*), castor-oil plant (*Ricinus communis*), and Peanut butter Cassia (*Senna didymobotrya*). The list of invasive plants is growing with exotic ginger, canna, oleander, water hyacinth, Brazil pepper, camphor and many others joining the list (Davis, August 13<sup>th</sup>, 1999).

*Lantana camara* (tickberry), originally from Central and South America, consists of various man-made hybrids, with different invasive capacity. Some 400 000 ha of KZN are said to be infested with Tickberry (Cronk & Fuller, 1995). Its brightly coloured flowers have ensured that gardeners have spread it widely. It is mainly a weed of highly disturbed habitats and rarely invades natural and semi-natural areas, threatening native flora and fauna (Cronk & Fuller, 1995).

Since its introduction to South Africa around 1880, it has invaded, amongst others areas, plantations, forest margins, overgrazed or burnt veld and relatively undisturbed rocky hillsides and fields (Cronk & Fuller, 1995). It is capable of growing in poor soils in full sunlight or in semi-shade, it can reproduce vegetatively from pieces of branches and can survive fire by regenerating from basal shoots. Allelopathic substances are produced by the shoots and roots which increases its competitive ability against native plants.

A write-up concerning *Solanum mauritianum* (bugweed), occurred in *Western Mail Options* (Davis, August 27<sup>th</sup>, 1999) and *The Highway Mail* (Patton, 1997). It is described as one of the most widespread of the alien plant species. Bugweed stems from Tropical Asia and because KZN has a similar climate, the weed thrives there. Bugweed grows rapidly, blocking access to forests. The fine hairs of this plant can cause skin and respiratory problems.

Invaders may remove a food source or introduce a food source where none existed before (Cronk & Fuller, 1995). The bugweed fruit is preferred to indigenous plant fruits by the Rameron pigeon with the result that some indigenous trees are facing extinction due to the fact that its seeds are no more dispersed, while the bugweed population increases.

Because the introduced plants have no natural enemies, alien plants multiply quickly and can invade large areas in a short space of time, causing imbalances within the ecology. Sedimentation processes are altered, land can become susceptible to erosion and can lose productive capacity. When invaders not suitable for river banks replace the natural vegetation, eroding of the banks may occur which often results in flooding. Indigenous flora is replaced over large tracts of land and this reduces the bio-diversity of natural areas with a resultant impact on eco-tourism.

Alien plants are in direct competition with indigenous plants and therefore affect plant diversity. Weeds can compete severely with indigenous plants for water, nutrients and growing space. Almost 1 900 of the 3 435

indigenous plants on the endangered list are threatened wholly or partly by alien invasion (The Teacher, 2000).

A decrease of approximately 58 % in the species richness of indigenous plants over a period of 35 years has been recorded under a plantation of pines (Armstrong and van Hensbergen, 1996). The cover of the native vegetation was reduced from 75 % to 20 %, and the mean native plant density was reduced to one third of its former value.

Invasive plants may modify natural or semi-natural habitats by, for example, replacing a diverse system with single species stands (Cronk & Fuller, 1995).

A large number of indigenous fauna are not suited to the habitat provided by the invader and this, together with the encroachment of development, places a strain on the confined animal populations and the resultant animal diversity.

Invaders may change the water or fire regime and change the nutrient status of the soil and humus (Cronk & Fuller, 1995). Alien invaders largely destroy wetlands and cause soil erosion in grasslands. Some invaders make agricultural land unsuitable for grazing. The amount of woody material at sites overrun by alien invaders is increased to ten fold, increasing fire intensities. Invaders are generally bigger and when they burn, they burn very hot, which damages the ground, stripping away nutrients, and produces major erosion. Millions of tons of precious topsoil is subsequently washed into the sea.

Alien vegetation can create seed banks that lie dormant for up to 50 years. Mature plants have higher removal costs and produce large quantities of seeds, increasing the period required to keep control. A hectare of lightly infested land may only cost R100 to clear now, but if left to become densely invaded, which could happen in as little as fifteen years, it could cost 40 times as much (Alien Busters, 2001).

Many types of alien vegetation are known to consume huge quantities of water and can diminish the level of the water table. In many catchment areas and riparian zones the indigenous plant cover is replaced by exotic plants like black wattle, pines and gums. These plants transpire large amounts of harvestable water, extracting from the river and springs around which they grow and reduce the amount of available water in the river.

Clearing of alien invaders has been shown to enhance water yield by 14 percent (DWAF, April, 1998). One of many case studies has shown that an 82 percent reduction in streamflow had occurred in two small catchments in the Drakensburg twenty years after planting pine trees (The Teacher, 2000). Some invader plants use the equivalent of over 200 litres of water a day.

Comparing the stream flow at an upstream and downstream weir (500 m) apart, after clearing invasive trees between the weirs to an average distance of 25 m from the stream, showed an increase in water flow at the lower weir of 120 %. This increase is equivalent to 30,5 m<sup>3</sup> of water per day (Dye and Poulter, 1995).

Another study (Prinsloo and Scott, 1999) indicated that clearing the invasive riparian vegetation during the dry summer months increased stream flow in three catchment areas by 8.8, 10.4 and 12 m<sup>3</sup> per day per ha cleared. A further study showed that water can be delivered at a cost of 57c and 59c kl<sup>-1</sup>, respectively, with and without the management of invasive plants (van Wilgen et. al., 1997).

Near plantations, invasive trees may rapidly spread into riparian zones. Their colonization is often promoted by the disturbance of the soil and damage to the existing indigenous vegetation during the harvesting of adjacent plantation trees (Armstrong and van Hensbergen, 1996).

Not only exotic plants are regarded and targeted as invader plants. Indigenous plants that are identified as indicators of bush encroachment are also targeted as invaders of grassland areas and Conservation of Agricultural Resources legislation requires that a land user of an area in which natural vegetation occurs and that contains communities of indicator plants shall follow practices to prevent the deterioration of natural resources and to combat bush encroachment where it occurs. Bush encroachment means stands of plants where individual plants are closer to each other than three times the mean crown diameter (Fuggel & Rabie, 1991).

Cronk & Fuller (1995) state that there is a “blurred distinction” between invasion by a native species, as part of natural succession, and invasion by an alien species. They report that in some nature reserves, the conservation objective may be to protect a species assemblage that may be invaded by native species.

#### 4.2.3.2(a). Invader control agencies

Alien invader control is an ongoing problem that needs regular funding. Alien invaders cannot be totally eradicated and continual follow-up operations are required to avoid further infestation that leads to higher costs.

Much of the land owned by the municipality is invaded and will seriously impact on the ability to control invaders on private land. An Alien Invader Plant Policy report dated 4/06/03 described the intention of the Parks dept. to establish an Alien Weeds and Invader Plant policy for the eThekweni Municipality. This policy will contribute to compliance with regulations of associated lists of weeds and invader plants, published in terms of the Conservation of Agricultural Resources Act (Parks Department, 2003).

The development of this policy is said to be in line with the Sustainable Management System of the eThekweni Municipality, Integrated Development Plan and has the target of reviewing all sectoral policies

relevant to the objective of sustainable development. The policy will contribute to the achievement of a desired outcome of the sustainable development plan, that is, to achieve quality natural environments and resources that provide the basis for both economic prosperity and social well-being (Parks Dept, 2003).

The Outer West Council realized that its areas were seriously infested in places by invasives, and concerned officials, councillors and bodies such as conservancies and KZN Nature Conservation Services, approached the management of Working for Water Program (WWP) to start the project locally. This was agreed and in 1998, the first teams of local unemployed people were recruited and trained with work commencing in March, 1998 (*Highway Mail Reporter*, March, 12<sup>th</sup>, 1999). However, at the end of that month, the project was temporarily suspended and recommenced in February, 1999, this time using emerging local contractors as opposed to the previous labour only system. There are presently three contractors working in Shongweni, Hillcrest and Alverstone who are concentrating on follow-up work in areas that were initially treated in March, 1998. The local area manager of WWP was reported to say that at least a further two contractors would be engaged in the near future.

WWP was launched in the Cape in 1995, at the instigation of the then Minister of Water Affairs and Forestry, Kader Asmal. The project initially used Reconstruction and Development Program funding of about R25 million in order to combat alien invaders which were said to dramatically ‘decrease the yield’ of catchment areas. From a meagre start of R25 million in 1995 the WWP project has grown with international grants of a possible R600 million in 1998/1999. Local Water Boards like Umgeni Water also supplied a grant of R10 million in 1997.

The local area manager for WWP envisaged, that nationally, the project could run for the next 20 years and would be sustained by a levy on water tariffs on a “user pays” basis. The more water used by the consumer, the higher would be the tariff on an exponentially increasing scale to encourage users of water to implement conservation measures.

An emphasis of WWP is the *upliftment and empowerment of unemployed local communities* (Milton, 2000).

The project aims to be democratic, sustainable, to address basic needs and to provide security and its vision is of building an economically viable future for thousands of untrained people in environmental and resource management (Milton, 2000).

Some of the goals of the WWP multifaceted project are:

- to provide employment,
- to advance water provision and
- to use the services of people who can remove invader plants in catchment areas.

This has allowed DWAF to address three major ecological and economic problems simultaneously, that is, unemployment (which impacts on the use of natural resources), invasion of species-rich vegetation by non-indigenous plant species (reduction in bio-diversity and associated value, for example related to tourism) and the decreasing quantity and quality of water supplied by catchments (costs of purification and user tariffs).

The WWP has now led to the establishment of over 200 alien control projects countrywide (van Wilgen *et al.*, 2000). The WWP is the biggest conservation project in terms of manpower use currently being undertaken in SA and during 1998, 40 000 jobs were created through this programme (Hosking and du Preez, 1999).

The view is that short-term jobs is no solution to poverty in SA. The capacity to be innovative, proactive and to manage money is said to bring far more benefits for individuals and the nation. Therefore *daily wages for alien vegetation clearing* was replaced by piece-work and incentive systems. Over the next few years WWP aims to develop skills and train participants in business management so that they eventually become independent of donor funds (Milton, 2000). A training program has now been initiated by WWP where local people are shown how to eradicate alien plants and to manage their finances (Mahaye, 2005).

The Green Trust is a subsidiary trust of the South African Nature Foundation (SANF) formed in 1990 and funded by an annual R1 million donation by Nedbank. The Trust funds community-based environmental programmes that repairs environmental damage and helps people to find alternatives to environmental destruction (van Wijk, 1994).

The Green Trust was formed through the realization of the necessity to find ways to provide for the needs of SA's population without destroying the resources we depend on for survival. Building peoples' capacity to identify and solve environmental problems forms an important part of projects supported by the Green Trust. In funding these projects, the Trust places emphasis on partnership rather than control, and self-sufficiency rather than dependence. In 4 years (1990 to 1994) the Green Trust had committed financial support amounting to more than R4.5 million to about 50 projects in both rural and urban areas (van Wijk, 1994).

The SANF is a local arm of the World Wide Fund for Nature (WWF) and was started in SA in 1968. The WWF is the world's leading non-governmental conservation body, with over 5 million people supporting the national organisations in 28 different countries.

Major funding contributions to environmental conservation by the SANF include assistance with the creation or expansion of 5 national parks and more than 30 nature reserves. Five chairs and several research programmes have also been established at SA Universities. SANF'S administration costs are covered by interest from trust funds and self-earned income. Thus the full amount of donations are committed to conservation projects (van Wijk, 1994).

The Green Trust Award winner for 1999 was Fauna Park Primary school who developed a project aimed at supporting alien invader control in the Kruger National Park. The project involved visiting residences in the catchment management area to assess the extent of alien invasion. This information was then passed on to the local town council and the water board which is using the research in its campaign to remove the invasives (Hammond, 1999).

The result of the research has seen the council and water board sending in a team of 60 people to remove the exotics. The pupils from the school also went on a community education drive, setting up information desks at shopping centres and putting up posters at shops, businesses and mines indicating which plants are exotic and need to be destroyed. They provided information on the best way to get rid of the exotics, whether removing them physically, using biological methods or chemical controls. Five pupils were selected to walk the length and breadth of the study area to map wetlands in the area. They collected data on the plants and animals found in the wetlands as well as taking water samples to assess the water quality.

Conservancies in the “e’Thekweni” area are now co-ordinating an “adopt a highway” project which involves partnerships with business in solving the alien invasion problem along the freeways. Emerging contractors are used to control the invaders. They are paid by business who are then granted advertising space along the highway for an annual fee. As the invaders are brought under control and less labour is required for removal, the balance of the annual advertising funds can then go to the conservancy involved.

#### 4.2.3.2(b) Control methods

The main types of action regarding invasive plants are: (Cronk and Fuller, 1995)

- Education and awareness
- Legislation
- Prevention of introduction
- Information
- Control

#### *Education*

Educating the public is to create awareness of the following: (Cronk & Fuller, 1995)

- the difference between exotic and native flora.
- the importance of native plants over and above alien plants.
- that alien plants can, in some instances, threaten native plants.
- that gardening or forestry can result in the naturalization of plants.

Environmental education should be a required component of schools, adult education should be conducted through the mass media and tourist education should be introduced by means of visitor literature (Cronk & Fuller, 1995).

Some 80 identified invaders have been highlighted in two posters ( *Beautiful But Dangerous invasive alien plants of Durban and the eastern, sub-tropical region of South Africa*) and prepared by the collaboration of the Botanical Society of South Africa, the Durban Metro Environmental Management Branch, the Durban Parks Department and the Durban Wildlife and Environment Society of SA (WESSA). Additional assistance came from the PPRI, Agricultural Research Council and various individuals. The objectives of these posters is to educate the public on the prevention of alien plant invasions which is far cheaper than control or eradication.

The first poster profiles some of the most aggressive weed and invader plants in the Durban Unicity area and were selected because they have or are expected to invade large parts of Durban and are likely to do so in other sub-tropical parts of SA and are potential transformers of natural habitats. The second poster profiles plants which are grown and sold by nurseries and used by landscapers and gardeners. These plants have escaped formally planted areas and are appearing to varying degrees in natural ecosystems. Some of these plants have not been placed in a category by the DOA and are thus not covered by the new legislation. Currently they are considered regional problems and/or their weed potential is yet to be established.

Glossy photographs allows for easy identification of invaders, suggested control methods are indicated and indigenous alternatives are prescribed. Useful contacts are provided for advice and planning of control work, for law enforcement, for information about the use of herbicides and to find indigenous plants and professional contractors who remove alien plants.

A field guide describing more than 400 species of problem plants with 450 full colour photographs is now available (Bromilow, 1995). The photographs are taken from angles and distances to show typical specimens, characteristic features and size and scale. Information such as common names, origin and other items of interest, hints on control techniques, weedy characteristics, economic importance and distribution are given.

DWAF has consolidated forestry weed control information into one document leading to a computer software package called "Weedman" (Cunningham & Viljoen, 1996). Weedman provides the user with colour images and general information on specific weeds, and gives information on methods to control them.

Progress with control of some invaders is hampered by poor dissemination of information. Research on current methods applied for the control of silver wattle, *Acacia dealbata*, and the progress being made, was specifically published in order to provide the information necessary for its control (Campbell, Bell and Kluge, 1990). An important problem that emerged from a survey amongst farmers was that no dissemination of

effective control methods was occurring within a community. Many of the farmers interviewed were unaware of the methods being used by their neighbours which seriously limited the progress made with the control of wattle within the community.

Wanted, “dead, not alive” display boards, with the name of the offending plant, have been erected along main routes close to KNR by local conservancies.

Staff members who work in nature reserves also need training and this applies to both managers and operations staff (Cronk & Fuller, 1995). Volunteer work in nature reserves helps to raise awareness about conservation and the problem of alien plants.

### *Legislation*

Many countries have legislation that allows invasive plants to be given “noxious weed status”. The problem is that this status is most often given to plants that already exist in large infestations (Cronk & Fuller, 1995), however, declaring a plant a noxious weed does draw the attention of the public.

In recognizing the threats posed by invasive plants, the National DOA has gazetted regulations and listed weeds and invader plants under the Conservation of Agricultural Resources Act (Act No. 43 of 1983) (Fuggle & Rabie, 1991).

In terms of the Conservation of Agricultural Resources Act, all declared weeds and invader plants must be controlled by land users, both in urban and farm areas. A list of offending alien invader weeds and plants has been gazetted by government.

Should any listed weeds or plants appear, the land user is required to prevent further propagation by implementing as many of the following measures as may be necessary:

- uprooting and felling.
- cutting and destroying (using fire or other suitable methods).
- treatment with a recognised weed killer.
- biological control (or other methods aimed at the destruction of seeds).

The Agricultural Minister may establish a scheme in terms of which subsidies may be paid to land users in respect of the combating of weeds and invader plants. Furthermore, the Minister may perform or cause to be performed any act related to the control of weeds or invader plants and may recover the relevant costs from the landowner concerned (Fuggle & Rabie, 1991)

Although the Act excludes “weeds” from the definition of agricultural resources, the function of conservation committees is to promote the conservation of natural agricultural resources. This should be extended to provide for compulsory reporting on and eradication of weeds. The Report of the three committees of the President’s Council on a national environmental management system contains recommendations with regard to the control of alien flora and the conservation of indigenous plants as natural resources (Fuggle & Rabie, 1991).

Alien invaders are divided into three categories for legislative purposes (Alien Busters, 2001).

\* *Category 1:* Invader plants that have been declared weeds and may not be allowed to occur on land or inland water surfaces. They must be removed and destroyed immediately. Trade is prohibited.

\**Category 2:* Invader plants that may only occur in areas that have been specifically demarcated for this purpose. Plants may be grown under controlled conditions only.

\**Category 3:* Invader plants that may continue to grow where they already exist. No propagating, new planting or trade is permitted

To aid in the combating of Category 1 plants, legislation allows plants in this category to only exist in biological control reserves. Category 2 plants may only exist in demarcated areas and any area may only be considered as a demarcated area on application in writing to the executive officer. A water use licence for stream flow reduction activities must have been issued for certain areas to be demarcated. No new Category 3 plants may be planted and a land user must take reasonable steps to curtail the spreading of propagating material of these plants. No land user shall allow Category 3 plants to occur within 30 metres of the 1:50 year flood line of a river, stream, spring, natural channel in which water flows regularly or intermittently, lake, dam or wetland already in existence (Alien Busters, 2001).

Local councils have the authority to insist on the removal of alien vegetation from privately owned land within 30 days, after which the plot will be cleared by the local authority and the owner invoiced for the cost. In the near future, before sale, transfer, rezoning or subdivision of land, an alien invader clearance certificate will have to be issued (Alien Busters, 2001).

There is a need for legal provisions to allow authorities in control of protected areas to remove noxious plants on private land up to 5 km away, as has been so successfully done in mountain catchment areas. It would be helpful to establish statutory servitudes on private land bordering on protected areas so as to act on this type of problem. (Fuggle & Rabie, 1991). Many government departments are involved in management initiatives within the existing legislative framework which is largely divided and uncoordinated (Fuggle and Rabie, 1991).

### *Prevention of Introduction*

Since this project focuses on established invasives and their migration into KNR from surrounding properties, the initial introduction of these invasives into the country will not be discussed,

### *Information*

The following types of ecological information is useful when considering the control of specific invasive species: (Cronk & Fuller, 1995)

- Seed dispersal mechanism
- Seed ecology
- Breeding system
- Rate of growth under favourable conditions
- Ability to resprout after cutting
- Requirements for germination and establishment
- Environmental factors (tolerance, nutrient water requirements etc.)
- Susceptibility to pests and disease
- Comparative ecology of invader species with that most likely to replace it after control

An impact assessment can determine the ecological effects of particular invading plants which may have important consequences for conservation and control (Cronk & Fuller, 1995).

Control of alien plants in a garden situation is probably best achieved by mechanical means. Light infestations should be tackled first and then denser infestations. Small plants may be pulled out by their roots especially when the soil is moist. Larger plants may need to be dug out at the roots. The key to success is to tackle the job in a planned way and to diligently follow up to remove seedlings and re-growth. New infestations should be dealt with straight away. It can cost many hundred times more to control a mature alien plantation than a new infestation since it is easier to remove the living plants than it is to exterminate the seeds in the soil.

Infestations may be limited by chemical or biological control, or by physical removal. The use of chemical versus mechanical weeding is highly dependant on the cost of labor. SA is not a country of cheap labour. Chemical weed control is less labor intensive, often less expensive and in many cases gives longer and more effective control than mechanical weeding (Gous, 1996).

Eradication normally involves a combination of several techniques. This integrated approach includes combining mechanical methods (felling, removing or burning alien invader plants), chemical methods (use of approved herbicides), and biological control, or bio-control (using species-specific insects or other invertebrates, and disease from the country of origin) (van Wilgen, *et. al.*,2000).

Integrating mechanical and chemical control aims to ensure that felled trees are killed. At the same time, biological control insects or pathogens are introduced to ensure that the invasive abilities of surviving plants are reduced (van Wilgen *et. al.*, 1997).

Fire is best used in combination with mechanical control through removing the cause of the build-up of surface seed, that is, parent plants that need to be uprooted.

#### *Herbicidal control*

Herbicides may reduce the numbers of invasive species, but unless repeatedly applied, will not limit its spread or prevent re-invasion. Herbicides that are unspecific may damage non-target flora and fauna. Some herbicides are persistent and can accumulate in the soil or in leaf tissue (Cronk & Fuller, 1995). Herbicidal application may take approximately a year to break down resulting in the affected area being devoid of vegetation during this period (Kloof Conservancy, pers. comm., 2002) As a result, herbicide cannot be used in sensitive areas.

Great progress has been made with the development of effective chemical control techniques for alien invader plants in KZN. Apart from guavæ (*Psidium guajava*), herbicides are now registered for the 15 most important alien invader plants occurring in KZN (Kluge & Erasmus, 1991). Table 4-1 provides a list of some of these plants with their registered herbicides.

Table 4-1 – List of invaders and registered herbicides

Alien invader	HERBICIDE				
	Triclopyr (Garlon)	Glyphosate (Roundup)	Imazapyr (Chopper)	Tebuthiuron (Graslan20p)	Picloram/ triclopyr
<i>C. odorata</i>	+	+	+	+	
<i>L. camara</i>	+	+	+	+	+
<i>Acacia mearnsii</i>	+	+		+	+
<i>Acacia dealbata</i>	+			+	+
<i>Rubus cuneifolius</i>	+	+	+	+	
<i>Solanum mauritianum</i>	+	+	+	+	
<i>Psidium guajava</i>	A				
<i>Pereskia aculeate</i>	Xa				
<i>Cestrum laevigatum</i>	+				
<i>Sesbania punicea</i>	+	+		+	
<i>Caesalpinia decapetala</i>	+	+			
<i>Acacia longifolia</i>				+	
<i>Melia azedarach</i>	Xa				

a = research in progress to improve efficacy of chemical control

An advantage of the herbicidal programme is that there is little soil disturbance which could result in alien invader seed banks being exposed leading to mass germination (KNR NCO pers. comm., 1999). The policy for KNR then is to apply herbicide to the invaders to avoid unnecessary mechanical disturbance of the soil resulting in further invasion. On the private land cut stumps of bugweed, unable to be uprooted, were painted with chopper.

The most commonly used application techniques include foliar, cut stump and basal bark/stem treatments. Herbicide applied to a circle of axe cuts made in the stem at ground level (frill method) was shown to be effective in killing bugweed (Denny and Goodall, 1992). Research is now focussed on improving the cost-effectiveness of the different treatments.

The Kloof Conservancy offers a herbicidal control service for conservancy members and the public at a nominal fee.

#### *Physical / mechanical control*

Physical control includes hand-pulling (for annual herbs and tree seedlings), cutting and slashing (for lianes, tree saplings and trees), digging/levering with mattock or crowbar (for plants that regenerate from underground parts, or tree saplings that will regenerate from cut shoots) or mowing/discing (for herbaceous plants) (Cronk & Fuller, 1995).

Mechanical control involves pulling, hoeing or digging out seedlings, fire and ringbarking. Ringbarking involves stripping away bark, usually from waist height, down to ground level. Although it is widely practised, mechanical control on its own is not a cost-effective control method in most situations. A work study has shown that the cost of clearing dense infestations of *Chromolaena odorata* by manual means was double that of foliar application of herbicide to coppice (Kluge & Erasmus, 1991).

Plant and ecosystem responses depend on the method of cutting and the time of the year (Cronk & Fuller, 1995).

While for some species physical control appears to work, for others this type of control is frustrated by features such as resprouting after cutting, a long-lived seed bank, regeneration from fragments and large volumes and efficient dispersal of seeds. Regeneration is avoided by stacking removed plants on racks to ensure that roots, stems and other parts are prevented from touching the ground. Once these plants have dried they can be used as a mulch.

The mechanical control of *Pinus* and *Hakea* species, the principle invaders in mountain catchment areas in the Western Cape has shown to be successful. The generally accepted treatment for these species is to clear stands mechanically to facilitate seed release, and then to burn the areas 12 to 18 months later to kill alien seeds, remove slash and initiate fynbos recruitment (Holmes and Marais, 2000).

Fire, both lightning and man-induced is thought to have played a role in the development of KNR vegetation (KNR Management Plan, 2003). Fire is cost-effective and plays a role in burning surface seeds of alien invaders. The control of invasive plants requires labor intensive treatment before or after burns, or both. This

has a bearing on the timing of controlled burning and requires a predetermined burning schedule, and preparatory and follow-up work loads. A wildfire through sparsely infested areas may greatly increase the subsequent intensity of infestation. Protection against wildfires may therefore indirectly inhibit further infestation. Wildfires in forests are prevented by careful management of the litter layer that provides the fuel for wildfires (Scott and Schultze, 1992).

The natural fire zone management and adaptive interference fire management systems are not suitable for infested areas. Controlled burning on a scheduled basis is required, but the labor-intensive preparatory invader plant operations place restrictions on the extent of the burning programmes which can be carried out with the available resources. Although fire is important for the reproductive cycle of many plants, it can, however, be destructive to others. Improved site conditions for germination of some indigenous forest species occurs after fire, but these conditions may also be exploited by some undesirable exotics including *Chromolaena odorata* (triffid weed), *Melia azedarach* (syringa) and *Lantana camara* (common lantana) (Booyson and Tainton, 1984).

Invader control should not absorb all the resources at the expense of fire management. It must be carefully weighed up to what extent ecologically undesirable fires should be allowed to occur in State-owned conservation areas owing to inadequate fire management in favour of clearing heavily infested, already permanently altered veld. In allowing this, prime conservation areas may be permanently damaged in favour of a marginally faster rate of invader clearing for the sake of water conservation on comparatively small areas (Seydack, 1992).

The use of fire needs to be carefully managed since the release of wildfires may cause serious cases of erosion and marked changes in the hydrological behavior of forest and scrub catchments (Scott & Schulze, 1992). A change in stormflow generation is caused by increased overland flow which results in shorter times of concentration and higher peak discharges during storms. Increased overland flows are linked to the widespread presence of water repellency and the combination of increased overland flow and erodibility of soils results in accelerated soil erosion (Scott and Schulze, 1992). Accelerated soil erosion can significantly reduce the nutrient base in catchment areas.

The Environmental Health Officer of Durban City Health was reported to say (Hilltop Reporter, June 25<sup>th</sup>, 1999) that, apart from the aesthetics aspect, there is the nuisance value of burning vegetation, and the more serious health consideration, particularly in cases of thermal inversion. Allergic people suffer the most under these conditions. A Wildlife Society member was quoted in the *Hilltop*, to say that “if one’s property is near a nature reserve or open land, there is a potential for runaway fires, and in the case of the former, it would seriously impact on the management of the nature reserve”.

Attempts to incorporate environmental issues within national accounting systems can be traced back to the early 1970s (Winpenny, 1991). By adding environmental values to normal financial transactions, the appraisals of gross national product would be revised to ensure that natural environment losses and gains were entered into the assessments (Blowers, 1993).

Whereas traditional economic techniques may be used to value commercially traded natural resources (such as timber), natural resource valuation encompasses a range of techniques for assigning values to resources that are traded commercially and informally, as well as for resources that are not traded. A resource may not always be directly measurable in monetary terms, but can nevertheless possess a particular value because it is able to fulfil a particular function in the ecosystem (Hugo, Viljoen and Meeuws, 1997).

Valuation is possible, but because it takes place in the real world of people, it cannot ever have the accuracy of traditional sciences. The demand to make valuation procedures scientifically accurate is therefore unreasonable (Barde & Pearce, 1991).

Environmental values can be used in decision making to assess planning and development alternatives, to allocate scarce human and financial resources, reconcile conflicting demands, to plan land uses, and to determine compensation levels for loss of resources (Ballance *et. al.*, 2001). Resource valuation can be the underpinning basis for decisions pertaining to sustainable development, from an ecological and economic perspective.

South African case studies have varied with respect to the type of values which have been considered, because each study was carried out to meet different research objectives (Ballance *et. al.*, 2001). Case studies therefore use different methodologies to cater for different objectives. Studies show considerable variation which hampers efforts to make comparisons between studies and to derive regional or national values (Shackleton, 2000).

For example, some set out to place a value on a specific resource in the wild, others have attempted to value an area of savannah, others have sought to value the use of a single resource by local artisans and entrepreneurs or along the market chain (Ballance, *et. al.*, 2001). Others have aimed to estimate the direct use value of all resources used by rural households.

To reduce incompatibility, future studies must make full descriptions of the objectives of the study, the background characteristics of the study area (including the social, political, economic, cultural and biophysical characteristics), the methods used, and assumptions made. In this way, the values reported from case studies may be used in other research and decision-making exercises (Ballance *et. al.*, 2001).

*Utilization*

If invasive plants have a value and can be traded, this may help in its control or, at least offset some of the costs of its control. At Phinda Game Reserve in KZN, people clear alien vegetation to make charcoal (Miller, 1999). Guavas have both nutritional and medicinal value

Utilisation of the green fruits of bugweed, *Solanum mauritianum*, for the production of solasodine, a valuable precursor for the manufacture of cortico-steroid hormones was considered as a long-term method to limit the accumulation of new seed into the soil (Campbell and Van Staden, 1990). The residue was assessed as an animal feed so as to reduce the cost of alkaloid extraction.

*Biological control*

Since there is no biological control program at KNR, this form of control is not discussed.

*Competition from indigenous vegetation*

Exotic plants do not easily invade stable natural vegetation covers and the presence of indigenous plants and grasses suppresses the invasion of alien plants significantly. There is greater competition for establishment sites than in instances where plots are denuded. How the ground cover is managed thus also plays an important role in the control of alien invading plants. Measures to reduce disturbance are important for reducing invasion and should complement other control methods (Cronk & Fuller, 1995).

In a study of the southern Cape forests, an artificial gap larger than 0.1 ha led to a deteriorated microclimate, dry soil and the establishment of herbaceous species without the regeneration of native trees, resulting in the invasion of exotics (Geldenhuys, 1991).

Seeding of grasses or other vegetation on denuded plots can also play a role in suppressing weed infestation. The use of grasses to rehabilitate disturbed land is widely practised in mining and civil engineering industries, but the use of grasses to suppress broadleaf weeds on disturbed sites is a neglected concept in weed science that is being revisited by some agriculturalists, foresters and scientists (Viljoen & Groenewald, 1995).

Plots that were burned and seeded two days later with six perennial pioneer and climax grass species showed a mean of 93% grass cover compared to a mean of 84% for control plots within three months (Viljoen & Groenewald, 1995). Regeneration of alien invader plants was suppressed to a significant degree, but follow-up operations were still required.

#### 4.3. Valuing natural areas

Natural resource valuation is a relatively new discipline which attempts to attach monetary values to natural resources as a means of demonstrating their worth.

Cultural changes, local, regional and national policies, seasonality of a resource, rights to a resource, employment and welfare status of resource users, and opening up of new markets will all have an effect on the value, and will contribute to variation in resource value between savannah studies (Ballance *et. al*, 2001).

Drivers of savannah value are such issues as the supply and demand for a resource, political, economic and social situation of resource users, macro-economic policies, changes in market demands, and availability of substitutes and alternatives (Ballance *et. al.*, 2001).

The supply is determined by the size of the resource and the difficulty in exploiting it, as well as other factors. The larger the demand and the smaller the volume or the more complicated its exploitation, the greater the value that will be attached to that resource (Hugo, Viljoen and Meeuwis, 1997).

Cost/benefit analyses (CBA), incorporating environmental values are usually performed in order to determine whether a particular development practice is viable. The cost of environmental degradation is often compared with the benefits that a particular development might have. CBA is criticized vehemently in many quarters, not least by environmentalists who see it as placing a money value on something that cannot be valued (Barde & Pearce, 1991).

The basic rule for guiding decisions on developments is that the benefits of the development should exceed the costs. The net benefits alone are, however, not good enough since what is really required is that the net benefits must be higher than the net benefits obtained by an alternative use of the funds in question (Winpenny, 1991).

Normally, for a development proposal to be accepted, the following is required:

$(B_d - C_d - N_{Bc}) > 0$  where  $B_d$  = money value of benefits of development (benefit of maintaining the integrity of KNR),  $C_d$  = money value of resource costs of development (budgetary requirements) and  $N_{Bc}$  = net benefits of conservation.

$B_d$  is determined from the TOTAL ECONOMIC VALUE (TEV) given as:

use values + indirect values + option value + existence value (Barde & Pearce, 1991)

(Ballance *et. al.*, 2001) determines TEV from: use value + option value + non-use value.

The method used for calculating TEV in this dissertation was similar to that of Barde & Pearce (1991) since those factors of KNR identified as contributing to the TEV were better placed within the formula as given by the mentioned authors. Tourist and domestic hiking and picnicking are examples of recreational non-consumptive use value that brings in economic revenue. Thus it is important to preserve the indigenous plants and animals and landscapes for scenic purposes.

Natural areas have educational value in that it fosters the social development of children and makes people aware of their place in nature, that they are a link in a large system of mutual co-operation (Hugo, Viljoen & Meeuwis, 1997).

Natural areas have scientific value in that the functions of the different components of the ecosystem and their relationship can be studied to guide management decisions around resource utilisation (Hugo, Viljoen and Meeuws, 1997). Indirect values result from the ecological role that the conserved area might serve.

The Environmental Branch Development and Planning Service Unit, 1999, (in O'Leary,2001) has listed the ecosystem services provided by open space such as KNR. These are:

- Gas regulation (e.g. carbon sequestration, oxygen and ozone production);
- Climate regulation (e.g. urban heat amelioration, wind generation, noise abatement);
- Disturbance regulation (e.g. flood control, drought recovery, refuges from severe environmental events);
- Water regulation (capture and gradual release of water by vegetation for urban use)
- Water supply (supply of water by rivers, watersheds and reservoirs for agricultural, household and industrial use;
- Erosion control (prevention of soil loss by vegetation cover and by capturing soil in seep areas
- Soil formation (weathering of rock by water, accumulation of organic material in woodlands and wetlands);
- Nutrient cycling (nitrogen fixation, nitrogen cycling through food chains)
- Waste treatment (breaking down of waste, detoxifying pollution)
- Pollination (supply of pollinators for plant reproduction)
- Biological control (predator control of prey species)
- Refugia (nurseries, habitats for migratory birds, regional habitats for species)
- Food production (e.g. fish and fruit that may be obtained)
- Raw materials (e.g. production of fuel, craftwork, building materials etc)
- Genetic resources (e.g. genes for resistance to plant diseases, plant medicines, ornamental species etc.)
- Recreation (e.g. eco-tourism, walking, bird watching etc.); and
- Cultural (e.g. scenic views, environmental education, research opportunities, sense of place, attractive living environment for DMA residents).

Option value refers to the value attached to a resource because it has the potential for use at some time in the future, or by future generations (Barde & Pearce, 1991).

An area of forest fringe has option value to a community for its potential to support tourism or to supply plants, should present supplies, from an alternative source decline. Added to this is the *quasi-option* value which relates to determination of options in the face of inadequate data or means to derive an option value (Ballance *et. al.*, 2001).

The non-use value used by Ballance *et. al.* (2001) may be related to the existence value of Barde & Pearce (1991) and is defined as the value attached to a resource without the valuer deriving any use from it. Examples are aesthetic values (scenic beauty), cultural values (heritage sites) and intrinsic values (non-anthropocentric values). The aesthetic value of nature conservation can become of inestimable significance in a world that is becoming largely urbanised. (Hugo, Viljoen and Meeus, 1997).

Ethical value (moral justification) is based on the premise that species have a moral right to exist, independent of any use we have of them, as put forward in the United Nations General Assembly World Charter for Nature, 1982 (Hugo, Viljoen & Meeuws, 1997).

Examples of indirect, non-consumptive use include provision of shade and ecological functions such as carbon sequestration and soil conservation. Indigenous plants on average provide more food, resting and nesting sites for our birds, mammals and other animal life than exotic plants.

#### 4.3.1. Value of plants

Plants are important in controlling some catchment problems. In catchment areas that are not built on or developed, the ground is still covered with natural vegetation which plays the following roles: (Eco-facts 4 , 1999).

- Plants reduce the speed of runoff water over the ground which allows lots of rain water to sink into the ground and thus replenish the groundwater. The groundwater then slowly feeds the river to ensure that it flows all the year round.;
- Plants prevent soil erosion since their roots stabilize the ground and stop it from washing away. Also the plants break the impact of the rain drops before they hit the ground, minimizing the erosion potential; and
- Plants in wetland systems and on riverbanks are of special importance since their roots bind the ground, stop erosion, regulate the flow of water and at the same time, purify the water.

When plant cover in catchment areas is stripped from the ground through agricultural or industrial practice, there is an increase in runoff water and erosion. At the same time there is less water sinking in the ground and

less to replenish the aquifers, with the result that the rivers only run in the rainy season. Much of the siltation in estuaries is due to the washing away of riverbanks that have destabilized due to the removal of plant cover.

The natural vegetation of the environment is usually totally destroyed by urban development. Vegetation in urban environments fulfils the following functions: (Hugo, Viljoen and Meeuwis, 1997).

- Micro-climate modification – shadow effects, windbreaks and lowering air temperatures by evapotranspiration ;
- Control of air pollution – gases like carbon and sulphur dioxide are absorbed by the leaves;
- Noise reduction – plants (including grass) absorb sound;
- Historic value – given to certain trees or tree-lined avenues;
- Social value – plants used as emblems or sought after for social status;
- Ecological value – resettlement and the establishment of animals (especially birds) will take place automatically if a suitable habitat is created. The cost of maintaining an ecologically viable natural park is much lower than the cost of maintaining a traditional urban park; and
- Ornamental/aesthetic value – apparently the most important reason why plants are kept in urban areas.

Direct, consumptive use values apply to natural products that may be harvested and used by the household or traded in the market place. People use woodlands for household needs as well as for raw materials for goods sold in the formal economy.

Forests and woodlands comprise a diverse range of environments which have a significant, but often poorly recognized economic, environmental and social value. The resource is declining, but at an unknown rate and as a result of pressures and changes which are not widely understood. Achieving sustainable management will require a marked improvement in our understanding of the value and status of the resource and the pressures that influence its management (DWAF, 1997).

About 12 000 plant species have been used for food, but only 150 species have been cultivated (Hugo, Viljoen & Meeuwis, 1997).

Natural areas also provide a genetic pool for cross-fertilisation of wild plants with modern hybrid varieties. This is done in order to strengthen the resistance of hybrid varieties to pests. Genetically modified organisms which are becoming more and more important also lean heavily on wild plants and animals for genetic material

Fuel wood, wood for carving, building materials and ingredients for traditional ceremonies and medicines are all obtainable from indigenous forests. Bark, roots and bulbs are removed from forests by traditional muti dealers.

Use may be perennial, as a more or less permanent element of the local economy (as in fuel wood), or intermittent, when people fall back on the fruits and other products of the woodlands during times of shortage, or for quality timber (Geldenhuy's, 1997). Resource management is poor to non-existent, and prices paid for the raw product are much below their true value.

There are approximately 30 000 isangoma (diviners) and izinyanga (herbalists) that operate in KZN. This large number of herbalists place a great strain on the indigenous plant population, leading to a vast amount of threatened species (Club Card, May / June, 2003).

Each year approximately R26 million rand changes hands in medicinal plant trade in the Bushbuck Ridge area of Limpopo and some drug companies have estimated the national informal medicinal plant trade at between R500 million and R1 billion. In 1990 exports of S.A. plants to Europe were estimated at around R52 million (Club card, May / June, 2003).

An estimated 6 to 10 million tonnes of fuel wood is consumed per annum in SA (van Rensburg *et. al.*, 1997). The bulk of this material is collected from natural woodlands, leaving only isolated patches of indigenous bush.

The extent to which the goods and services provided by the indigenous forest of KNR are used by the community is unknown, but indigenous trees and plants are used extensively for medicinal purposes and for fire wood. Commuters between place of residence and work have access to KNR at the Upper and Lower Molweni areas resulting in the potential for abuse of the indigenous vegetation. Efforts to fence off these areas have failed due to the cutting and theft of the fence wire (KNR NCO, pers. comm., 1999).

Although indigenous plants are being removed /damaged, a total monetary value on these losses cannot be determined. Trees of which bark has been removed for medicinal purposes have been identified, but the removal of other plants e.g. bulbs cannot readily be quantified (KNR NCO, pers. comm., 1999).

Wetlands protect water. They purify it, store and regulate storm flow, ensure water in drought periods, recharge groundwater, control soil erosion and reduce flood destruction (Gowans, 1997). Wetlands influence the quantity and quality of run-off water and, if lost, have an estimated replacement value of R185 000 per hectare per annum (Botanical Society of SA, the Durban Unicity Environmental Management Branch, the Durban Parks Department and WESSA, 2000).

Consumption of water from the Emolweni River occurs outside KNR, but the quality (and quantity) of the water depends on its purification and release by wetlands within KNR. Thus KNR has an indirect ecological function that provides value for water consumption, the purity of which may be indirectly affected by pollution and erosion stemming from KNR. The wetlands in KNR effectively purifies the water that feeds the Emolweni river from which the Molweni community abstract their drinking water. Although consumption does not take place directly in KNR, the integrity of the reserve has an indirect effect on the value of the commodity.

Wetlands, apart from protecting wildlife, maintaining bio-diversity, having a high domestic stock grazing potential, are also valuable producers of fibre for handicraft and construction, and are of value for education and recreation. An estimated 50 percent of South Africa's wetlands have already disappeared (Gowans, 1997).

#### 4.3.2. Devaluing factors for KNR

Ian Patrick was quoted to have stated that the entrance fee of R5 per person would discourage vandals from coming into KNR to deliberately cause damage to facilities (Gray, October 15<sup>th</sup>, 1999).

Hikers in the KNR are especially prone to attacks with most reports coming from the tail end of the nature reserve (where uncontrolled entry occurs) and near the Uve entrance.

The way in which people view KNR determines the type of value they place on it. If hikers were to view KNR as being over-run with alien invaders or picnickers were to view KNR as having poor recreational facilities, the corresponding value will be assigned to it. These views may, however, differ from a subsistence user who may regard the fruit of an alien invader (e.g. guava) as valuable.

Criminals place a high value on KNR since attacks may occur in isolated areas and there is plenty of area to hide away or to hide stolen goods. Criminal activity has subsequently taken place relatively frequently in KNR

In 1997 an attack occurred along the Nkutu trail where 5 hikers were robbed of equipment valued at R7000 by 6 youths wielding bush knives. The number of organized hikes through KNR has diminished considerably over the years due to this problem.

Discussions with the chairman of Backpackers Hiking Club reflected a dim view of future day hikes through KNR. He mentioned that the main trail leaders who would normally take the hikers through the nature reserve were emigrating. It is well known that many people emigrate from SA due to the high crime rate.

The conservation officer in charge knows of 8 reported incidences in the three years i.e. 1997, 1998, 1999. The public relations officer at the Kloof Police Station was quoted to say that it was the sixth attack in that year (*Highway Mail* reporter, November 28<sup>th</sup>, 1997) which would mean that the crime rate is decreasing since only two cases of attacks would have occurred in 1998/1999.

This deduction is apparently false since on speaking to the NCO in charge, he mentioned that a further three attacks have occurred in the past few months (late 1999, early 2000). Unreported incidents may make the number of actual attacks much greater than is currently gathered. Many people have become more wary and are avoiding hikes.

Housebreaking and theft are common occurrences for communities bordering KNR and cases of this crime are known to have occurred near the Azalea Place entrance. Houses alongside undeveloped areas are especially targeted. Thus funding appears not to be the only recreational threat to the reserve.

#### 4.4. Integrated Catchment Management

Integrated Catchment Management (ICM) is a management strategy that involves co-ordinating the management of land-use activities to ensure that there is a sustainable balance between utilisation and protection of all environmental resources within the catchment (Umgeni Water, 1998).

The goals of sustainability require new market mechanisms and controls designed to achieve environmental efficiency, the conservation of natural resources, the maintenance of health, and the enhancement of social equality, where such is possible (Blowers, 1993).

The World Summit on sustainable development held in Johannesburg (August, 2002) wrestled with contentious issues that were negotiated by government delegates for the phrasing of the Plan of Implementation (Munusamy, 2002). Some contentious issues identified are:

- achieving significant reduction in the current rate of diversity loss;
- that policies should be developed to improve access by the indigenous people and their communities to economic activities;
- that assistance should be provided to increase income-generating employment opportunities, respecting International Labor Organization core standards; and
- that policies and programs that secure equitable access to land and tenure reform processes should be promoted and supported.

ICM refers to a style of management that takes into account all aspects relating to a particular catchment, for example, the management of water resources, the management of the substrate and the biota, the management

of the area for multiple land uses and the management of the people who interact with the catchment. An integrated approach is essential since the one aspect may impact on the other.

Integrated river basin management implies that informed decision-makers take into account all uses and resources of the basin, following an ecosystemic approach. The overall goal is to ensure that human collectivities will benefit forever from the basin through the development of harmonious relationships between its users and between man and the river (Versfeld, 1996).

Where ICM is to be implemented, agency and land-owner representatives must combine across disciplines that tackle the natural resource problems that now face them. The need to broaden participation and thereby democratise the process of ICM for sustainable water resource development is fundamental to peaceful, holistic and equitable progress in SA (Versfeld, 1996).

The KNR management plan identifies the following threats that need careful management requiring the co-operation of “neighbours”.

- Poaching of game within the park ;
- Illegal plant harvesting within the park ;
- Alien plants from neighboring properties ; and
- Inappropriate agricultural practices.

The aim is to develop partnership (co-management) forums with representation from community interest groups and leaderships around KNR, to consider ..... (KNR Management Plan, 2003):

- Resource harvesting ;
- Employment opportunities ;
- Problem animal control ;
- Compliance ; and
- Security.

Important stakeholders include Tribal authorities, municipalities and landowners. Issues for consideration / deliberation are:

- Controlled free access for neighbors ;
- Open days ;
- Protected area planning and management ;
- Conflict resolution between protected area and neighbors ;
- Boundary and land issues ;
- Sustainable use of wildlife resources in protected area (no current use) ;
- Preferential appointment ;

- Job creation and promotion of local entrepreneurship ;
- Communication strategies for protected area neighbors ;
- Monitoring/review ; and
- Research

Programs providing environmental education (formal and informal) and awareness for “neighbors” are envisaged, as well as nature conservation extension activities.

The ICM process results in a product which is a communication framework and a Catchment Management Plan (CMP) that incorporates environmental, social and economic considerations, and is based on a set of development objectives which allow working across political jurisdictions to manage the water resources on a catchment basis (Umgeni Water, 1998).

The CMP is a holistic management strategy that takes into account the current state of the catchment and develops management strategies that will guide the use, conservation, management, control and protection of the water resources in the catchment (Umgeni Water, 1998).

The vision of the Department of Water Affairs and Forestry (DWAF) is a joint process from the senior management downwards and from community-based organizations upward. It is the focus of DWAF to devolve the management of specific catchment areas to the local level.

Workshops on community-based conservation intend to bring together students, practitioners from governmental and non-governmental organizations (NGOs) and community leaders to mingle and discuss relevant issues. The purpose of this approach is to:

- assess the potential of conservation to contribute to empowerment and income generation among the unemployed ;
- assess the feasibility of community based socio-economic development leading to environmental awareness and sustainable use of natural resources ; and
- find practical ways for conservation agencies working with communities to avoid pitfalls and achieve the dual goals of resource conservation and community development (Milton, 2000).

Community-based conservation is not easy to facilitate and takes time to develop. It involves more than consultation and participatory planning. There needs to be an economic incentive to conserve rather than to over-exploit resources. Some of the associated problems are: (Milton, 2000).

- Identifying the community – there is likely to be strong differences within any group of people living in a single geographic area. ;
- It cannot be assumed that participants have an interest in the natural environment or an awareness of environmental issues ; and
- Participants are often donor dependant, entrepreneurial talent is rare and, unlike business skills, cannot be learnt. Many lack the confidence or drive to become self-employed.

Among the obstacles to participatory planning are the inflated expectations of potential benefits to be gained from protected areas and the absence of institutions that can manage monetary benefits and negotiate agreements. Protected areas are costly to run and resource-exploitation is time-consuming to monitor. Thus monetary benefits and harvestable products available from protected areas for communities may be disappointingly small (Milton, 2000).

Other tangible benefits for communities from protected areas are the provision of electricity and medical services, training and capacity building, markets for craftwork and services and rights to royalties (Milton, 2000).

The diverse skills and services that project participants in community conservation will be able to market include alien plant control, fire management, vegetation restoration, hiking trail maintenance, eco-tourism, adventure tours, mountain rescue and wood-based industries (Milton, 2000). The success of the programme depends on developing local and foreign markets together with business capacity and the environmental sustainability of the industries.

Two models for setting up a small business are possible (Milton, 2000). One involves a hierarchical approach with an owner using subcontractors who employ workers.

The other is a co-operative which is preferred because it leads to greater economic empowerment. However it is more difficult to set up and is notorious for failure because it depends on group cohesion and decision-making (Milton, 2000).

Access to benefits from natural resources should lead to an improved quality of human life, which in turn should sensitise people to the value of natural resources and motivate them to conserve species and use limited resources more wisely. Training sessions and workshops are usually needed to develop trust and build the capacity of communities to make decisions about the management of natural resources, habitats and species (Milton, 2000).

Goal 5 of the White Paper on Environmental Management Policy in South Africa is to promote the environmental literacy, education and empowerment of South Africa's people, to increase their awareness of,

and concern for, environmental issues, and assist in developing the knowledge, skills, values and commitment necessary to achieve sustainable development. Supporting objectives given are (DEAT, 1998):

#### Education & Training:

- to integrate environmental education in all learning programmes accredited under the National Qualifications Framework in formal education ;
- to integrate environmental education into all training and unemployment relief programs ;
- to enhance environmental literacy through the use of all forms of media ; and
- to ensure that environmental education programmes and projects foster a clear understanding of the inter-relationships between economic, social, cultural, environmental and political issues in local, national and global spheres.

#### Empowerment of citizens through capacity building:

- to promote capacity-building programmes and projects that assist people, particularly those from disadvantaged backgrounds, to manage their environment with due care and address their environmental concerns. These projects should pay particular attention to using local and external knowledge to develop social and organizational skills ; and
- to assist small, medium and micro enterprises in developing appropriate environmental management procedures.

#### Marginalised and special interest groups:

- to encourage and support the involvement of special interest groups such as women, workers, the unemployed, the disabled, traditional healers, the elderly and others in the design, planning and implementation of environmental education and capacity building programmes and projects.

#### 4.4.1. Managing water resources

The river's catchment or drainage area includes the ground from the mountain tops to the sea, drained by a single river and its tributaries. The characteristics of any river (physical, chemical and biological) is determined by the nature of the catchment area and the natural as well as human activities that take place there. A wetland is an area seasonally or permanently saturated with water. Wetlands range from mountain springs and midland marshes to swamp forests, estuaries, riverbank wetlands and even coral reefs less than six metres deep.

Groundwater, wetland and spring protection, erosion and flood control are important when considering the holistic management focus required for the river's drainage or catchment area.

SA's water policy does not aim to at all costs prevent impacts to the water environment. This will not allow the country to achieve much-needed social and economic growth. The challenge is to obtain the right balance between protection and utilization of water resources. To achieve this balance, there must be some water for everyone (equity) forever (sustainability). The two elements of equity and sustainability are also the key elements of Agenda 21, the international blueprint for sustainable development (DWAF, April, 1999).

The National Water Act (NWA) sets out the framework that provides for the establishment of Water Management Institutions (WMIs) which include Catchment Management Agencies (CMAs) and Water User Associations (WUAs).

Some of the purposes of the NWA are:

- meeting the basic needs of present and future generations ;
- protecting aquatic and associated ecosystems and their biological diversity ;
- reducing and preventing pollution and degradation of water resources ; and
- managing floods and droughts.

Catchment management decision-making needs to take into account the principles underlying the National Water Resource Strategy (NWRS) which is the overarching legislation. The management of water resource catchment areas is based on a Catchment Management Strategy (CMS) which stems from the NWRS. The NWRS must promote the management of catchments within a water management area in a holistic and integrated manner (National Water Act, 1998).

It must establish water management areas (WMAs) and determine their boundaries. In determining WMAs the watercourse catchment boundaries, social and economic development patterns, efficiency considerations and communal interests within the area in question need to be considered. Comments were invited after publishing in the gazette the intention of defining WMAs on 31st March, 1999.

The NWRS is binding on all authorities and institutions exercising powers or performing duties under the NWA.

The CMS must be in harmony with the NWRS. The strategy is to progress developmentally through consultation and is to provide the framework within which water will be managed at regional or catchment level, in the defined WMAs (National Water Act, 1998).

The CMS should reflect, for example...

- the needs and expectations of different water users.
- current and future activities which affect / might affect water resources.

- nature of stakeholder interest in the catchment strategy.
- local knowledge about existing protection, use, development, conservation, management and control of water resources.
- factors that focus on the operations and functions of the CMA.

The CMS is to be developed by the CMA which must seek co-operation and agreement on water-related matters from the various stakeholders and interested parties (National Water Act, 1998).

Examples of technical expertise and infrastructure available from Umgeni Water that will support the development of the CMS are: (Umgeni Water, 1998).

- pollution prevention, chemical, microbiological and biotic monitoring and assessment.
- environmental education.
- identification of critical problems, preliminary objectives and possible management strategies within a catchment.
- water conservation pilot studies and demand management.
- the initiation of catchment management forums and committees.

The Minister must advertise in the Gazette that the strategy is to be implemented, invite written comments and state where the strategy is available for inspection. The CMS must set principles for allocating water to existing and prospective users, taking into account all matters relevant to the protection, use, development, conservation, management and control of water resources.

The CMA may be established for a specific WMA after public consultation, on the initiative of the community and stakeholders concerned, who must provide such a proposal to the Minister.

The purpose of establishing these agencies, run by a Governing Board (GB), is to delegate water resource management to the regional or catchment level and to involve local communities, within the framework of the NWRS. Where the necessary capacity does not exist to establish a CMA, an Advisory Committee: Process may be appointed to develop the necessary capacity as the first step towards establishing an agency.

The CMA will be funded from water use charges within its area. A CMA will need, as a minimum, the following to carry out its initial functions:

- A Chief Executive Officer (CEO)
- Secretariat
- First - line managers e.g. a Water Resources Manager, Financial Officer and Communications/Public Participations Officer.

- The first-line managers are accountable directly to the CEO, who is in turn accountable to the GB.

Figure 4-1 below provides one possible model of a CMA structure.

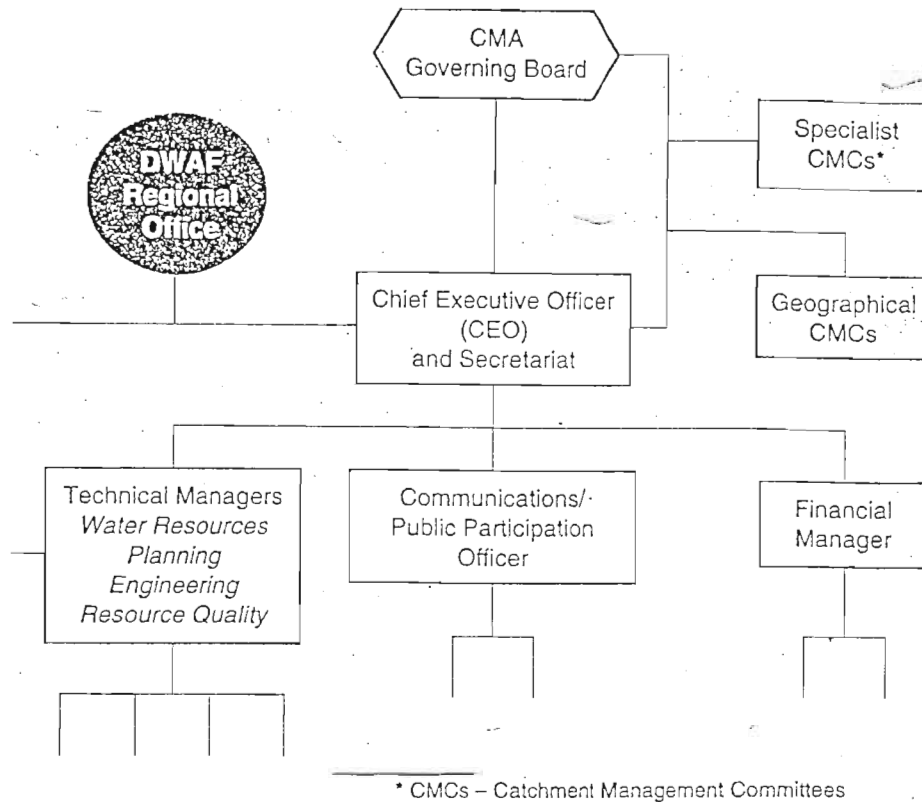


Figure 4-1 - One possible model of a CMA's organisational structure (DWAF, April, 1999).

The GB of the CMA, consisting of 9 - 15 members, will be constituted in such a way that interests of the various stakeholders are represented or reflected in a balanced manner, and the necessary expertise to operate effectively, is provided. The GB requires skills in technical water resource management, strategic planning, finance and legal and public participation matters.

Some of the stakeholders identified are:

- water users.
- potential water users.
- local and provincial government.
- environmental interest groups.

The GB must also have gender and demographic representation, representation by DWAF and national government, as well as representation by disadvantaged communities.

The CMA must ensure that low income communities are able to participate effectively in subcatchment forums and that the necessary resources are available.

An Advisory Committee: Governing Board (about 5 to 10 members) will assist the Minister in the task of establishing a GB. Members of the GB may be elected or nominated by the different water user groups for appointment by the Minister, and the Minister, on his/her own accord, may make further appointments. The Minister also has the power to remove a board member, if need be.

The GB is accountable to the Minister for the performance of the CMA. It must set the vision, mission and strategic direction of the CMA within the policy framework set out by the NWA and must prepare business plans and monitor the performance of the CMA against these plans. The role of DWAF is to audit the strategy and performance of the CMA

The Minister may, after consultation with the relevant CMA, assign the agency certain powers or duties, but may limit the area in which the assigned power may be exercised and may attach conditions to the assignment. The Minister may use his/her own initiative when establishing an agency or receiving a proposal to establish one.

The Minister may not delegate the power to appoint a member of the GB of a CMA. When there is no agency or when the agency formed is not functioning then the Minister must fulfill the functions of an agency. DWAF is itself an agency.

Every WMA is different and has specific requirements. The NWA recognizes this by providing a range of options and institutions that may be employed in the establishment of CMAs driven by local needs.

The CMA will be guided by a sustainable CMP in its investigation and advise on the protection, use, development, conservation, management and control of the water resources in its WMA.

A proposal to establish a CMA must contain at least ...

- a proposed name and description of the proposed WMA of the agency ;
- a description of the significant water resources in the proposed WMA and information about the existing protection, use, development, conservation, management and control of these resources ;
- the proposed functions of the agency, including functions to be assigned and delegated to it ;
- how the CMA will be funded ;
- the feasibility of the CMA in respect of technical, financial and administrative matters ; and
- an indication whether there has been consultation in developing the proposal and the results of the consultation.

**Figure 4-2** indicates stages of the CMA establishment process.

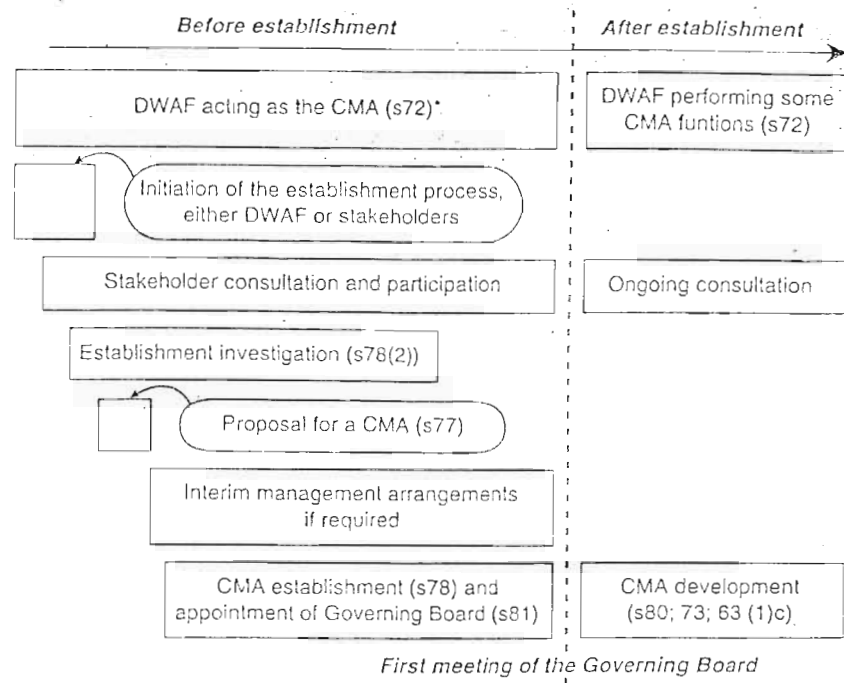


Figure 4-2 - Stages of the CMA establishment process (DWAF, April, 1999)

#### Stage 1: Initiating participation

Most CMA establishment processes will start with awareness creation, public participation and the formation of Catchment Management Forums (CMFs). Where these CMFs provide adequate representation of all stakeholder interests, a proposal can be developed and the CMA established (thus going directly to stage 4).

#### Stage 2 : Formalising participation

Stakeholders may feel it necessary to create a formal, but non-statutory relationship in the form of a Catchment Steering Committee/s, representing all stakeholders and guiding the further process of establishing a CMA. The emphasis at this stage is the strengthening of relationships and planning for the future.

#### Stage 3 : Interim management arrangements

In some WMAs, capacity and resource constraints may cause a delay in CMA establishment. Certain functions may be delegated to either a single Advisory Committee: Management for the entire WMA, possibly associated with a number of non-statutory Subcatchment Steering Committees or to a number of Catchment Management Committees (CMCs) that represent different catchment areas.

#### Stage 4 : The CMA

The ultimate goal of the process is to establish the CMA, with the appointment of a GB based on the recommendations of the Advisory Committee: Governing Board.

The establishment of the agency needs to be gazetted. In some cases the four stages of the CMA establishment process will be moved through sequentially, while other establishment processes may pass or quickly move through one or more stages, depending on local needs and circumstances. Figure 4-3 below indicates some of the possible paths followed during the establishment process.

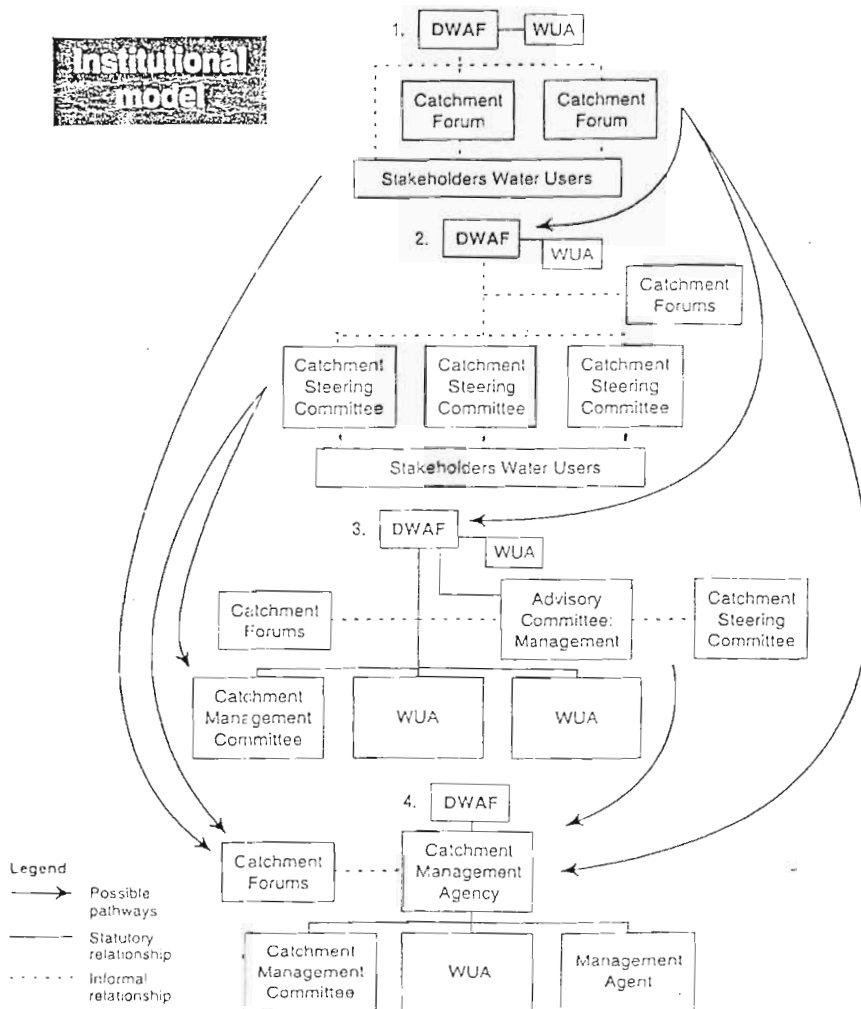


Figure 4-3 - Possible paths through the four stages of CMA establishment (DWAF, April, 1999).

When assigning a power or duty to the agency the Minister must consider the capacity of the agency to exercise the power or perform the duty and the desirability of assigning that power or duty.

The initial functions of the CMA are –

- to investigate and advise interested persons on the protection, use, development, conservation, management and control of the water resources in its WMA.

- to develop a CMS.
- to co-ordinate the related activities of water users and of the WMIs within its WMA.
- to promote the co-ordination of its implementation with the implementation of any applicable development plan established in terms of the Water Services Act (1997).
- to promote community participation in the protection, use, development, conservation, management and control of the water resources in its management area.

Additional powers and duties that may be assigned to CMAs are to establish water use rules and management systems, to direct users to terminate illegal uses of water, and to temporarily limit the use of water during periods of shortage.

The CMA may establish committees, including an executive committee and consultative bodies, to perform its functions in a particular WMA or generally to advise it, and must determine how the CMA must function. Catchment Management Committees (CMCs) provide an important means by which CMAs can broaden their management and technical capacity.

CMCs are directly accountable to the GB. Their membership may include Board members, technical employees of the CMA and any other person or body. Specialist CMCs will typically deal with certain functions over the whole WMA, while geographical CMCs will focus on specific areas.

The CMA may delegate power to a member of its GB, an employee of any WMI, any CMC established by the agency (which consists only of members of the GB or employees of the CMA) and any other person or body, only with the written consent of the Minister. The CMA must be funded by money appropriated by Parliament, water use charges and money obtained from any other lawful source.

Besides the CMA, other WMIs identified are:

- Water User Associations (WUAs).
- International Water Management Bodies.
- CMCs.
- Water Services Institutions (Water Boards).

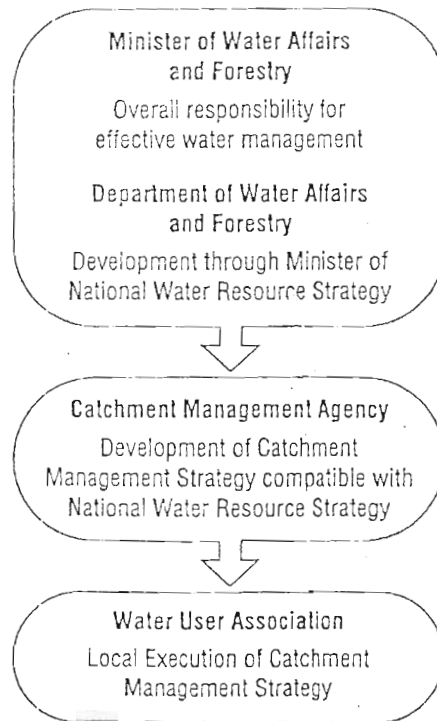


Figure 4-4 – “CMA”s and WUA’s within the context of water resource management (DWAf, April, 1999)

The broad role of a WUA is to enable people within a community to pool their resources (money, human resources and expertise) more effectively to carry out water-related activities (DWAf, November, 1999). Members will benefit from addressing local needs and priorities

CMAs are in charge of managing water resources for the whole WMA, whereas WUAs will normally have a local interest. WUAs will assist with the implementation of the CMS at local level. WUAs may be represented on the CMA GB and on CMCs. The NWA provides that WUAs be established and monitored by the Minister but these powers may be delegated to the CMA providing it with direct control over the WUAs.

A major role of the CMA is to manage activities impacting on water resource management in their area and to promote community participation in water resource management. This requires co-operative governance, enshrined in SA’s Constitution, meaning the fostering of friendly relations, assisting and supporting each other, informing each other and consulting on matters of common interest, co-ordinating actions with each other and adhering to agreed procedures.

Stakeholders of representative consultative catchment structures will raise diverse contributions. This diversity enriches decision-making. An experienced facilitator should assist stakeholders in appreciating the diversity of opinion, rather than it turning into conflict.

Through gaining a better understanding of the issues at stake, and each other's needs and expectations, stakeholders can then deliberate options for mutual gain as well as criteria from which to evaluate them. Consensus-building will take place in the CMAs and WUAs where smaller groups can deliberate the issues face to face.

The DWAF will offer support and assistance to Catchment Management Forums (CMFs) and will play an auditing role, rather than a service. To ensure the effective functioning of the CMF and its constituents, the forum needs to be assessed for capacity, availability of resources, socio-economic representation etc. The CMF itself will have no legislative powers, but once formed, it may be elevated to committee status where it will have limited legislative powers.

The CMF membership has no restrictions and would hope to be representative of the surrounding community as well as NGOs, service providers, local council etc. In order for ICM to work at the forum level, it is essential that all community members and stakeholders become part of the decision-making and implementation process since ICM requires all environmental, economic and social issues within a river basin to be integrated. Without economic development, natural resources are unlikely to be sustainably managed or conserved.

Key stakeholders include:

- Local Authority representatives from each Department ;
- Farmers ;
- Non-governmental Organisations (NGOs) ;
- Representation from the businesses in the area such as the Chamber of Commerce and individuals whose business may impact on the quantity and quality of the water resource ;
- Any water management organisation such as irrigation boards, water committees and water boards ;
- Environmental groups ;
- Educational Institutions ;
- Community representatives ; and
- Conservancies.

CMF members would be active in:

- collecting information and data.
- identifying all the resources within the area of concern.
- identifying solutions and an implementation process.

- monitoring their own progress.

The CMF will submit CMPs to an established CMA. The plans will have to be approved by the GB of the CMA who will ensure that they are in line with the overall strategy at WMA level. Once CMPs are submitted and approved then funding may become available for use in the management of a particular catchment/subcatchment. The funding base is water use charges, for example, the charges obtained from Umgeni Water.

A situational analysis provides a sound information base for catchment management planning and decision-making and can be drawn up for a particular subcatchment which will support the development of the CMP.

A situational analysis investigates and reports on the current context which may govern use, and value (and hence changes in use and value) of the resource, in terms of the following broad categories (Ballance *et. al.*, 2001):

- ecological/biological ;
- historical ;
- cultural/social ;
- legal ;
- technological ;
- political ;
- institutional ;
- economic ; and
- spatial and temporal scales.

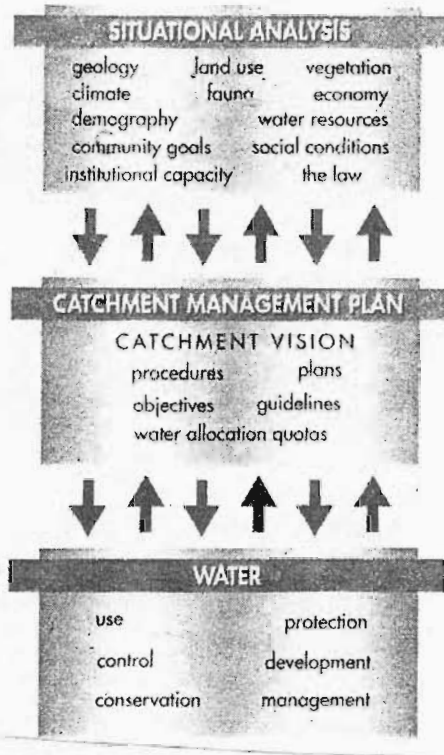


Figure 4-5 – Relationship between a situational analysis and a CMP.

The protection of water resources is fundamentally related to their use, development, conservation, management and control. Certain measures are to be taken which are to be developed progressively within the context of the NWRS and the CMS. These measures involve the classification of water resources and the identified resource quality objectives, determining the Reserve and pollution prevention and remediation. DWAF is obliged to determine the Reserve and classify the water resource (Water Act, 1998).

In July, 1997 DWAF developed and tested these resource directed measures co-ordinated by the Institute of Water Quality Studies (IWQS). It is a large multi-disciplinary study in which most of the country's foremost water specialists take part.

According to the IWQS, protection measures will have to be practical and should be able to take into account the extreme variability and differences in the natural characteristics of aquatic ecosystems.

Socio-economic conditions in the country need to be considered as well. A new set of scientific tools and approaches, in addition to those that already exist, is needed to achieve this. Scientific input must be balanced by stakeholder consultation (DWAF, April, 1999).

These measures are fundamental to ICM and will guide the CMA in terms of how much water can be allocated and the water quality to be maintained in a catchment.

Water Quality Objectives (WQOs) must be set, based on the *class* of the resource and the *Reserve*.

#### Classification system for water resources and water quality objectives

The system may establish guidelines and procedures for determining different classes of water resources. With respect to each class, the system may establish procedures for determining the Reserve and may establish procedures designed to satisfy water quality requirements of water users, as far as is reasonably possible, without significantly changing the natural water quality characteristics of the resource. Finally, for each class, the system may set out water uses for instream or land-based activities which must be regulated or prohibited in order to protect the water resource.

The provision is made for any other matters relating to the protection, use, development, conservation, management and control of water resources, as seen fit by the Minister.

The onus is on the Minister then to provide water quality requirements for each class of water resource. In determining the WQO for each resource, a balance needs to be found between the need to protect and sustain water resources on the one hand, and the need to develop and use them on the other. Preliminary classifications will lead to formal classifications which will then be binding by law.

A notice must describe the geographical area in which the WQOs apply, the requirements for achieving these objectives, and the dates from which the objectives will apply.

The WQOs may relate to the Reserve, the instream flow, the water level, the presence and concentration of particular substances in the water, the characteristics and quality of the water resource and the instream and riparian habitat, the characteristics and distribution of aquatic biota, the regulation and prohibition of instream or land-based activities affecting quantity and quality and any other characteristic of the water resource in question.

Written comments on the proposed classification and/or WQOs of specific water resources will be accepted after 60 days following the publication of the notice outlining the classification.

The Reserve consists of two parts, that is, the basic human needs reserve and the ecological reserve. The basic human needs reserve includes water for drinking, for food preparation and for personal hygiene. The ecological reserve relates to the water required to protect the aquatic ecosystems of the water resource. Thus the Reserve refers to both the quality and quantity of the water resource. Once again, preliminary determinations of the Reserve may receive written comments after 60 days following the notice published in the gazette that describes the Reserve for a particular water resource.

The NWA deals in particular with the situation where pollution of a water resource occurs, or might occur, as a result of activities on land. The person who owns, controls, occupies or uses the land in question is responsible for taking measures to prevent pollution of water resources. If these measures are not taken, the CMA concerned may itself do whatever is necessary to prevent the pollution or to remedy its effects, and to recover all reasonable costs from persons responsible for the pollution ( National Water Act, 1998).

Catchment management charges, which is neither a tax or a levy, will be used to finance the CMAs, in order for them to become self-financing. The use of water, which, in some cases was free, will now be charged for in order to develop the required funds. The user / polluter pays principle will be used as the basis for catchment management charges.

Measures may include those required to cease, modify or control any act or process causing the pollution, measures that will force compliance with any required waste standard or management practice, measures to contain or prevent the movement of pollutants, eliminate any source of pollution, remedy the effects of pollution and remedy the effects of any disturbance to the bed and/or banks of the watercourse.

A CMA may direct any person who fails to take the required measures to commence taking specific measures before a given date, diligently continue with these measures and complete them before a certain date.

The agency may not only claim cost recovery from the transgressors, but also any person benefiting from the measures undertaken as described above. The costs claimed need to be reasonable, and may include, without being limited to, labour, administrative and overhead costs. When more than one person is liable for the costs the agency must, after hearing each transgressor, apportion the liability, but this apportionment does not relieve any of the transgressors of their joint and several liability for the full amount of the costs.

Maintaining an indigenous forest is a valid and realistic management option within plantations and mountain catchments (Scott and Lesch, 1996). Results have suggested that indigenous riparian forest is a good plant cover from a water-use point of view. They appear to use water sparingly, maintaining excellent water quality, and are suited for the protection of soil and water-yielding characteristics of the riparian areas.

However, other researchers have suggested that to promote water quantity and quality, management of riparian zones should maintain a healthy, stable cover of short indigenous vegetation such as grassland, scrub or fynbos. This should maintain a catchment's ability to continue to yield sustained flow (Prinsloo and Scott, 1999).

This would require the design of riparian zones such that the vegetation can be kept as a herbaceous cover by regular burning. A riparian buffer strip composed of a healthy, short grassland with a high basal cover provides a very effective trap for eroded soils and ash in a burnt plantation (Scott and Schulze, 1992). The

herbaceous vegetation will transpire and therefore have some influence on stream flow, however, this is likely to be small in winter and early spring when many of the species lose their leaves or become dormant (Dye & Poulter, 1995).

Eco-facts 4 (1999) deals with catchment areas and discusses some of the problems associated with catchment areas and rivers like vanishing wetlands, some perennial rivers drying up and rivers, weirs and dams being increasingly polluted. A separate Eco-facts pamphlet exists for indigenous and alien vegetation entitled: Indigenous, Exotic and Invader.

The following are guidelines given for what young people can do to help with catchment management problems:

- Report all cases where catchment areas are misused to the local nature conservation authority
- Involve yourself in a catchment conservation project in your area.
- Enter the South African 'Youth for Water' competition and win big prizes by contacting the Wildlife and Environment Society of South Africa (WESSA).

Some co-ordinated responses to catchment area problems are highlighted, for example, the DWAF establishment of the CMA for combined management of catchment areas by stakeholders.

Also mentioned is the 'Land Care Programme' (DOA) which believes that proper catchment management is the key to agricultural productivity and environmental welfare and encourages land users in the same catchment area to work together for each other's benefit and to preserve and manage their ground holistically.

Contact addresses for DWAF (to find out more about CMA's and the WWP) and the DOA (Land Care Programme) are given.

#### 4.4.2. Managing natural vegetation

Forest produce falls under the category of natural resources which is defined as "those structures and processes that can be used by humans for their own purposes but cannot be created by them (Enger *et. al.*, 1983). Even though they are renewable, natural resources are not inexhaustible.

In terms of the National Forests Act (NFA) a woodland is taken to mean a group of indigenous trees which are not a natural forest, but whose crowns cover more than 5 % of the area bounded by the trees forming the perimeter of the group. This is different from a natural forest that is defined as a group of indigenous trees whose canopies are largely contiguous. However, the NFA allows the Minister to declare a group of indigenous trees whose crowns are not contiguous to be a natural forest (DWAF, 1997).

The definitions of forest and woodland based on canopy cover overlooks the fact that canopy cover is a dynamic attribute that changes in relation to management and disturbance (Shackleton, 2000). To many researchers the term woodland is seen as synonymous with the term savannah and may be defined as follows:

The term savannah, or woodland, refers to a suite of tropical and subtropical vegetation types in which fire-adapted, co-dominant, continuous or discontinuous herbaceous and largely deciduous woody strata of indigenous plants, experience markedly seasonal growth patterns and processes in relation to the seasonal delivery of precipitation, which occurs during hot summers, followed by cooler, but warm dry winters. Generally the herbaceous stratum is dominated by C4 grasses and sedges, but this, and the overall cover of the woody and the herbaceous strata, may be temporarily altered by a range of disturbance phenomena.

Few South Africans realise that they live in a region which, in terms of plant life, is arguably the richest in the world (Fuggle & Rabie, 1991). The South African landscape is characterized by great diversity and, relative to other parts of the world, great antiquity. A consequence of the landscape antiquity is that most soils of the subcontinent are highly weathered and, especially in the wetter regions, relatively infertile. Owing to the steeply dissected landscapes of the wetter eastern margin of the region and duplex (sand and clay) structure of many of the soils, the potential for soil erosion is very high (Fuggle & Rabie, 1991). Thirty four percent of SA's vascular species are found in nature reserves (Pott, 1990).

In SA closely related tropical or subtropical forests exist along the southern and eastern coastal regions where the warm Mozambique ocean current allows enough rainfall to maintain these forests which cover approximately 0.5 % of the land surface in SA ( Hugo, Viljoen & Meeuwis, 1997). KZN has 91 000 ha of closed canopy indigenous forest (Seydack, 1997). Seven vegetation types and around 2 500 indigenous plant species occur naturally in Durban.

Plants are categorised as:

- herbs, including bulbs, groundcovers, grasses and other small herbaceous plants, usually less than 1 m tall
- shrubs, between 1 and 3 m tall
- small tree, woody between 3 m and 7 m tall
- tree, woody greater than 7 m

These categories were taken from an illustrated poster guide to plants in the Durban area containing glossy photographs (Botanical Society of SA, the Durban Unicity Environmental Management Branch, the Durban Parks Dept and WESSA, 2000). There is approximately 4000 species of indigenous flora and fauna in the outer West and KNR has approximately 3000 of them

The plants selected for this poster were based on the following criteria:

- They occur naturally in Durban ;
- They are especially attractive to birds, bats, insects and other animals ;
- In combination with other plants, they supply suitable habitats for urban wildlife ;
- They are attractive garden subjects ; and
- They are available in nurseries.

Indigenous forests were heavily exploited by the early settlers for wood and construction work, manufacturing wagons, furniture, fencing poles and for use in the mines (Hugo, Viljoen & Meeuwis, 1997). As a result much of the forest area was totally destroyed or badly damaged and now only occurs in a number of isolated patches.

While fuel wood collection probably plays the most significant role in the denudation of woodlands and its associated environmental degradation, other activities such as clearing land for agriculture and settlement, wood collection for fencing, and overgrazing also represent major causes of the decline in indigenous forests (van Rensburg *et. al.*, 1997).

Any resource management scheme should depart from the premise that “nature knows best” (Hugo, Viljoen & Meeuwis, 1997). The closer one can get to the natural situation, the better.

The ecological approach to resource management is that people should strive towards long-term sustained yield. The current view in resource management is that ecology recognizes the necessity for growth and development, but does not accept the view that environmental degradation is an inevitable consequence of growth and development (Hugo, Viljoen & Meeuwis, 1997).

The requirements of conservation, particularly in its stricter forms, place restrictions on the extent and types of utilization. However, for maximum benefit to be derived from our indigenous forests, both conservation and utilisation must be accommodated. Provision must be made for the full spectrum from strict conservation (system of representative strict nature reserves) to areas where maximum sustained utilisation is paramount (Seydack, 1996).

The NFAP (1997) has expressed the need to develop and apply a sound understanding of the value, condition and management requirements necessary for the “sustainable management” of natural forests and woodlands.

The development of the National Forestry Action Programme (NFAP) and promulgation of the National Forests Act (NFA) have established a new vision for the care, management and distribution of benefits from South African woodlands (Shackleton, 2000). This is the first time in SA that woodlands have received

legislative significance, along with a positive vision for the productive use and maintenance of the woodlands for the benefits of the country as a whole.

Indigenous forests have an inherently low resource productivity, particularly in relation to increasing population pressure. Under such conditions, an unfavourable supply/demand ratio applies and control of sustainability is difficult. Unless something is done to preserve our forests and mountain catchment areas, at the present rate of degeneration, ecosystems that have taken years to develop will be overrun by alien invader plants and totally annihilated within the next generation (Seydack, 1997).

Effective conservation and management of the forests are hampered by (Geldenhuys, 1997):

- a lack of well-trained staff.
- inadequate operational funds.
- a lack of well-coordinated, sustained multiple-use forest development and management systems.

One of the developmental problems identified in the general plant control framework of South Africa, in the absence of a central co-ordinated policy, is the depletion by unscrupulous traders of indigenous trees and plants for medicinal purposes (Fuggle and Rabie, 1991).

At the 1993 Earth Summit in Rio de Janeiro, a treaty came into force that recognised the need to conserve global biodiversity and emphasized that natural resources are the property of individual countries. Four documents were produced that are relevant to this project.

1. The Rio declaration on Environment and Development has 27 principles that define the rights and responsibilities of nations as they pursue human development and well-being.
2. Agenda 21: A blueprint on how to make development socially, economically and environmentally sustainable.
3. Convention on biological diversity: An aim to adopt ways and means to conserve the variety of life, and to ensure that the benefits derived from using biological diversity are equitably shared.
4. The Statement of Forest Principles is contained within the United Nations Conference on Environment and Development (UNCED) Agenda 21. This is a non-legally binding authoritative statement of principles for global consensus on the management, conservation and sustainable development of all types of forests and endeavours to reconcile the economic role of forests with their conservation, environmental and social roles (Lawes *et. al.*, 1999).

Local Agenda 21 was initiated in August 1994 and was designed to facilitate the implementation of Agenda 21 at the local level (DEAT, 1998). The White Paper on Environmental Policy in South Africa (DEAT, 1998), goal 2 provides for sustainable resource use and impact management. One of the supporting objectives is the conservation of biodiversity through:

- conserving the diversity of landscapes, ecosystems, habitats, biological communities, populations, species and genes throughout South Africa, by taking necessary measures including the establishment of 'protected areas' such as national parks ;
- using biological resources sustainably and minimising adverse impacts on biological diversity ;
- ensuring that benefits derived from the use and development of South Africa's genetic resources serve national needs ;
- expanding the human capacity to conserve biodiversity, to manage its use, and to address factors threatening it ;
- creating and implementing conditions and incentives that support the sustainable use of biodiversity ;  
and
- promoting the conservation and sustainable use of biodiversity at the international level

South Africa signed the Convention on Biological Diversity in November 1995. The convention supports community-based resource management on the grounds that national policy relating to natural resources should integrate protected areas into the broader social and economic landscape (Milton, 2000).

The various treaties and agreements aim to develop structures and strategies for researching the medicinal and other properties of plants as well as maximizing commercial potential while ensuring sustainability of the resources and equity in terms of indigenous knowledge. The original keepers of plant knowledge will benefit from commercial operations, in the form of *educational programmes, technical advancements and royalties* (Milton, 2000).

Protection of intellectual property in the area of plants and phytomedicinals is a widely discussed, controversial and rapidly changing issue that has had a profound impact on several national economies (George & van Staden, 2000). Agreements like the Trade-related Aspects of Intellectual Property Rights and the Convention on Biological Diversity have called for amendments to patent laws on plants and bio-prospecting of plant-based drugs from less-developed nations, to safeguard the interests of both developed and less-developed nations.

Finding acceptable solutions is vital for the progress of gene-rich, technology poor nations. South Africa should gear itself towards establishing well drafted patent laws for plant products and engineered flora (George & van Staden, 2000).

On 24<sup>th</sup> April, 2003 an agreement was reached where the CSIR (Council for Scientific and Industrial Research) has to pay the San people eight percent of all milestone payments from Phytopharm, a company

processing traditional medicinal plants. They also get six percent of all royalties received by the CSIR once the drug is commercially available (Club Card, May/June 2003).

In 1996, a number of research priorities were identified by the Conference of Parties of the Convention on Biological Diversity at its third meeting in Buenos Aires. Two critical issues were identified:

- the development of criteria and indicators (C & Is) for forest quality and biodiversity conservation as part of sustainable forest management (SFM), and
- the assessment of human influence on forest ecosystems.

UNCED Forest Principles also identified the need to develop cost-effective C & Is. Many international initiatives, leading from UNCED, focus on implementation of sustainable forestry, and have generally accepted the following definition of sustainable forestry (Geldenhuys, 1997), that is:

“the stewardship and use of forests and forest land in a way, and at a rate, that maintains biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national and global levels, and does not cause change to other ecosystems”

The definition has three main categories of focus:

- environmental: to sustain the natural physical and biological components and processes ;
- economic: to sustain the main forest products, and the industries and people that rely economically on the forest and its products ; and
- social: to sustain the provision in the needs of people for activities (jobs) and non-timber products.

The development of sustained, multiple-use management systems for the natural forests should focus on the following elements (Geldenhuys, 1997)

- policy for sustainable, integrated, multiple-resource use ;
- assessment of socio-economic needs at local and regional levels ;
- assessment of resource potential ;
- yield regulation and harvesting ;
- strategic marketing of products ;
- regeneration and rehabilitation ;
- monitoring of resource-use impacts ;
- training and education of people ; and

- ecological and socio-economic research programmes

The harvesting system in use should maintain the species composition and disturbance regime of the forest, and at the same time optimise the growth rate of the future crop. However, often information on recruitment, growth and mortality is lacking, and the resource inventory could be used to provide interim and approximate information until further studies could provide such information (Geldenhuys, 1997).

Sustainability of resource use is the central guiding principle for the management of our indigenous forests.

“This implies sustained yield management (SYM) and not sustainable management, a phrase currently in vogue. The latter is meaningless” (Seydack, 1997).

It is not management which we want to be sustainable, but the level of resource use.

*SYM* (defined below) is enacted through the appropriate yield regulation systems.

- Sustainable harvesting implies that similar amounts and types of products (dimensions, quality, species) continue to be harvestable at periodic intervals in perpetuity ; and
- Harvesting must therefore be organized in such a way that it remains within the renewability capacity of the forest system both in respect of growth as well as the success and type of regeneration.

Sustainability of land use, when maintaining a scarce resource for multiple purposes under conditions of mounting user pressure requires the effective use of relevant information. Information from surveys, inventories and monitoring programs need to be interpreted at various levels by managers, planners, specialist experts and researchers in order to effectively implement policy directives and management descriptions (Seydack, 1997).

One of the supporting objectives of the Information Management for Sustainable Development of the White Paper on Integrated Environmental Management (Department of Environment Affairs and Tourism, 1998) is to provide resources for effective environmental research, monitoring and data collection in order to:

- develop and implement information management systems ;
- report on the state of the environment ;
- measure progress in achieving sustainable development ;
- monitor environmental quality and environmental management ; and
- ensure that planning for sustainable development in all sectors is based on the best science and information available.

The White Paper on Environmental Management Policy has goal 6 as Information Management for Sustainable Development (DEAT, 1998), to develop and maintain information management systems to provide accessible information to interested and affected parties that will support effective environmental management.

One of the supporting objectives is to establish and maintain an effective and efficient national information management system, for the development, co-ordination and organisation of environmental statistics and indicators. This information management system must ensure informed decision-making, measure progress in policy implementation and enable public participation in environmental governance.

Indigenous forest management involves two areas of activity: the procurement, evaluation and interpretation of information, resulting in policy directives and management prescriptions and the implementation of these directives.

When an area of indigenous forest is to be placed under professional management, it has to be subjected to a process of management planning, involving the following phases (from Seydack, 1997).

- Spatial organisation: This involves the mapping and subdivision of the forest area into compartments which serve as units of description, recording and management ;
- Forest type mapping: Forest types are identified and mapped and these provide an indication of the nature of the resources available, their ecological sensitivity and use potential ;
- Management classification: Compartments are allocated management classes (e.g. produce harvesting, protection, nature reserves, recreation, research), which indicate the applicable primary land-use type ;
- Inventories: Resource availability is quantified through inventories ;
- Management systems and prescriptions: These are developed in order to facilitate the effective pursuit of stated objectives of management ; and
- Monitoring: Rates of change of renewable resources and managerial success are monitored, allowing adjustments or improvements to be instituted.

Criteria and indicators (C & Is) are part of a hierarchy of assessment tools that can be used both in the process of conceptualizing SFM and its implementation. They can also be used as a reference for the assessment of the quality of forest management (Lawes et. al., 1999). C & Is provide a means to measure, assess and demonstrate progress towards SFM and are thus a measure of how closely management matches reasonable performance (as opposed to procedural) standards. The exact and most appropriate set of indicators for a given criterion may vary between regions.

C & Is are intended to provide a common understanding of what is meant by SFM. They provide a common framework for describing, assessing and evaluating a country's progress towards sustainability at the national level.

The C & I framework is not legally binding. Although the National Forests Act, No. 84 does empower the minister to set C & Is and enforce SFM, it is not clear how the legal framework will be used – indeed it is debatable whether C & Is can be used as standards in the context referred to in the Act. Neither is it a compliance document nor an operations manual. Through the measurement and monitoring of these indicators the overall effects of forest management interventions, or indeed non-interventions, can be assessed and evaluated, and forest managers can take the necessary action to progress toward SFM (Lawes *et. al.*, 1999).

The Forest Stewardship Council (FSC) is an independent NGO representative of environmental institutions, the timber trade, the forestry profession, indigenous people groups, community forestry groups, and forest product certification groups. The FSC established principles and criteria for forest management, and guidelines against which the practices are certified as satisfying the requirements of the principles and criteria. The 10 principles of FSC, each with 5 to 10 criteria, are broad-based. Indicators are not included as these have to be developed at a regional or national level (Geldenhuys, 1997).

A criterion is a distinguishing characteristic by which something can be judged. It describes the broad forest values that society seeks to maintain and describes a condition that should be in place as a result of adherence to a principle of SFM. An indicator is defined as any variable or component of the system in question (forest ecosystem or management system) used to infer attributes of the sustainability of the resource and its utilisation. Indicators provide verifiable measures of change in criteria over time.

Criteria are formulated to permit a verdict on the degree of compliance in an actual situation. Each criterion relates to a key element of sustainability in forestry and is characterised by one or more related qualitative, quantitative or descriptive indicators.

An example of a criterion, based on the principle that the ecosystem and its inherent biodiversity shall be maintained, conserved and appropriately enhanced is given below: (Lawes *et. al.* 1999),

“The diversity on a Forest Management Unit (FMU) resembles the original condition and impacts on biodiversity are minimized”.

Examples of indicators relevant to the criterion given above are:

#### Ecosystem diversity

- Extent of area by forest type and tenure ;
- Fragmentation of indigenous ecotypes is avoided and landscape pattern is maintained ; and
- Changes in habitat diversity are within critical limits.

#### Species diversity

- Endangered plant and animal species are protected ;
- Alien invasives are controlled ;
- Community guild structures do not show significant change ; and
- Population sizes / structures do not show significant change.

#### Genetic diversity

- amount of genetic variation within and between populations of representative species.
- extent of native habitats that have genetic resource conservation plans prepared and implemented.

In order to monitor the use of forest produce, mapping of the area will be necessary. The principle that requires the ecosystem and inherent biodiversity to be maintained, conserved and appropriately enhanced needs checks and balances requiring a thorough knowledge of species composition and relative abundance for a particular FMU.

Statistics on the extent, species composition and productivity of the woodland communities are essential for the development of policy, long-term planning and decision-making on alternative land-uses (Geldenhuys, 1997). Forest or woodland inventories (including associated maps) are essential components of woodland statistics, but are often considered as too expensive to be useful. However, each kind of inventory should be planned to provide the required information at the appropriate scale in the most cost-effective manner to satisfy specific objectives. For example, the objectives and sampling design for a regional inventory would be totally different from that of a management plan inventory.

One of two general approaches or options to data collection in forest inventories are generally followed (Geldenhuys, 1997):

Approach 1 where the focus is on immediate, short-term economic gain with no sustainable utilisation possible with such information (for example, quantity of utilisable species).

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- Approach 2 where the resource status of economically and ecologically important species is assessed and the focus is on long-term, sustained-use management with economic stability and ecological balance.

In 1992 a group of botanists under the auspices of the South African Association of Botanists (SAAB) initiated the production of a revised vegetation map of South Africa, published in 1996, based on vegetation structure and species composition (McDonald, 1997). The map and booklet were aimed at filling the particular need of schools and tertiary education institutions for information on southern African vegetation. According to McDonald, however, this does not serve as a definitive map of the vegetation of SA. In response to this need, a collaborative initiative, entitled the National Vegetation Map of SA Project, or VEGMAP, funded by the DEAT, was developed.

The aims of the project are to:

- determine the variation in southern African vegetation based on the analysis and synthesis of data from vegetation studies
- compile a vegetation map

The map must accurately reflect the distribution and variation in southern African vegetation and indicate its relationship to the environment. Available data needs to be standardised since collection often takes place in a variety of formats by different researchers. Taxonomic compatibility of the records is a primary aim that needs to be achieved before analysis can proceed. Although the analysis is meant to hinge more on the floristic stands of vegetation (presence/absence data) than on the relative abundance of the species concerned, one of the data requirements would be to make relative cover and abundance ratings compatible across surveys. Another requirement is an accurate record of the locality of a sample in terms of latitude and longitude (McDonald, 1997).

The information will be entered into a geographic information system (GIS) database to facilitate mapping the vegetation. The VEGMAP handbook will include what plant communities are found, what the dominant species are and what the key species are for diagnostic purposes.

#### 4.4.2.1. Management using fire

Fire management is defined as the pursuit of the burning pattern optimally suited to the achievement of applicable objectives and with the lowest effective input required under the prevailing situational constraints (Seydack, 1992). The most important factors influencing fire management are management objectives, ecological considerations, fire hazard and invader plant control considerations.

Biennial burning takes place in KNR to limit woody plant encroachment, while also adapting the burn to maintain the protea communities (KNR Management Plan, 2003).

The grass sward in humid areas (rainfall exceeding about 1000 mm yr<sup>-1</sup>) retains its cover and vigour with annual burning. Because woody components usually begin growth in early spring before grasses are active,

“late” dry season burns maintain grass at the expense of shrubs and trees. Grass is highly sensitive to burns in the growing season and burns at this time will favor woody plants (Hugo, Viljoen & Meeuws, 1997).

In grassland and wooded savannah, pyric succession is essentially a process of vegetative recovery, requiring 12 months in humid tropical conditions, seldom involving great changes in plant populations. Fire prevents the climax stage from being reached. This direct interference results in a disclimax, which would never develop under normal conditions (Hugo, Viljoen and Meeuwis, 1997).

Owing to their long evolution with fire, most savannah (woody) plants are adapted to it, and the proportion of species which are easily killed is very low. There is, however, a continuum from those that are highly susceptible to those which are extremely resistant. Most species are easily killed as seedlings and their resistance increases with age. Regeneration occurs from adventitious buds on stem bases (Booyesen & Tainton, 1984).

The frequency and seasonality of the burn depends on the management objectives, as does the intensity, duration and chosen area for the fire. Intensity is an important variable, favoring grass if it is high, but not if extreme as with high fuel loads when fire is deferred. Frequency generally favors grass if high due to the relatively slower growth-rate of woody species. Burning areas to reduce fire hazards can have detrimental effects on the indigenous biota if the burning is done at inappropriate times of the year. Burning at inappropriate times can lead to declines in vegetation density and seedling recruitment and to changes in vegetative structure and species composition. Severe damage to the vegetation, with reduced growth rate during recovery, may occur if the vegetation is burnt during periods of active growth (Booyesen & Tainton, 1984).

Fire is best applied within an area’s natural fire frequency. Burning too often can damage the soil and interfere with the growth patterns of certain vegetation. Organic matter, which is one of the most important immobilizing substrates in the soil, is lost during burning processes. Fire reduces vegetation height, biomass and cover. Seed-generating plant species may become locally extinct if the interval between successive fires is less than that between seed crops (Armstrong & van Hensbergen, 1996).

Some resprouters are also affected or destroyed by repeated burning at short time intervals. If the interval between fires is too short, the mature vegetation structure will not be reached. A local extinction of fauna species dependant on the mature stage of the vegetation may then occur. New growth after burning attracts browsers and open grassland supports game sighting. Burning reduces the height of browse plants and may be used to alter species composition (Armstrong & van Hensbergen, 1996).

Postponing the burn to way after the natural burn cycle can lead to the smothering of indigenous vegetation, with the result that those plants dependant on fire-induced regeneration from seed or underground storage

organs may become locally extinct if the longevity in the soil is shorter than the interval between burns. Where grassland is seral to scrub or forest, species richness of plants is highest in the climax vegetation, which develops where the fire interval is some decades (Armstrong and Hensbergen, 1996).

If burning is not done in sections on a rotational basis, then local extinction and accelerated soil erosion might occur. This requires burning in a season when vegetative recovery is rapid provided there is adequate fuel load and low humidity.

When managing for general catchment conservation, nature conservation and recreation, fire management entails the maintenance of fire patterns allowing the natural vegetation to persist in full diversity. To meet this objective, the overwhelming majority of fires must burn within the ecological thresholds of plant/fire adaptation with regard to frequency, season and intensity. Fire size may also have ecological consequences. This requires that most fires burn at intervals between 10 and 30 years during summer/autumn and under more extreme fire weather conditions (Seydack, 1992).

From an ecological perspective, fire intervals should optimally be between 15 and 25 years. The minimum rotation should be sufficiently long to allow adequate regeneration of the slow maturing species, that is, should not be shorter than 12 years. For safe prescribed burning low fuel loads (young veld) and cool, moist fire weather conditions are preferred. Low intensities are, however, detrimental to the regeneration of certain plant taxa (Armstrong & van Hensberg, 1996).

Two fire management options available are natural fire zone management and adaptive interference fire management. Fire management in natural fire zones entails allowing fires with a natural source of ignition (lightening and rock falls) to burn themselves out without interference, but at the same time excluding man-made fires as far as is practically possible. The central assumption is that the ideal fire regime for the maintenance of natural diversity is one exhibiting a natural or normal range of variability in respect of fire frequency, size, season and intensity (Booyesen & Tainton, 1984)..

Adaptive interference involves the use of both natural and artificial ignition and involves the control of the resultant fires in both space and time as far as practically possible according to a set of rules stipulated in advance (Seydack, 1992).

The availability of funds, determining the size of the labor force, is the crucial managerial resource-setting limit to the intensity and success of catchment area management. The minimum fire management intensity for each area must be determined so that the fire management system with the lowest input requirements still allowing goal achievement may be appropriately applied for maximum effect with the limited resources (Seydack, 1992).

When accommodating specific objectives or goals, some deviation from the optimum range of conditions is sometimes required, but preferably over limited and specifically defined areas only. The ideal is to optimise managerial action in a goal-directed way, but allowing for pragmatic adaptation to circumstances. A systematic approach towards fire management involving the application of well-founded and differentiated fire management systems, and the continued evaluation of their performance is required (Seydack, 1992). Accurate and complete fire recording is therefore essential.

In the fire management system selection process *three sets of factors* have to be assessed for each area (Seydack, 1992):

- management objectives
- situational constraints
- resource limitations

Areas are classified into conservation priority classes according to veld condition and dominant land-use form. Areas with a low priority in this regard owing to impoverished diversity, heavy invader infestation or land-forms incompatible with nature conservation, could then be more safely burnt under ecologically otherwise less acceptable conditions. They would then act as a buffer for the ecologically acceptable fire in adjacent areas of high conservation priority (Seydack, 1992).

The suggested priorities of the allocation of resources given by Seydack (1992) are:

- (i) Fire management of sufficient extent to maintain biotic diversity in prime state-owned conservation areas.
- (ii) Invader control over larger areas only sparsely infested with alien invaders, that is, the prevention of invader spread and intensification by wildfires. This will reduce the labour required to remove light infestation required for pre-burn operations.
- (iii) Clearing of densely infested areas

**Protection** from fire apparently involves processes both of growth of already established species, as well as **immigration**, establishment and growth of new forest species. Thus in all grassland and savannah experiments, fire exclusion has resulted in increased species richness, usually as a result of the immigration of woody species (Seydack, 1992).

#### 4.4.2.2. Legislation

While the primary purpose of the 1982 Environment Conservation Act was merely to make provision for the co-ordination of all actions directed at or liable to have an influence on the environment, the preamble to the 1989 Act evidences a much wider intent by now providing for the effective protection and controlled

utilization of the environment. Effective protection indicates a non-utilitarian, ecocentric perspective, while controlled utilization indicates a utilitarian, anthropocentric emphasis (Fuggle & Rabie, 1991).

All plants indigenous to the Republic of South Africa and Namibia are in principle included in the schedule specifying protected indigenous plants. Only a few plants are listed as unprotected indigenous plants, while specially protected indigenous plants are listed separately. The KZN provisions for the conservation of plants thus apply in principle to all indigenous plants (Fuggle & Rabie, 1991). The Natal ordinance also regulates the purchase, sale, donation and exchange of indigenous plants. A permit is required to lawfully “pick” and sell protected indigenous plants. Pick or gather is defined in wide terms as including cut, chop off, take, pluck, uproot, break, damage or destroy. The forestry branch of the DEAT and various provincial and homelands conservation departments currently control 80 percent of our forests and mountain catchment areas.

No forest produce may be cut, disturbed, damaged, taken, collected, destroyed or removed. However the Director-General may perform acts or take measures not inconsistent with the following objectives: (Fuggle & Rabie, 1991).

- \* the restoration of ecologically disturbed habitats ;
- \* the prevention and combating of soil erosion and of veld, forest and mountain fires ;
- \* the maintenance of the natural genetic and species diversity ;
- \* the exercise of control over undesirable plants and animals.; and
- \* the *removal and marketing of forest produce*, research, education, and, in the case of nature reserves, also the making available to the public of open-air recreation facilities

When a permit is requested to sell wild flowers, the following information is required (KNR NCO, pers. comm., 2003).

- The scientific names of the flowers to be sold/gathered must be supplied.
- The full name and residential address of the applicant and the place where the plants are to be sold must be given.

No fee will be required for such a permit. Rare or endangered plants are especially protected and a separate permit is required for these.

Besides the given requirements for protected plants, a permit for the sale of rare and endangered plants will only be granted if the place where the plants are cultivated, developed or maintained, is given. A fee of R7 is charged and any person who carries on the trade of selling shall keep an invoice book in which the following

particulars shall be recorded on the invoice by them in respect of each sale of rare wild flowers or endangered wild flowers:

- the name and address of the seller ;
- the species and quantity of such wild flowers sold ;
- the name and address of the person to whom such wild flowers are sold ; and
- the date of the transaction.

The invoice shall be completed in duplicate immediately after the relevant transaction, and the original handed to the buyer. Records should be kept for a period of 12 months.

A separate permit is required to *gather* rare or endangered wild flowers. The species and numbers of rare and endangered wild flowers, the place where they are to be gathered and the date or period that the gathering is to take place must be submitted. No fee will be charged.

An officer of the Board may inspect any rare or endangered wild flowers in the possession of any person and demand the production of any relevant permit, licence or invoice issued to that person in terms of the Ordinance, or any relevant invoice book in the possession of such person.

Traditional health practitioners are regulated by the National Environmental Management: Biodiversity Act of 2004 (KNR NCO, pers. Comm., 2004).

Prior to 1994, DWAF was responsible for the management of Primary Conservation Areas on State forest land. These areas included nature reserves proclaimed under the Forest Act (of 1984) and areas with no specific statutory conservation status other than being proclaimed State forest. Most of the forests, and almost all the woodlands, however, fall outside the administration of the DWAF. These areas are either the responsibility of the Natal Parks Board (KZN Conservation Services) or, provincial administration and conservation agencies. Local authorities are responsible for forests on communal land. Other forest/ woodland areas are on privately owned commercial farms Fuggle & Rabie, 1991)..

The Forestry Act of 1986 provides mainly for: (DWAF, 1997)

- the management of State forests ;
- the protection of land, vegetation and forest produce ;
- the protection against, and the combating of, fires ;
- the control and use of land for afforestation ;
- the regulation of forest produce ;
- the protection of natural water resources where afforestation is involved. ; and

- the control and management of a National Hiking Way System and the National Botanical Institute.

The white paper on Sustainable Forest Development in South Africa identifies the necessity to replace the Forest Act of 1984 (DWAF, 1997). The purpose of the new Act would be to provide for the effective protection, management and utilisation of all types of forest resources in South Africa, in order to promote the sustainable development of the forest sector, including the ecosystems and the biological resources they contain, for the benefit of the present and future generations.

This would accord with international principles and reflect the principle of stewardship under which every forest owner must ensure that the entire forest resource is sustainably managed (NFAP, 1997).

The following guidelines are given for the new Act: It must ....

- be cast in the mould of the new constitution ;
- recognise international norms and standards ;
- provide for a dynamic approach to forestry and natural resource management ;
- provide for local interests ;
- provide for a people-driven approach to development ; and
- embody other necessary aspects of new national policy.

This new Act must also be co-ordinated with other legislation and policy documents such as those on land, agriculture and the environment, including the Conservation of Agricultural Resources Act, the Environment Conservation Act and the Water Act (DWAF, 1997).

#### 4.4.2.3. Conservation cells and corridors

5.8% of South Africa has been set aside for formal conservation (Pott, 1990). However, natural areas are extended considerably by the efforts of conservancies.

Natural open spaces are the last remaining spaces located within undisturbed natural and undeveloped areas. KNR is thus a “natural” open space within an urban environment and plays an important part in promoting the DMOSS (Durban Metropolitan Open Space System) concept in that it is one of the largest open spaces in the DMA. This corridor for wildlife is extended by the Emolweni and Nkutu River catchment areas outside the borders of KNR. It may play a further role in extending the DMOSS concept to outside its borders by encouraging indigenous gardening amongst residents.

Since 1978, when the idea of urban conservancies was first formalised, KZN has now registered 210 conservancies (involving 3000 land owners) and more than 1 million hectares of agricultural land (10% of KZN’s area) has been placed under some form of conservation (Hugo, Viljoen & Meeuws, 1997).

Urban conservation is different from rural conservation in that it primarily follows the principle of island biogeography and is primarily concerned with the continual survival of islands of vegetation surrounded by a sea of concrete structures. These islands are isolated from the main body of their plant or animal communities. To optimize diversity it is important to have large conservation areas as close to each other as possible and that are well linked by wide corridors (Parks Department, 1989).

Not all habitats are represented by nature reserves and thus the preservation and protection of small portions of habitats by land owners and local authorities is necessary (Hugo, Viljoen & Meeuws, 1997) and can contribute to conservation in a significant way.

Areas of urban “open space” identified by Durban authorities ( Environmental Branch Development and Planning Service Unit, 1999 in O’Leary, R., 2001) are :

“any vegetated area or green area within an urban environment, such as nature reserves, private and public gardens, park areas, golf courses and other sports and recreational grounds, cultivated, derelict and underdeveloped land and even roadsides, rail verges and transmission line servitudes as well as any open hard surface (brown areas) such as shopping malls, plazas and other paved and concrete areas.”

Avenues, road reserves, swamps, marshes, bush thickets, rivers, cliffs, hills and ridges, coastal dunes, ravines, gorges, generally regarded as worthless, from a developmental point of view, are habitats for a variety of plants and animals. Supplementing these various habitats are different types of artificial habitats like domestic gardens and municipal parks (Hugo, Viljoen & Meeuws, 1997).

Since people generally think that conservation is something carried out by a government department in a nature reserve, to change this mode of thinking the Department of Environmental Affairs encourages land owners with a piece of the natural environment to have it registered as a “natural heritage terrain” (Hugo, Viljoen & Meeuws, 1997). It is hoped that eventually this will result in natural links or corridors between nature reserves.

DMOSS is a system that integrates the built environment with the natural environment in urban planning. Open areas in the Durban Metropolitan have been valued at several billion rand due to their indirect roles of flood and fire attenuation and psychological well-being (Kloof Conservancy member, pers. comm., 2003). This is besides any direct use value it might have.

The urban conservancy project in Durban was designed to integrate diverse and complicated urban systems such as high-density residential and industrial developments, Central Business District areas, parks and recreation areas, the beachfront, freeways and interchange systems as a network of conservation cells. Thirty

two urban conservancies are now established in Durban (Hugo, Viljoen & Meeuws, 1997). This creates a corridor for wildlife for migration and nesting purposes, and for city dwellers the opportunity to escape from the pressures of urban existence.

The Outer West of Durban is a rapidly developing area and increasing numbers of people are migrating to this area, putting more pressure on the resources. This is aggravated by the subdivision of land and the trend of cluster-housing developments. Golf estates are becoming popular, with low density housing, but little conservation. Eco-estates are now being developed as an alternative to golf estates in the conversion of sugar cane farms to housing.

Instead of fairways between the houses as in a golf estate, corridors ranging from 60 to 100 m wide would be found between the houses to allow for the passage of game. Everything is discussed and approved by KZN Wildlife and ecology experts are used to determine the correct species and density of animals for the estate (Whitfield, Dec. 28<sup>th</sup>, 2003).

#### 4.4.3. Disturbance, regeneration and ecological succession

An ecosystem is defined as any unit including all the organisms in a given area interacting with the physical environment so that the flow of energy leads to clearly defined trophic structure, biotic diversity and material cycles within the system. Ecology deals with the relationship of organisms and their environment and a specific biotope will be filled with a specific community of organisms, which may modify the biotope and provide suitable conditions for other communities.

Ecology attempts to understand the structure, function and behaviour of ecological systems, whereas environmental science is defined as an inter-disciplinary science leading to management of ecosystems to man's best interest. The relationship between ecosystem functioning and management actions requires close co-operation between these two groups of researchers (Zwolinski, 1990).

Subtropical rainforests generally regenerate continuously and in mixed-species patches. A forest has been defined as a large-scale mosaic in which species *are succeeded* by a different combination of species and also defined as a spatial mosaic of structural phases which change over time as a result of *dynamic processes* driven by canopy gaps (Lubbe & Geldenhuys, 1991).

The frequency distribution over height classes of woody regeneration indicates an abundance in the regeneration class up to 0.75 m, with progressively fewer plants in bigger size classes (Lubbe & Geldenhuys, 1991).

Clear differences in floristic composition between the adult and juvenile trees in a stand have been observed. Dominant seedlings are found to be associated with the dominant parent trees in the study area. The rate and

pattern by which a particular species regenerates determines its contribution to the future forest canopy (Lubbe & Geldenhuys, 1991).

*Succession* may be defined as the more or less orderly process of change in ecosystems over time, cumulative and directional for the duration of a limited interval, and involving a progressive change in the structure and composition of the vegetation and fauna. Primary succession is the establishment of pioneer species on or in a newly formed habitat whereas secondary succession is the establishment of pioneer species in habitats that were previously populated. Secondary succession thus involves changes following disturbance of a previously vegetated site (Hugo, Viljoen & Meeuwis, 1997).

Succession accompanies a number of fundamental processes, which may be successive or interacting. In the initiation phase the processes include nudation (the processes that cause the site to be exposed), migration (the arrival of propagules at the site), ecesis (germination), establishment and growth and reaction (the effect of the established community on the site). Reaction modifies the site in favour of new immigrants. If the original vegetation is forest, shrubs will soon follow the initial herbaceous plant growth and after several years, trees will re-establish themselves to form the original forest. Secondary succession takes place at a faster rate than primary succession and is often characterised by a larger number of pioneer species and may also consist of plants from different seral stages (Lubbe & Geldenhuys, 1991).

Conservationists have traditionally been inclined to ignore disturbance as an important factor for functioning of natural biota. Ecologists now recognize disturbance as an integral part of the ecosystem rather than an external destructive force. Human disturbances may or may not be more intensive or frequent than natural disturbances. Genetic diversity usually increases when populations are exposed to disturbances. Sensitivity of an ecosystem to disturbance may differ, depending on the character and intensity of the disturbance, the successional stage, and the defence system (for example, sensitivity to fire, genetic resistance to pests). The intensity and frequency of disturbance determines the regeneration that will occur (Zwolinski, 1990).

Species *diversity* has been shown to be *highest in a more recently disturbed site, than in sites close to climax*. An increase in species diversity was shown in boreal forests for the first 8 years after disturbance, after which a steep decline occurred. In general, during succession, species diversity first increases then decreases as the climax is approached (Lubbe & Geldenhuys, 1991).

The decline in species diversity with increasing maturity of the stand may be related to the recurrent initiation of succession and creation of establishment sites which then decrease with undisturbed further development. Over time, disturbance history becomes less important as the biota gain more control over climatic and edaphic factors during succession (Lubbe & Geldenhuys, 1991).

Ecosystem stability has sometimes been related to species diversity in the biocenosis. However, functioning of an ecosystem is maintained by sufficient components acting within specific environments. Self-maintenance can only occur when all ecological niches (functional groups) are present. It is functional complexity, rather than simple community measures such as number of species that increases ecosystem resistance to low-level disturbance. Thus neither a species-rich nor species-poor ecosystem can become stable if any of the functional groups is missing. However, functional replacement of an eliminated species can be more easily achieved in species-rich communities (Zwolinski, 1990).

There is usually an increase in biomass accumulation and complexity when an ecosystem changes to the climax. Modern ecologists accept the concept of steady state equilibrium being characterised by exceptional stability measured on the same time scale as any of the successional phases. The concept of climax would be useful as a definition of the level of complexity required to achieve stability. This type of stability is essential to limit invasion by exotics. Without disturbances, closed nutrient cycles prevent major changes in nutrient budgets and the complex forest systems have a relatively low demand for nutrients (Zwolinski, 1990)

A distinction may be made between early- and late-successional species. The former are those that seem to be highly vagile, quick-growing, short-lived and intolerant of competition for resources (light, nutrients etc.), while the latter are less vagile, slower growing, long-lived and tend to tolerate competition for resources. They are respectively equivalent to r- and K-species in terms of evolutionary ecology (Booyson and Tainton, 1984)..

Only certain pioneer species are able to establish and these early occupants modify the environment so that it is unsuitable for further recruitment of early-successional species. These pioneers react on the site to favour invasion by later-successional species. When the habitat is altered by the plant community itself, the process is referred to as autogenic succession. The sequence terminates when the site is occupied by species that do not facilitate invasions. In two models of succession, early-successional species are killed in competition with later-successional species, but in the third model they are not and die through local disturbance or natural mortality factors (Hugo, Viljoen and Meeuwis, 1997).

Within forests at least two species types are encountered among pioneers: local persistence through long-lived seed in *V. oroboides* and probably extreme vagility in *T. orientalis*, both being intolerant species dependant in their life cycles on periodic catastrophe (Booyson & Tainton, 1984). An area which has been exposed to a large-scale disturbance is usually characterised by the release of resources – nutrients and water. A system will gradually deteriorate if nutrients are lost by leaching or harvesting. These resources are utilised more effectively by plant species which have a rapid growth rate and high rates of nutrient absorption, in order to minimise loss of nutrients from the ecosystem (Booyson & Tainton, 1984).

*T. orientalis* and *G. physocarpa* are two of these “pioneer” species that were marketed. They were often encountered in growing bags where the ground is severely disturbed. Part of their popularity to the indigenous gardener is attributed to their quick increase in size.

The ecological function of pioneer “weeds” as a successional force preventing nutrient loss is important. The implications are that these species of the early successional stage respond well to fertilisation, but are vulnerable to abiotic and biotic stressful agents. Successively these pioneers are suppressed by other species which have low growth rates, but higher resistance to harmful factors (Booyson & Tainton, 1984)..

The usual successional sequence (Afromontane forest) is defined as follows: (Booyson & Tainton, 1984)

- 1. A stage of dense weed growth, among which are coppice shoots of overstorey trees and seedlings of shrubs of the second stage ;
- 2. The second stage of “weak, woody shrubs” where short-lived species may form single species or mixed stands, 3m or higher within 18 months, in which seedlings of *H. lucida* and *B. bubalina* may be present at this time ;
- 3. If the site bore *Virgilia oroboides* (keurboom) then seedlings establish post-fire and grow through the 1<sup>st</sup> and 2<sup>nd</sup> stages to dominate and form a stand 7 m to 10 m tall, with seed as well as coppice regrowth of various overstorey forest species below the canopy ; and
- 4. Replacement of the weak shrubs and/or *V. oroboides* by canopy species.

The whole series of communities, from grass to shrub to forest, that terminates in a final stable community is called a sere and each stage is called a seral stage (Hugo, Viljoen and Meeuwis, 1997).

In tropical coastal forest (Zululand), vegetation analysed on a burnt (intense fire) site three years after the fire was dominated by trees rather than herbs or soft shrubs, but tree basal area was reduced to about one fifth of that of unburnt forest. Tree species composition had changed by 57 % and the regenerating forest was overwhelmingly dominated by the seeding tree, *Trema orientalis*, pigeonwood, (**Figure 9f**), a pioneer r-strategist absent from the unburnt stand (Booyson & Tainton, 1984).

Slow-growing species tolerate shading and/or other effects of the closing stand to survive and grow. *B. bubalina*, Wild Pomegranate, Fig. 2-13, although slow growing, is known to be an active coloniser of disturbed areas and appears to be an opportunistic species which prefers a disturbed site (Lubbe & Geldenhuys, 1991). Because it is slow growing and is established early, it is tolerant of shade. *B. bubalina* and *H. lucida*, Tree Fuschia, Fig. 2-12, are regarded as “weedy” species that establish themselves during early successional stages. They become subcanopy trees in the understory of forests. Canopy species present in regenerating vegetation recovered mainly by sprouting.

#### 4.4.4. Horticultural techniques

Horticultural techniques will have to be applied in order to maintain a sustained yield of different plant produce. Different propagation methods of 53 indigenous trees, that is, seed, cuttings and truncheons were compared in the Northern Province (van Rensburg *et. al.*, 1997). Cuttings were 5 to 25 mm in diameter and 25 to 30 cm in length. Truncheons were 30 to 120 mm in diameter and 90 to 100 cm in length.

Truncheons and cuttings were prepared simultaneously from large branches. Rooting hormone was applied to some cuttings. Seeds were subjected to simple treatments to modify hard seed coats, to remove inhibitors and to reduce the time for germination. The truncheons were planted in particular places, horizontally and vertically, to act as experimental “woodlots” and the cuttings and seed were planted in nursery bags and watered. Planting occurred directly after the truncheons had been cut and after the holes and furrows had been filled with water.

The best results were obtained by planting truncheons horizontally and completely covering with a layer of soil during the early part of winter. The majority of sprouting truncheons planted horizontally produced 1 to 6 sprouts along the length of the host.

No definite advantage from using root hormone with cuttings was observed and the response to the hormone appeared to be species specific. The low success rate can largely be ascribed to uncertainties regarding the correct concentration, mode of application and mixture of root-promoting substances (van Rensburg *et. al.*, 1997).

Propagation by means of seed was easiest for most trees, although access to seed is a limiting factor, regarding availability and viability. Of the various pre-treatments, soaking hard-coated seeds in cold water overnight was the most advantageous (van Rensburg *et. al.*, 1997)..

#### 4.5. Conclusion

The foregoing management structures/activities and ecological processes/products may be useful as a template to mould an environmental management strategy for the Emolweni subcatchment in the e'Thekweni Outer West region. Current policies and procedures of role players will require evaluation and need to be assessed for best practice management. Appropriate policies and procedures should then be integrated into broader forums and structures so as to increase the effectiveness and efficiency of delivery.

The KNR Management Plan contains the essential ecological, social and economic elements in their approach to solving the management problems discussed and essentially provides the backbone for what needs to be done. The focus in this dissertation is on *how to* implement these plans based on the situation on the ground and the various policies underpinning the proposed environmental procedures.

Ecological / horticultural processes and products can be used as tools for the enhancement of bio-diversity and to develop the concept of wildlife corridors and conservation cells. Underpinning the environmental activities will be the social function of educating the public and providing employment / self-employment to satisfy the economic need. The TEV of natural areas may be used as an environmental lobbying tool, to buffer the effect of encroaching development.

## Chapter Five

### 5.1. Introduction

Despite the drastic cut in the budget and the late implementation of user charging the NCO reported that the funding had come in time to prevent any ecological / recreational deterioration of KNR. The funding required to maintain the ecological integrity of KNR was sufficient and the focus of the dissertation shifted away from *the means to act* and towards *how to act*

Even though invasion of exotics into KNR is under control, the approach to invasion is still based on treating the symptoms. A preventative approach, which is far more cost effective, is needed through the education of the public whose properties are the source of the invasion. The capacity to undertake inspections needs to be built, which will require a further injection of funds for training and wages. Thus further funding should be sought / applied for from the funding organizations mentioned in the previous chapter. Details on the way in which these funds may be acquired was considered to be beyond the scope of this dissertation. However, the importance of developing catchment plans and submission to the CMA to access catchment funding is emphasized. The other funding organizations mentioned are generally well known to environmental managers who could access the relevant detail from the funders.

### 5.2. Budget analysis

The 1997 KNR budget allocation of R108 000 was slashed to R32 667 in 1998. There was a slight improvement in 1999/2000 with a budget of R57 408 being granted. Table 5-1 indicates how the budget has changed over the years 1997 to 1998 to 1999/2000. Specifically, the budget changes per relevant item, is given in Table 5-2.

Table 5-1 - KNR budget (Rands) – 1997, 1998 and 1999/2000

	1997	1998	1999/2000
General	2500	-	-
Vehicle Running Costs	24700	7185	7400
Vehicle Reg. & licences		446	300
Erosion Control	5000	-	-
Exotic Control	8500	-	-
Fencing	9000	554	-
Fire Control	4200	598	600
Telephone	4000	2000	4100
Stationery	500	287	-
Photocopying	300	300	-
Uniforms	8400	-	10320
Gas	2000	2112	1992
Electricity	10000	11400	12996
Water	6000	6000	6000
Cleaning materials	570	18	400
Chemicals	400	-	400
Toilet Paper / san. prod.	1600	1060	1500
Sundry	1500	12	400
Workshop Consumables	250	33	500
Exhibition expenses	400	-	-
Maintenance tools/equip	1000	374	900
Cons./ small tool / equip	-	110	800
Buildings	16000	144	4600
Roads	2000	-	-
Postage	-	27	-
Photographic expenses	-	7	-
Maint. Exp. (plant/mach)	-	-	200
Rates & Levies	-	-	7000
<b>TOTAL</b>	<b>108 020</b>	<b>32 667</b>	<b>57 408</b>

Table 5-2 - Relevant itemised budget changes - 1997 to 1998 to 1999/2000

ITEM	1997	1998	SHORT	1999/2000	SHORT
General	2500	-	2500	-	2500
Veh. Runn.	24700	7185	17515	7400	17300
Erosion	5000	-	5000	-	5000
Exotic contr	8500	-	8500	-	8500
Fencing	9000	554	8446	-	9000
Fire control	4200	598	3602	600	3600
Uniforms	8400	-	8400	10320	+1920
Buildings	16000	144	15856	4600	11400
Roads	2000	-	2000	-	2000

The shortfall of R75 333 experienced in 1998 when compared to the 1997 budget and the shortfall of R50 592 still experienced in 1999/2000 could lead to the possibility of the deterioration of KNR.

The budget for the maintenance of facilities was drastically reduced, e.g. building maintenance from R16 000 to R144 to R4600 and roads from R2000 to R0, and fencing from R9000 to R554 to R0.

Although there has been an improvement in the size of the overall budget for 1999/2000 i.e. from R32 667 (1998) to R57 408, the increase in allocations have been in areas that will not lead to the prevention of ecological deterioration of KNR (Table 3).

Even though increases in the overall budget for facilities maintenance is evident, low budget for buildings and zero allocations for roads and fences will hamper any further infra-structural maintenance and development. Item increases below that support the maintenance of facilities are marked with an asterisk (\*).

From Table 2, the budget increases from 1998 to 1999/2000 are for: telephone (R2100), uniforms (R10 320), electricity (R1596), \*cleaning materials (R382), \*chemicals (R1000), \*toilet paper (R440), \*workshop consumables (R467), \*maintenance of tools and equipment (R526), \*tools and equipment consumables (R690), rates and levies (R7000), sundry (R388), fire control (R2), \*vehicle running costs (R215), \*buildings (R856) and \*maintenance expenses, plant and machinery (R200).

Total increase for these areas of allocation = R2100 + R10 320 + R1 596 + R382 + R1000 + R440 + R467 + R526 + R690 + R7000 + R388 + R2 + R215 + R856 + R200 = R26 182.

The overall increase in budget from 1998 to 1999/2000 is given as:

R57 408 (1999/2000) - R32 667 (1998) = R24 741.

The difference between the total increase per named categories and the overall budget increase is: R26 182 - R24 741 = R1441. This is due to higher budget allocations in 1998 than 1999/2000 for vehicle registration and licence (R146) + fencing (R554) + stationary (R287) + photocopying (R300) + gas (R120) + postage (R27) + photographic expenses (R7) = R1 441.

What is further evident from Table 2 is the huge cuts from the 1997 budget, i.e., no allocation for “general” items (R2500 shortfall), a R17 300 shortfall for vehicle running costs, no allocations in 1998 or 1999/2000 for (and thus shortfalls of) R5000 (erosion control) and R8 500 (exotic control), no fencing allocation (R9000 shortfall), R3600 shortfall for fire control, no stationary allocation (R500 shortfall), R1100 sundry shortfall, no allocation for photocopying (R300 shortfall), cleaning materials (R170 shortfall), R100 shortfall for toilet paper, no exhibition expenses (R400 shortfall), buildings (R15 000 shortfall), no allocation for roads (R2000 shortfall), maintenance of tools and equipment (R100 shortfall).

The huge cuts in vehicle running costs, soil erosion, fire and exotic control, fencing, roads and buildings are evident in the more than 2/3 budget slash from 1997 to 1998. The funding shortfall for these important tools required to manage and maintain the recreational, professional and ecological integrity of the nature reserve is R60 400 which is a relatively large sum to be made up.

Table 5-3 below gives the minimum budget shortfalls to be made up in order to maintain the ecological and recreational integrity of KNR.

Table 5-3 - Funding amount required to prevent the ecological and facilities deterioration of KNR.

	Amount required (Rands)
Buildings	15 000
Roads	2 000
Exotic Control	8 500
Fire Control	3 600
Erosion Control	5 000
TOTAL	34 100

The budget cuts in soil erosion, fire and exotic control could reduce the value attributed to the nature reserve by picnickers, hikers and indirect valuers. The deterioration or discontinuation of these ongoing projects will also impact negatively on the ecology of the subcatchment. The budget shortfall/transfer has the potential to devalue the nature reserve if the funds are not found and, in the long term, will have disastrous effects. With the loss of the “general” allocation and the huge cut in “sundry” items there appears to be little room for any budget transfers.

### 5.2.1. Facilities maintenance

Picnicking and hiking are the two main recreational activities that take place at KNR. The use value for picnickers will diminish if the facilities are not maintained. Approximately thirty barbecue areas are available to the public, there are various marked trails and a large grassed open area for picnicking. Grass cutting, removal of rubbish and structural repairs of buildings (toilets) at sites and on roads all go into maintaining the entertainment areas.

Secondly there is the task of maintaining the marked hiking trails. Materials for path maintenance and development have been received from a hiking club, but falls short of the requirements, not only in number of poles, but the labour cost of laying the poles.

The interpretative centre and staff housing also need maintaining. Any broken fences that would allow unauthorised access to the reserve would need repair.

Reduced budgets for roads, buildings and recreational facilities will impact negatively on the way picnickers value KNR, should the roads/buildings/facilities deteriorate. People who visit KNR will have to contribute to the budget shortfall (R15 000) if they expect buildings (toilets) and picnic areas to be maintained and further developments to take place. A mere R1000 per annum is not enough, when compared to the costs to maintain these facilities.

The labour cost to maintain recreational facilities and hiking paths are substantial since there are two and a half to three thousand visitors per month, who place wear and tear on the facilities, including roads. The budget change for buildings (staff housing and interpretative centre) from R16 000 (1997) to R144 (1998) to R1000 (1999/2000) will apply further labour pressures since the funds for contractors to do the maintenance work will not be available. The NCO had little opportunity to attend important conservation meetings due to the reduced budget for vehicle running costs, affecting his capacity for professional networking. This impacted on the efficiency with which KNR was managed after the budget cut was experienced.

### 5.2.2. Alien invader control

No more funds have been made available for control of alien invaders since 1997.

Table 5-2 shows that there was a deficit of R8 500 in both the 1998 and 1999/2000 budgets. According to the NCO, this amount was the exact amount needed during this period for the herbicidal control of alien invasion at KNR. Any backsliding in the alien invader program during the period when there was no allocation for alien control in the budget was prevented through funds being made available by the local conservancies e.g. raised in the Open Gardens Project which could then be used by KNR management

The use value for hikers will diminish if alien invaders are not controlled and the hiking paths are not maintained or developed.

Since the user charging only began on 1st November, 1999, the availability of funds for the continuation of the alien control programme during 2000 has been limited and needed to be obtained elsewhere. The advantage of initiating user charging during this period (November/December) is that many holidaying people are attracted to KNR at this time with a substantial potential income. However, consideration must be given to the fact that there is a relatively high rainfall during this period, reducing visitor numbers.

The lack of funding for the monitoring of the extent of invasion in feeder areas (vehicle running costs) and the slight backsliding in the alien control programme of 1998/1999, will lead to higher costs as exotics increase their infestation. Even though the alien invader control budget is cut, it is extremely important to continue with the control project to minimise any increase in costs.

The problem of alien infestation in the KNR area will not be solved until the properties surrounding the area are cleared of invaders. The spread of alien vegetation into KNR is mainly due to the alien plants in the gardens of the surrounding community whose seed is carried by water, wind or birds that pass by.

Any cleaning of KNR will be futile if seeds from neighboring properties cause a re-infestation. This can lead to a huge waste of time, money and manpower. Thus much of the effort in dealing with the problem involves educating the public by extensive media coverage and providing ultimatums and advice for alien eradication.

The role of educating the public that the NCO can play will be severely diminished due to the lack of a viable vehicle running cost budget. The NCO stated that in 1998 he was unable to leave the area where he was stationed. Since the education of the local community and management plans to implement programs of control involves a substantial networking input, a low budget for vehicle use may hamper development of these activities.

The infrastructure involved in educating the public is vast and includes the local media and conservation publications supported by NGOs, business, academics and Government. Not much has filtered through to the schools, which is important since children should be included as they are the future custodians.

Prevention through education is the most cost-effective way of controlling alien plants. Educating the local community surrounding KNR is imperative since this will ensure that new seed produced is not distributed and that existing plants are not allowed to seed. The educating role is mainly expected to come from the local conservancies, e.g. the Kloof open gardens project. There are many conservancies in the area, but the Kloof Conservancy is the most active. They produce a magazine which reaches +/- 250 families (and friends) where they stress the importance of growing indigenous plants.

The Kloof Conservancy arranges for a parents function at Kloof Junior Primary as a fundraiser for the school where they are shown how to landscape using indigenous plants. Part of this exercise is the identification and removal of alien vegetation from the school grounds. This exercise should be extended to other schools in the area.

Street committees play an educating role amongst local residents. Kloofview Ass. was formed to look at security and environmental awareness in the area along Kloofview road, Forest Hills. Neighbors in Valley Rd, Forest Hills have started a street committee and have eradicated 95 % of the alien infestation in resident's gardens. Co-ordinating a similar project with schools in the vicinity of KNR should attract funding from the Green Trust.

The skills to identify alien invaders and indigenous plants and to apply horticultural and alien invader control techniques need to be taught. People who have local knowledge of plants should be trained as trainers. Training in alien invader identification and removal and indigenous plant recognition can be provided by the KNR management forums and local conservancies. Skills in the cultivation of endangered species should be taught.

A botanical / ecological / educational programme like this could easily be integrated into the school curriculum to teach skills in a practical way. Principles of catchment management and alien vegetation control could then filter into the homes of the surrounding community through organised school projects. Much of the organising will have to come through networking and forum meetings and will require some of the funding to be prioritised for vehicle running costs.

Private and public areas alike are invaded by exotics that may invade KNR and it is hard for the municipality to prosecute private owners when they are guilty of the same offence. Conservancies have now taken the initiative to clear public places (for example. highway project, street committees etc.). Because the method used by the council of plot clearing by cutting does not remove the cause, even worse cases of alien infestation may occur as dismembered parts of a single plant may spread over a larger area, budding plants. Although handpicking will not be cost effective in the clearing of plots, training should be given to plot clearers to recognize indigenous vegetation that could be left to provide competition for any further infestation of alien invader plants.

This type of image of the dragon slayer, decapitating an evil monster, is shown in the Alien Buster's comic endorsed / sponsored by the National Department of Agriculture, DEAT, Forest Owners Association, South African National Parks, Ecoguard, Dow Agrosciences, Zeneca Agrochemicals, Cyanamid and the WWP.

The advantage of having these sponsors is that the magazine may be provided freely and thus ensure that there is a wide circulation. Although this type of depiction of the hero saving the world has a particular attraction for young people (typical blockbuster movies), a wrong message is being sent since dismembered plants have the potential to spread. This type of message may have the potential to cause a worse type of invasion. Turning swords into spades may be a better message that was advised 2000 years ago.

Since the council only reacts to complaints by neighboring plot owners, few of the instances of alien vegetation infestation are known by the local authority. There is a need to build capacity to conduct inspections and enforce legislation. Funding should be made available to schools to do a community survey. This will be useful even if the survey is done at the school or at the homes of teachers and pupils. This must include schools that are representative of all the KNR community neighbors. Funds could be sourced for extra work like for the survey of public land and the school itself.

Proper training for verge cutters in the reporting and eradication of alien invaders on public (and possibly) private property would help in exposing / dealing with some infestations. At the same time verge cutters could be trained to recognize valuable horticultural / medicinal plants that they could avoid cutting. Wherever possible, strips of natural vegetation could be left to provide links between conservation cells.

Property owners who have invading fruit trees in their garden need to be educated on using indigenous trees to attract birds and/or be given concrete instructions on how to fully utilize these invaders to prevent spreading. The use of exotic invaders is recommended by the Krantzklouf Management Plan. These invaders may have nutritional or medicinal value.

The indirect, secondary effects alien invasion has on fire, flood and erosion control, wetland destruction, replacing indigenous flora, reducing fauna populations and impacts on the Reserve are further factors that need to be considered for the argument of prioritizing the alien control programme in KNR.

Considering that alien invaders cause soil erosion in grasslands, the increase in invader infestation will contribute to the problem of erosion, of which the budget allocation for the control of has been reduced to zero (Table 5-2). Also, increasing fire hazards are known to occur due to alien infestation. The level of devastation caused by fire would be less if the natural vegetation was not replaced by aliens.

Since the funding provision for invader plant control (R8 500) has been eliminated from the budget in 1999/2000 and external funding may be piecemeal and unpredictable, alternative means to dealing with the

invader problem may be necessary. Whatever the funding base, alien vegetation control is regarded as an important priority.

As a precaution against re-infestation, the regular burn in KNR will destroy surface seed while at the same time keeping back the “bush encroachment”. This may occur too often (biennial) to allow any development of woody component value. Use of fire would be necessary where KNR management objectives were to maintain grassland species assemblage. Withholding forest development will satisfy one of the aims imbedded in the KNR Management Plan (2003), i.e. to maintain the grassland to forest ratio.

Although the species composition will be altered by the invasion of native species, invasion by exotics will be more far-reaching and could push out all the native species and cause a local extinction. However, some invading exotics act only as early successional species and are useful as a forest precursor.

### 5.3. Other sources of income .

R18 000 in the open gardens project (2000) and R5400 for the interpretative centre (over 9 months). In 2004 the open gardens project fundraising venture netted R50 000, which will close the shortfall required for ecological and facilities maintenance.

#### 5.3.1. Funding organisations

Although user charges and other sources of income may be sufficient to overcome budget shortages, development work in and around KNR may require a further injection of funds.

#### Catchment Management Funding

The pricing strategy for water use charges (National Water Act, 1998) involves setting a level that will allow funds to be used for *water resource management* including the related costs of *gathering information* and *water resource protection*.

Since KNR is a subunit of the Emolweni/Umgeni catchment, funds to manage this subunit should become available once a CMP is drawn up for the Emolweni subcatchment. The KNR Management Plan (2003) has all the essential elements to assist in drawing up a CMP for the area. Funds will come from the CMA and will be administered by the ESF.

These funds could be used by schools who might gather information and who are much in need of fundraising since they are also facing budget cuts. Alien control in wetland areas should also attract funding.

#### Green Trust and WWP

Funding for research into the extent (or control or effects) of alien invasion may be obtained from proposals submitted to the Green Trust. Funds could be applied for to undertake a similar task to the one followed by

Fauna Park Primary in the Kruger National Park area. Liasing with WWP work in the Outer West can help identify and eradicate pockets of infestation that may be invading KNR.

#### Conservation Trust

The development of the Conservation Trust Fund allows part of the interest on the capital amount to be applied for which could alleviate the shortfall. It may be that KZN Conservation services, who produced the 1997/1998/1999/2000 budget realised that the shortage of funds for these projects may be supplanted by funds from the Conservation Trust. One of the hiking clubs has asked for the R5 entrance fee *and a donation* to the Conservation Trust. This is a prerogative of the Honorary Officer who provides expertise for those joining the hike. The decline in the fundraising amount for the Conservation Trust is predictable and the request for users to make donations could be a measure to help fill these coffers. The NCO of KNR (2003) has reported that a much less sum has been received for the Conservation Trust, an average of R50 a month, which is 1/20 of the original R1 000 received per month before the policy of user charging.

80 % of the respondents said they would donate less than half to the Trust now that they have to pay entrance fees. Nearly all (90 %) interviewed knew that the money they donated was going to conservation, but only a few respondents were aware of the purpose of the Trust Fund.

#### 5.3.2. User charges

When first approached with regard to user fees in 1999, the NCO stated that the problem lies in, not whether people are prepared to pay for the facilities, but the logistics of collecting the remuneration. Access roads are generally main roads (Kloof Falls / Azalea Place) and any gate fee would obstruct traffic. A summer/winter survey in 1997 revealed that people were prepared to pay, on average, R2,50 per person on entry.

The results from the interviews with 50 recreational users (1999) is given below (Tables 5-4 to. 5-11)

Table 5-4 - Percentage frequency of visitation of the individuals interviewed (in days/annum).

	<2 days / annum	3→5 days / annum	6→19 days / annum	20→50 days / annum
% interviewed	34	10	20	36

Table 5-5 - Percentage of people who indicated that certain amounts were a fair user charge (per picnic site).

User charge	R4	R5	R8	R10	R15	R20
%	6	10	18	52	4	10

Table 5-6 - Percentage of interviewed groups incurring various travel costs (in km).

	< 2km	3 →5	6 →19	20 →35
% interviewed	42	18	6	34

Table 5-7 – Percentage of respondents who were aware of the budget slash and the percentage of unaware respondents prepared to pay more after being told of the budget slash for facilities maintenance.

	aware of the budget slash	unaware of the budget slash	Unaware, but now prepared to pay more
%	32	68	50

\* 17 people who were unaware of the budget cut did not regard the budget cut as a reason to increase entrance payment.

Table 5-8 - Percentage of adults who donated various amounts to the Conservation Trust Fund.

Amount	R0	< R2	R2 – R4	R5 – R7	R8 – R10	R11 - R20
%	8	6	42	8	30	6

\* 4 people (8 %) who had not donated money stated that they had not been approached for donations.

Table 5-9 - Percentage of respondents that were approached for donations at various percentages of their visitation times.

Approached	10 to 30 %	31 to 50 %	51 to 70 %	71 to 90 %	91 to 100 %
%	8	12	0	36	44

Table 5-10 - Percentage of people who will cut their donation to the Conservation Trust by a certain fraction now that they are charged R5 per person.

Fraction	0	¼	½	¾	1
%	8	18	16	8	50

Table 5-11 – Percentage of respondents that will cut their visitation times compared to the percentage that won't now that a compulsory entrance fee of R5 per person is charged.

	will cut	will not cut
% interviewed	42 %	58 %

Table 5-5 shows that 52 % of the people thought that R10 was a fair price to pay per picnic site. The calculated average amount visitors would be prepared to pay per picnic site at KNR is R8. With each site being used twice during a weekend (Saturday and Sunday) and during school holidays, a potential income of

104 days (weekends) and +/- 70 days (holidays) = 174 days X 30 sites X R8 = R41 760, then the budget shortfall could be made up.

However, some of these days may not be conducive to picnicking with certain loss of income. A more conservative estimate would be 150 days X 25 sites (not all sites are used on each day) X R8 = R30 000. This will leave a shortfall of just R5 200. The balance could be made up from other sources of income like the Open Gardens Project and the hiring of the interpretative centre which amounts to +/- R30 000.

A different approach to estimate the potential income can be made through the estimate of the number of visitations per month. The average picnic user contact percentage is given as 80 % (**Table 5-9**) and the percentage of hikers of the total number of visitors (which are not approachable) is estimated at 10 %. This means that 70 % of the visitors are chargeable:

$$70/100 \times 2\,500 = 1\,750 \text{ people.}$$

The average number of users per picnic site is estimated at 4 which means that in 1 month :  $1\,750 / 4 = +/- 400$  picnic sites used per month.

In a year .... $400 \times 12 = 4\,800$  picnic sites are chargeable and at an average charge of R8:  
 $4\,800 \times R8 = R38\,400$  potential income which will close the shortfall.

The sum collected would depend on how successful the management is in securing funds from the total number of visitors and the effect of user charges on the frequency of visitation of the estimated 2500 visitors. Even though the average percentage of user approach by management is given as 80 %, most people approached who were frequent users of KNR responded that they were approached for donations 90 % of their visitation times.

Considering the user fee (per person) ...

A portion of the user fee (20 %) goes towards a community levy that will be used to assist needy communities with their projects. A further portion (20 %) is to help defray costs incurred by the emergency rescue services operating in KNR. The community levy is boosted by the input from other nature reserves and the building of a school and a clinic in the Molweni area has been recommended by the Community Conservation Committee, in charge of administering the funds

Considering a visitor's entrance fee of R5 that was implemented in November, 1999, and 2500 visitors per month, the potential income per annum (at R5 per person) is  $2500 \times R5 \times 12 \text{ months} = R150\,000$  which is considerable. The number of visitors, however, will decline due to this charge. Specifically, most people who have a high rate of visitation will reduce their number of visitation times.

From Table 5-11 it is evident that 40 % of those interviewed are likely to cut their visitation times. Thus the estimated chargeable 1750 visitors per month may reduce by 40 % if all these visitors *cut their visits completely* and they visited KNR once a month.

60 % of 1750 visitors per month gives 1050 users at least from which the fee of R5 may be obtained if 40 % who visit on average once a month cut their visitation completely.. Most respondents were uncertain about the amount of visitation times they would cut and had to be prompted for an answer. .

1050 charges per month X R5 = R5 250 per month.

R5 250 per month X 12 months = R63 000 p.a. Since 40% is allocated to a community levy and to emergency rescue services, the balance is R37 800 p.a. or R3 150 per month.

The month of November 1999 (including levies) collected R3 065 in user charges, with a net balance available for use in KNR of R1 840. December collected R7 745, with a net balance for use in KNR of R4 645. January collected R7 455, with a net balance of R4 475. The December/January periods may be regarded as “peak” times and on New Year’s day, 2000, up to 200 people visiting the site was noted, with a possible collection of R1000 on that day alone.

However, the weather patterns would have severely affected the amount raised in user charges and the amount of rain that the area experienced in November / December /January 1999/2000 and the fact that these rains are expected to continue in February may see this fundraising venture fall short of its target.

Considering then that the average takings of these three months may be regarded as a reasonable estimate of the average expected during the other months of the year (which are drier months, but not “peak” months), the estimate per month for 2000 is:

$R1\ 840 + R4\ 645 + R4\ 475 = R10\ 960/3 = R3\ 653,33$  per month or R43 840 p.a. which will close the shortfall.

Frequent users of KNR, mainly from the surrounding communities, will mostly be affected by charges. Specifically, frequent users with large families and users who arrange functions involving many people, for example birthday parties, will cut their frequency of visitation. Since frequent users are most likely to cut their visitation and, if their average number of visitations per month amounts to greater than one, then the total number of visitors per month could be less than the estimated 1050.

Although the entrance fee increased from R5 to R7, the total user charge income remained more or less constant (NCO pers. comm., 2003). This implies that there has been a decline in the number of visitors after this increase. However, numbers appear to be on the increase again (NCO pers. Comm., 2005) presumably due to the successful recruitment of visitors by Nature Conservation Services.

Most residents in the middle to low economic status communities will be unable to visit frequently. KNR is mainly used for family outings and to enable frequent visitors with families from middle to low economic status to continue visiting, a subsidy for children will be required.

Consider an average family of 2 adults and 2 children. If children were allowed free then those 40 % of the visiting families who would ordinarily cut their visitation, may consider the outing affordable and KNR could gain on the charges for adults. This means, however, that the children of the other 60 %, who could normally afford it, would not be charged and this is a potential loss which is greater than the potential gain.

However, economic gain is not always the criterion to be used and careful consideration of the objectives of providing recreational facilities for family outings should be taken.

Residents of Kloof area, being of relatively high economic status, are likely to be able to afford (R5 is small change) the charges even if they are frequent visitors. Since 60 % of the respondents were local (Kloof, Hillcrest, Waterfall, Forest Hills, Everton, Gillits) and 40 % said they would cut their visitation time (none of the further afield said they would), Thus 20 % of the local community will not be affected by the R5 user charge.

This may correspond to the ratio between local communities classed as high economic status (mainly Kloof and Hillcrest) and those in the low to middle income bracket (mainly Crestholme, Waterfall, Gillits, Everton, and Forest Hills) = 2:4 or 1:2, which corresponds to the 20% (can afford) and 40% (cannot afford) ratio. Most of the income will therefore have to come from the less frequent visitors who are generally from further afield.

Some respondents from the local community felt that their fees should entail some type of service, for example, a bundle of firewood for the picnic site. Now that people are paying for use of KNR, it will be important for management to provide the type of service that will satisfy the customers. One respondent said that he did not mind paying, but he expected toilet paper to be present when he wished to use the toilet. This may have occurred when the 1997 budget was cut by R540 in 1998. The 1999/2000 budget is now only R100 short of the 1997 budget.

All hikers interviewed (Tables 5-12 to 5-14) were unhappy with user charges going to a general fund and would be reluctant to pay the full price indicated if that was the case. Interviewed hikers were asked what

projects would need the greater allocation of user charges and the average amount was that 66 % of the funds should be allocated to alien removal, 34 % to trail development and 0 % to the establishment of trail guides (Table 5-14).

Table 5-12 - Average frequency of visitation (hikes / annum) for casual and organized hikes.

NATURE OF HIKE	CASUAL	ORGANIZED
HIKES / ANNUM	1	3

Table 5-13 - Percentage of hikers prepared to pay various user charges per organized visitation.

Charge	R4	R5	R6	R7	R8	R9	R10
%	10%	40%	20%	10%	10%	-	10%

All hikers interviewed were aware of the budget slash and therefore question 3 was not relevant.

Table 5-14 - Average percentage of user charges recommended by interviewed hikers to be allocated to various projects

	path development	Alien control	trail guides
% of funds	34 %	66 %	0 %

Hikers who use the main entrances will be charged, but those entrancing at other points will not easily be able to be charged. If the management of KNR can liaise with the hiking clubs then money should easily be obtained from organised hikes. From Table 5-13, the highest percentage of hikers (50 %) are prepared to pay R5. 2 hiking clubs at 3 organized hikes per annum = 30 hikers x 3 visits p.a. [Table 5-12] x R5 = R450. More hiking clubs, for example from schools, scouts etc. make use of KNR for educational and other purposes and will also make a contribution.

Unlike the hikers who would prefer user charges to be used for specific projects, 90 % of the picnicker respondents were happy to pay into a general fund that may be used for various projects that have had budget cuts.

Information on the number of times per annum that a particular school used KNR for educational purposes is given below.

- \* Hillcrest Christian Academy (primary) - each grade uses at least once a year ;
- \* Hillcrest Primary- do not visit, environmental programme on recycling ;
- \* Forest View Primary - do not visit, environmental programme discontinued mid-99 ;
- \* Pinetown Girls High - do not visit, but hope to in the future ; and

\* Kloof Primary - do not visit, but actively involved in alien removal and indigenous tree planting within the school grounds.

Hillcrest Christian Academy = 300 pupils X R5 = R1500/p.a.

Local conservancies and the Wildlife Society were also approached to determine their frequency of use of KNR for educational purposes. Their response is given below:

\* WESSA (Wildlife and Environment Society of S.A.) members average three times a year on plant identification courses

\* Waterfall/Crestholme Conservancy arranges tree identification meetings monthly

\* Kloof Conservancy group visits 5 X per year

WESSA = 15 visitors X 3 times/annum X R5 = R225

Waterfall Conservancy = 12 visitors X 12 months X R5 = R720

Kloof Conservancy = 20 visitors X 5 X R5 = R500

TOTAL = R1 145

Grand Total for Educational Users = R1 445 + R1500 = R2 945

#### 5.4. Possible impact of budget shortfall

The R43 840 per annum estimated to be obtainable from user charges will be able to cover for the underfunded projects, where the shortfall has been calculated at R34 100 (excluding "extra" income). Thus the potential impact is expected to be zero and there may be a recreational user funding surplus of +/- R10 000. Charging the direct user fee will have the advantage of a percentage of the money being able to be used straight away instead of having first to apply for funding with the inevitable wait that may lead to higher costs.

Thus the shortfall in funding is not a major concern, with further backup from the KZN Conservation Services who had the foresight to prepare for this inevitable scenario via the Conservation Trust.

If the facilities maintenance shortfall is secured then the main source of income (from recreational users) will be protected. Funds raised by the local conservancies (e.g. Open Gardens Project) may then be applied to other important areas like alien invader eradication.

On discussion with the NCO of KNR (1999), he stated that the alien control program continued during 1998/1999. He also stated that there has been no erosion within the nature reserve, barring that of man-made structures like roads, hiking paths etc.

### 5.5. Use value

The way in which people view KNR determines the type of value they place on it. If hikers were to view KNR as being over-run with alien invaders or picnickers were to view KNR as having poor recreational facilities, the corresponding value will be assigned to it. These views may, however, differ from a subsistence user who may regard the fruit of an alien invader (e.g. guava) as valuable.

Criminals place a high value on KNR since attacks may occur in isolated areas and there is plenty of area to hide away or to hide stolen goods. Thus funding appears not to be the only recreational threat to the reserve. The crime factor within KNR boundaries has a negative impact on how the users value the site and one of the respondents approached for an indirect valuation in a shopping centre had reduced their visitation from frequent to not at all due to this threat. The need for security increases the concentration of dogs that puts pressure on the animals in KNR.

People will be much more willing to visit KNR if their security is assured and if the crime rate increases it will reduce the number of visitations and thus the potential income.

One of the main factors causing the high crime rate is the high rate of unemployment amongst the Emolweni community. It is therefore extremely important to develop income generating projects for the unemployed (potential muggers) as soon as possible in order that the high value associated with KNR will remain.

Crime and removal of forest produce that damages resource value are associated with entry at uncontrolled points, that is, at the bottom of KNR near Molweni and the Uve entrance near KJoof. Fencing these areas off to deter some of these activities has been futile since the fence has just been cut away and removed.

#### 5.5.1. Water consumption

The value of KNR will diminish if safe water can no longer be consumed from the Emolweni River. Tables 5 – 15 and 5 – 16 estimate the possible costs to the community.

Table 5-15 - Estimated costs if 2000 people contracted gastro enteritus per annum (increase in toxicity).

Cost to cure sickness	R20 X 2000 = R40 000
Cost of transport	R2 X 2000 = R 4 000
Income loss	R50 X 1000 = R50 000
TOTAL	R94 000

Alternatively, the cost to the community due to the deterioration in water quality (increase in sediment load) was estimated by the need to travel to obtain pure water or the cost of building 10 settlement tanks (Table 5 – 16).

Table 5-16 - Estimated settlement tank costs divided into materials and labor.

materials per tank	R700 X 10 tanks = R 7 000
Labour per tank	R1300 X 10 tanks = R13 000
TOTAL	R20 000

If the tanks operate efficiently for 5 years then the cost per annum will be:

$$R20\ 000 / 5 = R\ 4000$$

Or ...the cost of travel to obtain pure drinking water can be estimated (e.g. 1000 people X R50 per annum = R50000).

If both toxicity and sediment load were increased then the total cost to the community could be: R94 000 + R4 000 = R98 000

### 5.5.2. Forest produce

The extent to which the goods and services provided by the indigenous forest of KNR are used by the community is unknown, but indigenous trees and plants are used extensively for medicinal purposes and for fire wood. Commuters between place of residence and work have access to KNR at the Upper and Lower Molweni areas resulting in the potential for abuse of the indigenous vegetation. Efforts to fence off these areas have failed due to the cutting and theft of the fence wire. Trees of which bark has been removed for medicinal purposes have been identified, but the removal of other plants e.g. bulbs cannot readily be quantified.

The cost of fencing has to be justified in terms of the gains likely to come from it, with crime figures down, removal of forest produce presumably occurring on a small scale and some people require openings to provide passages to work. The socio-economic and political context of the use of access points in the Molweni area will have to be taken into account.

The plant wholesale marketing study, considered as a direct, “consumptive” use is given a *quasi option value* of **R300 000**.

Thus there is a lack of relevant data required to evaluate the subsistence or commercial use of forest produce in KNR and will have to be estimated at **R30 000** per annum. This will include the amount that comes from nursery sales.

To estimate the potential income for KNR we would need to take into account the extent of appropriate areas and *accessibility*; accessibility to vehicle pick-up points, to water, to markets etc. To estimate then one would have to do a feasibility study for all the potential areas. In this way the total area open to the development of nurseries may be quantified and compared to the private land where the study took place. The estimate of R300 000 for this development project was arrived at as follows:

One person working on average once a week can build an income (average) of R1 600 p.a. working in an area of approximately 0.4 ha. If we consider that approximately 10 % of KNR may be amenable to nursery development then this is 67.5 ha. The average income then for this area is  $67.5 / 0.4 \times R1\ 600 = R270\ 000$ . Adding the other R30 000 possibly obtained from the sustainable removal of medicinal plants and from the KNR nursery, gives an estimation of R300 000 p.a.

This would be an estimation value based on the sustainable removal of forest produce. The unsustainable consumptive value of forest produce in KNR will be much greater than the estimated R300 000

Indigenous plants are often assigned conservation or medicinal value. Common plants with little conservation value and limited medicinal value are generally left out in any valuation. These plants may, however, have significant horticultural value. Even disturbed areas have an inherent potential value owing to the horticultural value of different types of pioneer plants. Regenerated patches of indigenous plants allows saleable plants to be removed sustainably since many of these regenerated plants will not reach maturity since they regenerate in dense patches that only allows the more dominating individuals to survive.

Many of the plants tested for marketability were commonly found and thus not threatened. If value can be shown to exist for these plants that can be removed sustainably then possibly interest in the utilisation of these plants will act as an alternative to the harvesting of muthi plants, which are being threatened. Keeping a low-key nursery at KNR to reduce the extent of competition with retailers in the area is understandable. Any nursery development then would be in the area of supplier, with plants that are harvested sold wholesale to the local nursery owners. Excess stock can be purchased by the local conservancies to use for the rehabilitation / landscaping of degraded public areas

Indigenous herbs, shrubs and trees are increasing in market value as more and more people wish to plant indigenous. Landscapers require indigenous plants and income could quite easily be generated from an indigenous nursery. Plants tested for their marketability are given below. Unless otherwise referenced the description of these plants come from Botha & Botha, 1997.

Nurseries provide an opportunity for educating the public about the value of planting indigenous plants, in general, and about the particular attributes of each plant. Besides promoting indigenous plants and warning about alien invaders with the help of glossy photographs and information displayed in conservation pamphlets, detailed information on individual plants could help in the popularisation and sale of the plants.

#### HERBS

*\*Scadoxys puniceus* – snake lily

Striking red/orange flower (Plate 5-1) produced in in early spring. Bright red seeds in summer. Specially protected. Great garden and pot plant.



Plate 5-1 – *Scadoxys puniceus*

*\*Crocoshia aurea* – falling stars

Brilliant orange, striking flowers (Plate 5-2) in mid to late summer, sun / shade



Plate 5-2 – *Crocosmia aurea*

*Aristea eklonii* – blue stars

Blue flowers (Plate 5-3) in spring, associated with grasses, sun / shade



Plate 5-3 – *Aristea eklonii*

*Plectranthus* sp – fly bush.

Vigorously growing groundcover with purple foliage underneath, capable of taking over shady areas. White flowers in late summer.

## SHRUBS

*Hibiscus peduncularis* – pink hibiscus

Large, bell-shaped pink flowers (Plate 5-4) produced in the second year in late summer and autumn. Good for hedging.



Plate 5-4 – *Hibiscus peduncularis*

*Dracaena aletriformis* – large-leaved dragon tree

Beautiful, tropical-looking form plant (Plate 5-5) reaching 2 to 3 m, with dark leathery leaves, prefers shade. Has sweetish-scented white flowers (after 3 years) which open at night and attract several species of hawk moths for pollination. The large, orange-red, berry-like fruits are eaten by forest birds and monkeys. Natal Robins nest in the leaf axils and it is the larval host plant of the Bush Nightfighter butterfly. Good landscaping subject, fairly fast grower (60 cm per year), fine form and texture plant, excellent indoors even surviving air-conditioning.



Plate 5-5 – *Dracaena alectrifolia* (Shrub or small tree)

*Gomphocarpus physocarpa* – Wild cotton

Pioneer plant with decorative seed pods (Plate 5-6) in summer used to make Christmas decorations. Larval host plant of Africa's biggest butterfly, the African Monarch. Birds use seed plumes for nesting material.



Plate 5-6 – *Gomphocarpus physocarpa*

#### TREES

\**Burchellia Bubellina* (wild pomegranate, small tree) see Plate 2-8

Shrub or small tree (2–5 m) growing slowly (30 cm/year) in sun or shade. Found as subcanopy of forest or on the forest fringe. Showy, orange tubular flowers (Plate 5-7) shows the flower of *B. bubalina*

with copious nectar found from the second year. Good for Sunbirds. Birds often split the pollen tube to get at the nectar. Urn-shaped fruits are snapped up by barbets, bulbuls, starlings and mousebirds and are even eaten by baboons. The plant has been widely used traditionally, including the preparation of a love potion. Makes a good screen plant and does best inland.

The wild pomegranate was given a flattering write-up in the Highway Mail (Dean, 1999). The aim was to educate the public with regard to the option of planting indigenous trees, which many gardeners, and even some nurserymen, believe are slow growing and lack colour. The following is an extract from this article:

'Yes, pansies are pretty and roses are beautiful - but plant a wild pomegranate with its wonderful orange trumpets in spring. Add to that myriads of sunbirds flashing in and out of the foliage like jewels - now that is a breathtaking site!



Plate 5-7 *B. bubalina*

*Halleria lucida* (tree fuschia)

(see Plate 2-7)

Bushy, evergreen shrub or small tree that is a wildlife magnet, fast growing (1 m per year) in the sun or shade. Does best inland. Can become fairly large if grown in forest conditions. Because it is often multi-stemmed with dense, drooping foliage, it makes a good screen and also provides a hiding place for birds hunting their prey. The orange to dark red tubular flowers (Plate 5-8), appearing after 2 years, hang on small stalks and are seen mainly in dense bunches on the trunk and old woody branches. They are so full of nectar that Zulus refer to them as "bird's beer". Many insects and birds such as weavers, sunbirds and white-eyes visit the tree.

The flowers are replaced by fleshy, sickly-sweet, edible berries which become black when ripe. Fruit eaters like loeries then visit the trees. The fissured bark makes an ideal hiding place for many tiny insects and invertebrates which attracts insect-eating birds. In the wild the leaves are browsed by game. The plant is considered a charm against evil and twigs are burnt when offering sacrifices to ancestral spirits.

The best place to plant one is on the edge of a terraced slope, close to a favorite sitting place. In this way it provides shade and visiting birds are easily watched from underneath.



Plate 5-8 – *H. lucida*

*Trema orientalis* - Pigeonwood. See Plate 2-9

Very fast-growing (2m per year) pioneer, small to medium tree (one observed to reach 7 m), described as an instant bird garden tree (Botha & Botha, 1995). Prefers sun, but happy in shade. Prolific small berries (in 2 years) enjoyed by bulbuls, lesser-striped swallows, white-eyes and canaries. Insect eaters also visit the tree since it is the larval host plant of several Charaxes, including the Giant Charaxes. Young leaves may be eaten as a spinach.

In the wild *Trema* provides the ideal shelter for young forest trees which like half shade, and any gardener trying to re-establish a natural forest on a large plot need do no more than plant a grove of *Trema* (Johnson & Johnson, 1993).

***Protorhus longifolia* – Red Beech** See Plate 2-4

Medium to tall, evergreen, sun and shade. Grows 80 cm per year and reaches 6 to 10 m. Tends to keep its lower branches and works better as a screen tree than a shade tree. Few bright red leaves on tree or ground, Spring and Autumn. Birds love ripe, purple, fleshy fruit. Bark exudes sticky gum used as a depilatory.

***Bridelia micrantha* (Mitzeerie)** See Plate 2-5

Fast growing (up to 2m per year), medium to tall deciduous canopy-forming, sun or shade. Sweet tasting berries (after 3 years) edible and loved by birds. Good shade tree with orange/gold and red leaves in autumn. Roots and bark used for sterility. Larval host plant of Giant Charaxes, Paradise Skipper and Morant's Orange butterflies. Food plant of processionary moth.

It is a particularly useful species where waterlogging is a problem, and provided that some of the roots have access to oxygen, the tree can survive periods of inundation. It has been used with great success in restoring damaged watercourses in over-exploited sugar-cane farms (Johnson & Johnson, 1993). The root is extensive and rapidly forms a mat across the stream bottoms, halting further erosion. In this situation it acts as a forest precursor, and visiting birds deposit seeds of other trees, so that the natural riverine community is reconstructed within 5 to 8 years.

***Strelitzia nicolai* – Natal wild banana**

Grows rapidly (at least 1m a year) to 8 m in height. Screen and form plant. Bats and frogs roost in leaves. Roots may damage buildings. Barbets and starlings eat the fruits and nectar-feeders like sunbirds feed from the flowers.

***Croton sylvaticus* – Forest fever-berry** See Plate 2-6

Deciduous, medium to tall (8 to 20 m), sun or shade. Good shade tree, fast growing at 1.2 m per year). Cream flowers visited by birds and other insects. Bright orange fruits loved by birds. Larval host plant of Green-veined Charaxes butterfly, *Charaxes candiope*. The croton wood is white or pale yellowish-grey, light, soft and easily worked as shelving, furniture and fruit boxes. Leaves are made into a poultice for pleurisy and the bark is used for rheumatism (Winter et. al., 1975).

The following trees were found to be popular, with a few sold, but were in short supply.

***Psychotria capensis* – Small, decorative, evergreen, does well in shady areas.** Grows 50 cm/year and with a mature height of 2 m. Striking flowers after 2 years, makes a good flowering screen and component of a bird garden.

*Macaranga capensis* (Wild Poplar) - Large tree (up to 15 m), fast growing (1m per year), with a broad evergreen canopy. Fruits (after 5 years) eaten by birds. Seeds not easily found and better to remove seedlings from the ground.

This tree is important for maintaining water courses. Its roots form a mat lining stream beds, and interweave across the stream to create small weirs. Stable ponds build up behind the weirs and stream velocity is reduced, minimising erosion. Good shade tree and ideal for restoring riverine vegetation on a large scale (Johnson & Johnson, 1993).

*Pavetta sp.* (Weeping Bride's Bush)– two species, *P. grandiflora* and *P. lanceolata* lovely scented flowers (*lanceolata*), large striking flowers (*grandiflora*).

*Trichelia emetica* (Natal Mahogany) – Large (8 – 11 m), imposing evergreen tree, with a broad canopy that casts dense shade. Flowers sweet smell, seeds (after 6 years) eaten by Hornbills. Rapid growth (1m per year) with shade canopy in 4 years. Ideal for car parks and avenues.

*Harpephyllum caffrum* (Wild Plum) – See Plate 2-10

Very large (10 – 14 m), fruits after five years. Fruits make tasty “lemonade” drink or jelly.

*Xymalos monospora* (lemonwood) – Large (8-14 m), moderate growth (50 cm per year). Fruit, appearing after 6 years, is eaten by birds. .

*Syzygium cordatum* (Umdoni) – Reaches 8 to 10 m, growth 60 cm a year. Fruits after 4 years eaten by birds.

The period during which the herbs, shrubs and trees were sold at wholesale prices to retail nurseries was 2000 to 2003. Income from sales amounted to:

- 2000 – R700
- 2001 – R1300
- 2002 – R1900
- 2003 – R2500

Forty different tree species were observed in total, some which could not be tested for marketability due to low numbers or the fact that they were not identified. Table 5-17 below gives the breakdown for these forty species.

Table 5-17 – Diversity of tree species and availability for sale

	Number	% of total number of species
Trees sold	10	25
Trees identified, but too few to sell	13	33
Trees not identified	17	42

Table 5-18 below gives the percentage income attributed to sales of specified plants

Table 5-18 - Percentage of income attributed to sales of specified plants

Herbs: <i>Crocosmia aurea</i>	14.1 %
<i>Aristea eklonii</i>	4.7 %
Shrubs: <i>Dracaena aleytriformis</i>	15.6 %
<i>Scadoxys puniceus</i>	9.6 %
<i>Hibiscus peduncularis</i>	7.8 %
<i>Gomphocarpus physocarpa</i>	4.7 %
Trees: <i>Halleria lucida</i>	9.4 %
<i>Burchellia bubaline</i>	9.4 %
<i>Protorhus longifolia</i>	9.2 %
<i>Trema orientalis</i>	6.3 %
<i>Strelitsia nicolai</i>	3.1 %
<i>Psychotria capensis</i>	1.7 %
<i>Macaranga capensis</i>	1.7 %
<i>Harpephyllum cafra</i>	1.3 %
<i>Croton sylvaticus</i>	0.9 %
<i>Bridelia micrantha</i>	0.9 %

Since plants were initially removed directly from the ground, those in abundance and identifiable were targeted for sale. In some cases supply was greater than demand and many plants were left to grow too large for the growing bag.

KNR runs a small indigenous nursery at the Nkutu entrance, sponsored by the Rotary Club of Kloof.

The nursery is non-competitive, low key, not well signposted and occurs at a formal entrance not receiving the most recreational visitors. Approximately R50 a month (R600 an annum) is netted (year 2002, horticulturist running the nursery). Trees for sale are less than 1m tall and planted from seed. Best sales occur with cycads and ferns.

Seed collection for the nursery in KNR occurs under the seed permit of the Krantzkloof Flora Project, which aims to establish a record of the flora within KNR by collecting plant specimens and providing them to established herbaria. The expansion of the nursery is therefore limited by the acquisition of seeds and cuttings and the policy of avoiding direct competition with other retail nurseries.

Some of the species for sale direct to the public at the Nkutu entrance and sale price (year 2002) are given below (Table 5-19):

Table 5-19 – Sale plants at KNR nursery - Azalea Place entrance

Plant	Price
<i>Croton sylvaticus</i>	R15
<i>Trichilia emetica</i>	R25
<i>Ficus sur</i>	R20
<i>Xymalos monospora</i>	R15
<i>Strelitzia nicolai</i>	R25
<i>Dracaena alectrifomis</i>	R15
<i>Encephalartus sp</i>	R20
Aloe sp.	R10
Bulbine, Crinum sp., ferns	R5

#### 5.6. Non-use value

The 1999/2000 Durban floods has cost almost R40 000 000 to clean up (Hattingh, 2000) and repair the damage of the Inner and Outer West. The magisterial districts of Pinetown and Durban were declared disaster areas.

The floods left 15 people dead and thousands homeless. The Inner West was most affected in the 1999 floods year with extensive damage to roads, bridges, culverts and storm water systems.

A report released by the Outer West Local Council has stated that more than 1500 families in the Outer West were affected by floods (even with KNR intact). All community access roads in the Outer West, including tarred ones, were extensively damaged. Road sinkholes and potholes resulted in three deaths, while mudslides claimed three lives and two people drowned in overflowing rivers.

The worst damage was from the erosion of river banks which completely destroyed some properties. The fact that the Inner West experienced the most damage when it rained consistently in both the Inner and Outer West is partly due to the fact that the large area of KNR effectively “sponges” the rainfall, protecting downstream

communities. The effective nature reserve area in the Inner West is smaller with a smaller capacity to assimilate the rainfall.

Flooding of this nature also causes overflows from septic tanks and water borne sewerage leading to health problems. The rain causes supersaturation of the soil which results in the filling up of streams and softening of the banks causing further damage

The damage to roads, car parks and foot bridges in KNR due to the flooding totalled R3 000 and since there has been no allocation for flood damage in the 1999/2000 budget, this money has had to come from user charges.

For flood estimates, 0.5 % of the cost of the damage to the Inner West from floods (R40 000 000) = R200 000

Because they are not by nature flammable, indigenous forests form valuable natural firebreaks. During times of fire hazard they provide havens for creatures seeking shelter and a means of controlling the spread of fire.

Fire control measures could diminish since the budget was cut which could lead to higher risks of fires with the resultant costs to the plant and animal life and surrounding communities. The damage made by fire due to the possible deterioration of KNR was estimated conservatively at R200 000.

Forty percent (40 %) of the people approached at the shopping centre felt that the responsibility of maintaining KNR was not the community's, but that of the government. Ratepayers, specifically, were adamant that they already pay high rates and some of the money going to local government should be channelled into maintaining KNR.

The average amount people were prepared to pay per month was R3.

+/- 5000 people (40 % of 12 500) X R36 p.a. = R180 000

### 5.7. Total Economic Value (TEV)

The costs to the community of allowing KNR to deteriorate are listed and totalled below (Table 5-20). The cost is based on a calculation of the TEV (or benefits of KNR to the community) and the resultant costs if these values were to be lost. Excluded from the calculation is values relating to carbon sequestration and promotion of psychological health etc. The estimated TEV is given in Table 5 - 20

Table 5-20 - Possible devaluation of KNR counted as cost to community.

## I. Use valuation

1.1. Direct, non-consumptive Recreational and educational users (hikers/picnickers/schools/conservancies)	
*Travel Cost	R28 500
User Charges	R73 000
1.2. Direct, consumptive (Quasi-option valuation) goods and services	R300 000
1.3. Indirect consumptive (i) drinking water (pollution/erosion)	R94 000
1.4. Indirect non-consumptive (i) fire control	R200 000
(ii) flood/erosion control	R200 000
Existence Valuation conservation, aesthetic and property	R180 000
Conservation Trust	R600
TOTAL	R1 076 100

\* Travel cost was calculated from the 40 % estimation (1000 people) from 20 -30 km away at an average of 4 people per car and a cost of R15 per car =  $1000/4 = 250$  cars per month X R15 = R1 250 p.m. X 12 months = R15 000 p.a.

60 % (1500 people) from 2 - 5 km away at an average cost of R3 per car =  $1500/4 = 375$  cars p.m. X R3 = R1 125 X 12 = R13 500

TOTAL = R15 000 + R 13 500 = R28 500

The net benefits of maintaining the ecological and recreational integrity of KNR is determined by finding the difference between the maintenance budget shortfall and the TEV, that is:

$$\begin{aligned} \text{Costs to community} &= 1\,076\,100 - \text{Budget shortfall (Table 10)} = R34\,100 \\ &= R1\,042\,000 \end{aligned}$$

There is approximately a million rand per annum difference between the funding required to alleviate the shortfall and the costs to the community if KNR had to deteriorate due to the shortfall. There is therefore a huge incentive to maintain this nature reserve and to find the funds for the shortfall.

## 5.8. Integrated Catchment Management ( *ICM* )

### 5.8.1. Community conservation

Socio-economic upliftment projects for the area that were initially given a certain amount of consideration by the management of KNR (year 2000) were:

Plan 1 - Identify, employ and train 4 people from Molweni to act as trail guides. The trail guide will operate as sole owner of an enterprise that will set a tariff for nature interpretation.

Plan 2 - Identify people in the community that could provide a tuck-shop type facility

Plan 3 - Begin an indigenous nursery, run in Molweni, growing indigenous grasses and plants which can then be sold at the various public entrances.

Plan 4 - Provide hiking trails that terminate within the Molweni community that can provide overnight facilities.

It appears that only the nursery plan has gone ahead, but based in KNR. However, the KNR Management Plan (2003) has outlined various activities that will cater for the social and economic development of the low income neighbors (KNR Management Plan, Part E, 2003).

Community development projects may stem from the Emolweni subcatchment forum where consideration needs to be given to all the stakeholders and any projects should take into account the diverse needs of the surrounding communities. All the various practices that impact on KNR and the Molweni subcatchment also need consideration.

On Wednesday, 27th October, 1999, a meeting was held to initiate the Emolweni River Subcatchment Forum. The meeting took place at the KNR Interpretative Centre.

Present at the meeting (besides myself) were:-

Ash Seetal - DWAF

Ian Patrick - KZN Nature Conservation Services

Barry Smith - Kloof Conservancy & Environmental Management Advisory Forum for the Outer West (EMAFOW)

Garth Sinclair - Camelot Estate

Robin Taylor - Kloof Conservancy

Helen Terblanche - Kloof Conservancy

John Hopkins - Gillits Conservancy

Jill v/d Schyff - Springside Nature Reserve, Hillcrest

Patti Eslick - consultant, water quality

Dennis Paxton - W.E.S.S.A

Trafford Petterson - Conserve

Pat Draper - Hillcrest Conservancy / Augusta Country Estate

Mary Botha - Springside Nature Reserve

Jean Lindsay - W.E.S.S.A. + Ingweni Trail

Apologies: Quite ironically the meeting was held at a time when we were experiencing floods and some of the invited who were affected phoned in their apologies the next day. They were: 1. Members of the Molweni Development Committee, apologies given by Mr Dlamini 2. Alain Rouillard of the Assegai Conservancy.

Apologies also came from Greg Bosch, Environmental Officer for the Local Council and Mike Cottrell from the Palmiet River Conservancy.

Ten schools in the area, specifically teachers involved in environmental clubs, were invited but did not attend. Umgeni and Metro Water were also invited, but did not attend. Some private individuals and resident associations whose properties border KNR or have the Molweni or some of the tributaries winding through their properties were invited, but did not attend. Hikers and hiking clubs were invited, but did not attend.

The large attendance by conservancies indicate their commitment to participate in the management of the catchment area. The existing structures of these conservancies will provide a sound base for the forum and existing projects could be written into the CMP. Conserve, the association of all Outer West conservancies, hosts joint meetings of educational programmes that could support the drawing up of a CMP (Trafford, 1999).

The conservancies of Everton and Waterfall/Crestholme were invited, but did not attend the meeting. Their participation in the forum needs to be ensured since the Emolweni/Nkutu and their tributaries have passage through these areas as well.

People who signed the register were asked to provide information on their current work presently involved in and what they thought the priorities were for the Emolweni catchment area.

Some of the activities that participants are currently involved in are:

- management and rehabilitation
- conservation,
- alien vegetation removal,
- water analysis,
- effluent control and
- eco-tourism.

Conservancies just outside the Emolweni Catchment area, like Shongweni, Alverston and Drummond were also invited but did not attend. Alain Rouillard from Assegai Conservancy sent an apology.

Their participation in the Emolweni Forum is not crucial to the drawing up of catchment plans, but may add valuable experience.

One loophole is that there is no established conservancy in Wyebank and it is vitally important for representatives in this area to provide input for catchment plans..

Priorities listed in Table 5-21 below were indicated by 68 % of those attending

Table 5-21 - Some of the areas of priority put forward by participants in the meeting to initiate the Emolweni SMF.. Each priority is listed according to the percentage of participants who indicated the priority

ITEM	%
pollutant control	10
Alien removal	50
development practices	20
public education	10
Recreation/tourism	10

Some factors that were highlighted for consideration under development practices were wetland destruction and tree planting. Table 5-21 shows that 50 % of the respondents at the Emolweni forum meeting of October, 1999 rated alien control as a top priority. This result, however, may be biased since the forum was not fully representative and was weighted towards conservationists.

The involvement of the Molweni Development Committee in the future of the forum will be essential as the forum needs to be well represented. The Committee, mainly concerned with economic development, includes members from the local council and clinic.

Interaction with schools in the Molweni valley below Wyebank has taken place with a donation of indigenous trees by Spoornet, Inchanga, Collingwoods and the public due to the efforts of the then Natal Parks Board via Ian Patrick of Krantzklouf. The school draws pupils from Clermont, Wyebank and Molweni to make up 450 and the grounds of the school consisted of mainly scrub, *Lantana* and dirt (Hilltop reporter, 1997).

Seeds donated by primary schools in the area via the Batcop programme of the Kloof SAP were given to be planted by the children. The KNR Interpretative centre was offered as a depot for any other further donated goods requested from the school during this period.

It is essential for members of the Molweni community to be represented, for socio-economic development purposes, for indigenous knowledge, to assess the use of flora and fauna at unofficial access points, to report on water quality and quantity and to provide information on criminal activity within KNR.

Conservationists appear to be the major driving force and are likely to be well represented. Expert knowledge on ecosystem functioning, taxonomy, rehabilitation, education and marketing etc. will be useful.

Recreational users, that is, picnickers and hikers must be represented since they will provide the bulk of funding for KNR.

Educational institutions, e.g. universities, institutes of technology, and specifically schools in the area, could provide research and expertise, as well as support for any envisaged projects e.g. surveys.

Community members whose properties lie alongside KNR, for example those involved in established street committees could report on the extent of alien invasion in properties bordering KNR. Upstream users of the Emolweni River and its tributaries, e.g. for agricultural purposes should be part of the forum. Representation by Umgeni Water, the local council and DWAF would add leadership and expertise to the forum.

The NCO of KNR (2003) has some concerns with regard to the building of the envisaged school and clinic from conservation levies. He believes that this may attract more people to the area, placing even greater strain on the flora and fauna in KNR.

This development needs to be monitored to determine any impact. If the clinic and school can be engaged in the monitoring and reporting on environmental issues and/or can be engaged in other projects like alien invader control and nursery development, then these institutions could play an important role in the education of

communities based in this area. The development of skills for the cultivation of medicinal plants (KNR Management Plan, 2003) can be taught through the schools and the clinic.

At the clinic, besides water / health information, information on muthi plants and their conservation significance can be advertised. When controlled utilization is allowed and cultivation skills are learnt, the clinic could be a good place for the sale of muthi plant products. The school could be provided with an extra-mural environmental education focussing on identified threats to KNR (see ICM, Page 51). The formal entrances can be used as venues for the sale of traditional crafts as an addition to and overshadowing nursery plants since the nursery aims to be “non-competitive”. The manufacture of crafts is encouraged by the KNR Management Plan, (2003), Part E.

### 5.8.2. Multiple use management

The infrastructure required to manage the resources needs to be multi-faceted and with a focus on protection and sustainable yield. Infrastructure is defined as the basic facilities needed for the efficient functioning of an organisation/country etc. A facility is defined as something that provides you with the means to do things.

KNR has *multiple uses*, with particular areas associated with particular uses. The management of these areas, their protection and development are then based on different objectives. A blanket approach to management activities may not always be appropriate in some cases or for some areas.

Dividing areas into manageable units will allow easier facilitation of management objectives. These manageable units can be linked with other manageable units within the Emolweni and Nkutu catchments, including feeder streams and surrounding private properties.

The KNR Management Plan (part 4.8, 2003) is to divide areas into blocks for vegetation inventory / research purposes (random blocks, fire exclusion blocks and exclusion of riparian belt).

The regeneration of the woody component as a potential resource (in a fire exclusion block) could be studied. Those areas that get significant alien invasion, have a generally low conservation status and are located at a forest fringe can be compared by dividing the block into two, on the one hand, using handpicking and, on the other, using herbicidal treatment for invader control. The nature and extent of regeneration (in terms of biodiversity and quantity) and the relative costs/gains of herbicidal and handpicking can then be determined.

The facilities required to manage KNR for multiple-use activities are varied and will require the input and support from various stakeholders. Forums need to be well represented and assessed for skills that might support multiple-use management in KNR

Multiple-use management in KNR implies the management of the following:

- the biota, that is, protected flora and fauna and alien invaders
- the people, that is, recreational, educational and subsistence users
- the riverine system, including the riparian zone and wetlands and any activity that impacts on the quantity and quality of water
- the substrate, specifically measures to curb erosion of river banks etc.

Managing the above will naturally contribute towards the management of fire and floods.

To achieve these management goals, people who use KNR and people who can offer expertise to support the management of the use of KNR need to be included in the ESF.

The Emolweni and its tributaries need to be monitored for quality and quantity on an ongoing basis. This will offer *protection and a sustained yield* for subsistence downstream communities and will add to the water budget in the Umgeni. The input of the Nkutu River and the Nkonka and other streams must be monitored as well as the passage of the Emolweni River itself from its source in Hillcrest until it leaves KNR.

Thereafter it needs to be monitored up till the point where it enters the Umgeni River. Part of this task lies outside KNR, but will still be important information required by the ESF since it will impact on the quantity and quality of water feeding the Umgeni system.

Since no major industrial development occurs in the Outer West there is unlikely to be much pollution, but because of rapid housing development in these areas, a decrease in quality due to sediment load is likely as well as a possible decrease in quantity due to low aquifer replenishment. Increased risks of flooding outside KNR may occur due to greater surface run-off. Thus the substrate too must be managed to ensure that stream/river banks are protected and measures toward flood attenuation are followed.

Technical support should be drawn from members of CMCs, for example the type of expertise offered by Umgeni Water, especially with tasks involving the monitoring of water quality and quantity. Training of local people to do the surveys, monitoring, inventories etc. should take place through the Emolweni SMF.

A management plan should promote the enhancement, protection and controlled utilisation of resources. These resources include recreational areas, funding, fauna and flora, soil and water. The interaction between these resources and between these resources and the surrounding communities requires an integrated approach to their management.

For example, alien vegetation impact on both the quantity and quality of water e.g. they can reduce the quantity of water in feeder streams and reduce the quality of water by causing erosion on riverbanks. Thus alien control must be integrated with the enhancement and protection of water resources.

Thus there is reason enough to manage resources more in terms of a geographical unit than as separate compartments. This involves finding ways to describe resources collectively. Common terms of legislation should be made available that attempt to satisfy the criteria for the protection and enhancement of all resources.

Consider the quality and quantity requirements for water resources. This phrase may describe biota as easily as it is used to describe water. *Abundance* would be the synonym for *quantity* and *quality* criteria would be related to the *degree of biodiversity* as well as the “*protected*” *value of scarce plants* and also the *market value* of a particular species.

All communities who use or abuse these resources, directly or indirectly, must be incorporated into the management plan. Thus the management plan must follow a community outreach programme that incorporates:

- the various socio-economic communities that impact on the nature reserve ;
- the educational community ;
- the scientific community ;
- people involved in conservation work and
- people involved in urban maintenance and development.

People who are resident in any of the riparian zones and people who have feeder streams within their area should also be part of the participatory management. Joint efforts amongst community members may extend the wildlife corridors (and smaller passages) by promoting the urban conservancy concept. In the protection of feeder streams “green belt” areas have been proclaimed in which development is to be limited. This has led to a clash between landowners and the council concerning rights to build. The problem is that green belt areas were imposed after the subdivision of land in some areas resulting in for example (resident, pers. comm., 2006) the available area allowed for building covering only 20 m<sup>2</sup>.

Open areas are highly valued in the Durban Metropolitan area and are given an estimated value of several Billion Rand (Kloof Conservancy, pers. comm., 2003). KNR is one of the largest open spaces and this research project took a conservative estimate of the true value, and is essentially a qualitative study, pointing out the type of values and to discuss ways in which they may be quantified. Biodiversity indicators are important indicators of whether the goals of the enhancement of biodiversity and the resultant development of wildlife corridors are achieved i.e low biodiversity in infested areas, increasing diversity in regenerating areas which then declines as the climax is approached. Indicators based on the criteria that the biodiversity of an

area should be appropriately enhanced is not really relevant to KNR itself where ground disturbance is minimized and biota are “conserved rather than enhanced.”

Extending corridors for wildlife also has problems, as some wildlife may not be compatible with urban existence as was noted when bush pigs looking for forage in winter, dug out banana tree roots and attacked a resident’s dog. On the other hand, packs of dogs that escape from surrounding properties catch and kill buck and rabbits. A special management plan will be needed for this. Although fencing keeps dogs out of KNR, it also inhibits the movement of some fauna (e.g. buck), that would allow for greater genetic variation in offspring.

The management plan for KNR will be incorporated into the larger subcatchment plans for the Emolweni and Nkutu rivers. The subcatchment plans should incorporate the entire subcatchment area from the source to the point where it enters the Umgeni. This includes the monitoring and mapping of feeder streams entering the two rivers as well as the type of impact made on the riverine area by the different bordering communities.

A proposal to build cluster housing in an area (upper end of the reserve) traversed by the Nkonka stream has recently undergone an Environmental Impact Assessment (EIA). Initially the developers hoped to get away with dumping treated effluent in the stream, but have since retracted this approach.

To facilitate a holistic and integrated approach to catchment management, terminology should favour collective phrases like The National Resource Strategy (NRS) stemming from the NWRS. This involves substituting the letter of a specific resource to a general term. WMAs become RMAs, WMIs become RMIs, WUAs become RUAs. Sustainable forestry management (SFM) becomes SRM, FMUs become RMUs. This allows consideration of resources together when managed as a single unit.

The term “enforcement” may have to be changed to “co-operative or participatory management” in terms of the constitution. Education and service is the key to co-operation. Hopefully forums could provide these two key issues of education and service that will help in the success of management at local level. Furthermore there is a need to provide education for the local authority.

Laws pertaining to the controlled removal of forest produce need to be revised in order to provide controlled access to subsistence users and nursery workers.

Inspections along the entire length of the rivers will be taking place since commercial water users are required to be registered. They will pay a levy that will be used for local management. People who are entrusted in doing this job could also be trained to conduct surveys and report on alien invader infestations and/or the vegetative covering of the stream bank. Water use charges may cover some of these costs. Teams may be required.

The inspection for any erosion of soil on riverbanks may be incorporated in the survey. The service of providing alternative vegetation for the bank through the conservancies should be considered.

The extent of use of forest produce in KNR is hard to quantify, and efforts to capture the perpetrators extremely difficult. Monitoring of the effect on quality and quantity of biota is important and inventories and mapping of these areas is required.

Teams working for the WWP in the Outer West were supposed to have removed some of the indigenous plants (conservancy member, pers. comm.). Perpetrators once more are hard to catch since they can always dig the plants out at a later date. It is assumed that these plants have greater value than the income from labour practices.

Before these teams begin their work, an inventory of indigenous plants should be conducted and mapped in terms of their location.

### 5.8.3. Regeneration and Ecological Succession

Herbs that invade disturbed ground play a role in suppressing the invasion by exotics, much in the way that grass does. *C aurea* (Plate 5-2) is one of these herbs with horticultural value that may perform this ecological role. Plate 5-9 shows the herb in mass covering approximately 20 m<sup>2</sup>.



Plate 5-9 – *C. aurea* as a ground cover

Removal of these herbs in the above figure has revealed seedlings of *H. lucida* that will be part of the sub-canopy of the forest.

*Aristea eklonii* also makes an effective groundcover (Plate 5-10). The plant regenerates readily from burnt grassland areas in KNR. Flowering *A. eklonii* is a common site on the verges of main roads in the Highway area.



Plate 5-10 – *A. eklonii* as a ground cover

*P. longifolia* and *B. micrantha* young trees (5 to 10 m) dominate the grassland at the private land where the research takes place indicating that canopy species are becoming established and are likely to shade out intolerant species like *T. orientalis*. Plate 5-11 below shows a young *P. longifolia* (canopy forming) growing taller than the mature *H. lucida* (subcanopy)



Plate 5-11 – *P. longifolia* (right) and *H. lucida* (left)

The small tree *B. bubalina* (Plate 2-8 and Plate 5-7) actively colonises disturbed areas and was observed to have survived entwined in a fence (together with Lantana – Plate 2-11, at a roadside verge, at the mercy of the verge cutters on the one hand and the landowner on the other.

Because *B. bubalina* is slow growing and is established early, it is tolerant of shade. *B. bubalina* and *H. lucida* are regarded as “weedy” species that establish themselves during early successional stages. They become subcanopy trees in the understory of forests. Mature *H. lucida*, *T. orientalis* and *B. bubalina* trees indicate that the area has reached at least the third stage of succession. Plate 5-12 shows a young *P. longifolia* growing taller than the mature *B. bubalina*.



Plate 5-12 – *P. longifolia* (left) and *B. bubalina* (right)

#### 5.8.3.1. Regeneration density

As much as ten *P. longifolia* were counted in one area of 1m<sup>2</sup> containing 13 trees (see Plate 5-13 below). At another site eight *P. longifolia* were counted in a 1 m<sup>2</sup> area containing 10 trees, which is indicative of their sapling dominance. Table 5-22 below gives the density of tree regeneration and % dominance by *P. longifolia*.

Table 5-22 – *Density of regeneration*

	No. of saplings/m <sup>2</sup>	% of saplings <i>P. longifolia</i>
Site 1	13	85
Site 2	10	80



Plate 5-13 - Regeneration density (site 1)

#### 5.8.3.2. Numbers / m<sup>2</sup> and wholesale prices

Twenty *A. eklonii* were counted in an area of 4m<sup>2</sup> ( 5 /m<sup>2</sup> ) @ R7 each. Fifteen *D. aletriformis* were counted in an area of 12 m<sup>2</sup> (1.25 / m<sup>2</sup> ) @ R30 each Fifteen *H. peduncularis* were counted in an area of 9 m<sup>2</sup> (1.67 / m<sup>2</sup> ) @ R15 each. 114 *C. aurea* were counted in a 1m<sup>2</sup> area, 3 per growing bag (114 /3 = 38 bags) @ R8 each). An average of 8.5 *P. longifolia* @ R30 each (large) were counted in a 1m<sup>2</sup> area. The values per square metre are given in Table 5-23 below.

Table 5-23 Wholesale horticultural value (per m<sup>2</sup>) of plants observed to regenerate in patches.

PLANT	VALUE / m <sup>2</sup>
<i>P. longifolia</i>	R255,00
<i>D. aletriformis</i>	R37,50
<i>H. peduncularis</i>	R25,05
<i>C. aurea</i>	R304,00
<i>A. eklonii</i>	R35,00

Most of the seedlings recruited during the early successional phase will die out and removal from the ground to sell is not taking away from the abundance and diversity of the savannah, but just a little bio mass and soil. Thus this activity, at low disturbance, and followed in a sustainable manner, is *not an option to promoting diversity*, but part of the process, with the added bonus of saleable produce.

Although regeneration occurs in patches and sampling in this manner is biased and the monetary value per square metre is likely to be less for the total area, further recruitment into the same area after removal of sale produce would increase the associated monetary value.

### 5.8.3.3. Supply and demand

Since most of the stock is directly removed from the ground, available stock depends on the stage of succession, since different plants will be available at different times. Supply considerations would therefore involve *rotating disturbance phenomena* to make sure that early succession plants are continuously available. Propagation of desired species as a back-up, market research on same-successional species and the testing of market value for new-successional species will be required.

The demand depends on the availability of these plants at nurseries or depends on other factors like popularity, aesthetic value, practicality and function. An expanded market should provide sale outlets for those plants whose supply is greater than the demand. Alternatively these plants could be used in remediation efforts and rehabilitation exercises at lower sale prices. Other forms of propagation should be considered for plants whose demand is greater than the supply.

Table 5-24. Supply / demand relationship for marketed plants

Low demand, low supply	<i>Harpephyllum cafra</i>
Low demand, high supply	<i>Strelitzia nicolai</i> , <i>Croton sylvaticus</i> , <i>Bridelia micrantha</i> , <i>Protorhus longifolia</i> (small)
Medium demand medium supply	<i>Hibiscus peduncularis</i> , <i>Trema orientalis</i> , <i>Aristea eklonii</i> , <i>Gomphocarpus physocarpa</i> , <i>Protorhus longifolia</i> (large)
High demand low supply	<i>Macaranga capensis</i> , <i>Psychotria capensis</i> , <i>Halleria lucida</i> (year 3), <i>Burchellia bubalina</i> (year 3)
High demand, high supply	<i>Dracaena aletiformis</i> , <i>Crocosmia aurea</i> , <i>Scadoxys</i> <i>puniceus</i> , <i>Halleria lucida</i> (years 1 and 2), <i>Burchellia</i> <i>bubalina</i> (years 1 and 2).

Although *C. aurea* was in demand, and abundant, attack by insects during the flowering stage reduced the numbers available for sale. However, due to the large quantities available, good sales occurred.

In other cases the demand was there, but the effort of producing more sale stock was not followed through. Good sales of *D. aletiformis* occurred, but sales could have been better, considering the large stock available in the ground.

In some cases the demand was greater than the supply due to low numbers or due to popularity. Saleable *B. bubalina* and *H. lucida* declined over the period due to the process of natural succession and new (still to be identified) trees are now migrating into the area. Several large mother stock of *B. bubalina* and *H. lucida* were left for regeneration purposes, however, very little effect on seedling recruitment was observed as ecological succession proceeded. *P. capensis* and *M. capensis* were in demand, but of short supply.

*S. puniceus* was in demand (even 1 and 2 year olds), but of short supply. It was subsequently grown from seed experimentally with a 90 % success rate. Two hundred seeds were planted in 2003. This was the most planted during the period of experimentation. The large volume of seeds obtained was due to a technique of obstructing their consumption by wildlife through the tying of an aerated plastic bag around the flower head once the seeds appear.

Some plants were left unclosed to allow for the natural process to be followed. The amount of available seed in unclosed heads was restricted by consumers and also by “damping” off.

Some plants had a balanced supply/demand ratio like *T. orientalis*, *H. caffrum*, *H. peduncularis* and *G. physocarpa*

*T. orientalis* and *G. physocarpus*, being pioneer plants and fast growers appear spontaneously in growing bags / disturbed areas and quickly grow to saleable size.

The large quantity and size of *P. longifolia* plants resulted in good sales. Young trees of up to 3 m were bagged with a 25 % recovery rate. *B. micrantha* trees of approximately 3 m were removed with an 80 % recovery rate. *P. longifolia* removed from “soft” soil recovered better than when removed from “stony” ground presumably from less damage to the roots.

Low sales of *C. sylvaticus* and *B. micrantha* occurred despite the fact that they were found in abundance, probably because the public generally find deciduous trees “messy” and for a certain time the branches are bare, and unappealing.

Some plants were well stocked in nurseries and difficult to sell like *Plectranthus sp.* and *S. nicolai* since they are easily cultivated and/or commonly found. Stock of forest grass, and canary creeper are being prepared to test their marketability. Both appear in the recommended indigenous plant list published by WESSA, NGOs, academics and government departments.

Splitting / root cuttings should be applied to *Aristea* in order to maximise the stock, *S. puniceus* may be grown from seed, *Plectranthus sp.* from stem cuttings.

*D. aletriformis* may be grown from stem cutting. *G. physocarpa* seedlings emerge in growing bags from using local soil and are quick growers from seed.

*B. bubalina* are often multi-stemmed and able to be split into a few separate plants. It also responds to stem cuttings, but may require rooting hormone. *T. orientalis* seedlings, after reaching a certain size, are difficult to transplant, although success with a 0,5 m tree has been achieved.. They often emerge in the bags and are quick growers from seed.

### 5.9 Conclusion

This chapter was written to prepare the ground for some of the possible solutions to environmental management problems in the eThekweni's Emolweni subcatchment. Recommendations on how to approach the goal of the conservation and development of natural cells and corridors simultaneously with social and economic development is given in the next chapter.

## 6. Conclusion & Recommendations

### 6.1. Introduction

Since the funding requirements needed for the ongoing maintenance of KNR has been secured through user charges the next step is to look beyond the borders to integrate management activities into broader forums. The KNR Management Plan contains the essential elements needed to promote community conservation which could well be incorporated into, and adapted for, use in broader forums i.e. may be adapted and developed as a “catchment plan” which may be incorporated into the catchment plan for the Emolweni subcatchment following which funding can be applied for. Thus these broader forums could also be a source of funding for the envisaged plans.

The implementation of policies and procedures as described in the management plan needs to be monitored to determine the extent to which they are successful in producing the required effect. The recommendations in this chapter outline procedures that might be followed in order for the goal of ecological, social and economic integration to be achieved. Although the monitoring of procedures suggested by the management plan falls outside the scope of this dissertation, further research will be necessary to determine whether the policies and procedures as outlined in this dissertation are adhered to and constraints to achieving these aims are identified.

### 6.2. Funding

The funding “crisis”, which was initially suggested by media coverage, has been resolved without any negative impact on the recreational or ecological integrity of KNR. On the contrary, the new funding mechanism that is in place has made larger sums of money available to the area for social development.

People provide the funding (resource value, “cash crop”) essential for the integrity of KNR. Income is derived mainly from picnickers and to a lesser extent from hikers, conservancies, educational institutions and hiring out of facilities. For that funding yield to be *sustainable*, recreational facilities need to be maintained to satisfy picnickers and alien invasive vegetation, crime and removal of forest produce will have to be controlled to satisfy hikers, conservationists and educational institutions. Thus funding outlays for recreational facilities should be prioritized since this is where most of the income is derived

#### 6.2.1. User charges

The number of visitors to KNR will have to be monitored and any increase of the recreational fee will have to be justified in terms of maintaining a similar number of visitors. A higher fee might still net the same income, at reduced numbers of people, but there shouldn't be a trade-off of money and people. The danger of this is that it may lead to exclusivity which is in contrast to the contemporary vision for nature conservation and catchment management. The level set for a user charge should be balanced by the need for funding and the relative exclusion of visitors.

The funding resource base needs to be *protected*. Sustainable funding is required since facilities maintenance and alien invader control need ongoing attention, deterioration of which will lead to higher costs. If they are neglected then the funding base that sustains these projects, that is, user charges, will also be threatened. User charges should also be prioritized for alien removal tasks to prevent secondary effects like wetland destruction, soil erosion, flood and fire damage, indigenous replacement, water quality deterioration etc. from occurring.

Frequent visitors should be rewarded for their contribution (as frequent flyers are) and should be given some type of discount that might make it affordable for them. The sale of "season" tickets should be considered. This would encourage local communities surrounding KNR to visit more frequently and thus give the management of KNR the opportunity to acknowledge its neighbours and to help instill a sense of "ownership" and responsibility.

Large families and outings involving groups of children will be hard hit by the user charge and a smaller fee should be charged for children, or, even better, no charge for children should be considered. This would at least then allow for some of the functions, like birthday parties and school visitations, to continue.

People interviewed who were happy to pay for their recreation stated that the advantage of the charge is that it tends to keep out people who are generally undesirable, unemployed and vagrant types. However there are many people, not of this character, who cannot afford to visit frequently. Furthermore, most people who behave criminally occur away from the main entrances. Thus the recommendation is that people are charged per picnic site (R20), that hikers/strollers are allowed free entrance, and that right of admission is reserved by the discretion of the field rangers. This will follow a less exclusive policy, while at the same time securing the necessary funds and controlling admission.

Tourism should be promoted as a means of fund raising. This could alleviate some of the funding pressure imposed on the regular users of KNR. Some way must be found to charge tourists a separate, inflated fee, for example, through tour guide organizations and interpretive activities.

### 6.3. Total Economic Value

The estimate of the TEV of KNR compared to the cost of maintaining KNR (budget allocations) indicates that there is a huge incentive to maintain this open space. This is essentially a very conservative estimate and if the value of all the intangibles and the non-sustainable utilization value of KNR is included, then the net benefits of maintaining KNR as an investment would be more obvious.

Many people may be indirectly, adversely affected by the deterioration of KNR, even if they do not visit there. In general, deterioration of the Emolweni / Nkutu subcatchments could lead to problems of disease, soil erosion, fire and flooding and failure to preserve our natural heritage for the use of future generations.

The cost to the surrounding communities and to the nature reserve and all its inhabitants will be enormous and far outweigh the cost of providing for the budget shortfall.

Inventory lists of plants should be assessed for their horticultural and medicinal market value . The usefulness of this is that natural areas can be given a direct “cash” valuation and avoids the trap of trying to quantify intangibles.

#### 6.4. Integrated Catchment Management

The KNR Management Plan (updated 2003) contains all the necessary information needed to draw up a Catchment Management Plan (CMP) and should be integrated into the CMP for the entire Emolweni subcatchment.

The quantity and quality of water entering the Umgeni River from the Emolweni subcatchment depends on all the activities that impact on the various component parts of the subcatchment. This includes areas outside KNR, where there has been significant development. To manage this holistically, each component needs to be managed according to its own specific objectives, based on the situational analysis. A pro-active and integrated approach to environmental management is essential in order that preventative measures are taken (through the surrounding community) rather than the reactive way of dealing with the symptoms in and around the nature reserve.

Not only must the Emolweni River be managed from its source in Hillcrest to where it enters the Umgeni, but its tributary, the Nkutu, springs and feeder streams need to be monitored. This has become especially important now that the area is fast developing and that cluster housing is a popular development trend leading to increasing environmental pressure.

Since different problems or different values occur in different areas, the management blocks of KNR should be divided into different units for management purposes. Some units may be better demarcated functionally, geographically or based on research objectives. Other boundaries between units may be catchment or community, land tenure or topographically related. Management objectives should be based on a situational analysis of each block, determined from information gathering, inventory and mapping exercises and from forum decision-making. Criteria and indicators should be developed for each management block, leading to micro-plans and the drawing up of strategic objectives.

Resource Management Units (RMUs) may be identified within the Emolweni subcatchment and placed within a compatible GIS system. Each unit must be mapped in relation to the subcatchment. Available data on the unit, for example fieldwork, maps, documentation on development trends or housing density figures, positioning of green belt etc. need to be included in the situational analysis.

When implementing management tasks in these different units the backing of a fully representative Emolweni SMF will be required drawing on its expertise in cases where it is needed. Carrying out management plans will require team work as units will have multiple resource value. Forums must provide technical and academic assistance to problems and provide a networking base through which plans may be mobilised.

The extent of a RMU may depend on the extent to which specific objectives apply. RMUs (blocks) offer opportunity for comparative research and similar RMUs can be used to compare different combinations of control techniques. For example, the affect on the biota of the exclusion of fire for different periods may be researched on adjacent RMUs where different management objectives might apply.

The debate on whether to promote or discourage woody growth stands within the general management burning plan which is to maintain the grassland to forest ratio. Grassland is being replaced by development and forests have a history of extensive exploitation. Forest fringes naturally spread into and dominate grassland. Certain grassland species are of conservation significance and need to be preserved. RMU maps can help make informed management decisions. In invaded, degraded / insignificant grassland areas the policy might be to promote the woody component. If the indigenous vegetation is properly managed, then alien invasion will be reduced. Allowing the ecosystem to reach fire absent climax (after +/- 12 years without fire) will make an important contribution to the ecosystem.

RMUs need to be of a manageable size. Important factors to consider for this RMU are the fast developing urban environment, the extent of alien invasion along the water course, the status of the river banks and the degree of erosion, and any water usage or pollution producing practices. Since people who use water require to be registered, inspections along the length of the riparian zone are likely. The recommendation is that this inspection does not only involve the use of water, but the state of the riparian zone also needs to be noted, which, once more, might require teamwork.

These inspections must be done in the spirit of the constitution if co-operation is required. Friendly advice and assistance with subsidies for those who cannot afford rehabilitation costs are in order. User charges may provide the subsidy for areas in the vicinity of KNR whereas catchment funding can be used for areas that are further afield. Any assistance to property owners in the task of rehabilitation must be followed through in a professional manner, rubberstamped by the ESF.

An example of a RMU could be the Nkonka stream that feeds the Emolweni, which could be studied as a functional unit, from the springs that produce the stream, to the place where it enters the Emolweni. Fresh development around the passage of the Nkonka stream is impacting on the D'MOSS corridor shown in Plate 2-1. However, the "green belt" demarcation is limiting the development allowed. This limitation of development is resulting in conflict between landowners and council. Landowners need to be informed on the extent of "green belt" on their properties which should be attached to any subdivision or sale documents. A

proposal to develop cluster housing close to the Nkonka stream has resulted in an Environmental Impact Assessment (EIA) to determine the most appropriate sewage disposal option, one of which even considers the discharge of treated effluent into the Nkonka stream.

#### 6.4.1. Community Conservation

The KNR Management Plan (2003) advocates the need for inclusion of neighbors, and suggests participatory planning, controlled utilization of forest produce, open days and free entrance for neighbors, specifically bordering schools.

Poverty relief will reduce some of the pressures put on KNR for goods and services. This may be taking effect at the moment with the fast development that is occurring in the area. However, this development cannot be sustained as land is being used up and traffic congestion increases. There appears to have been no apparent reduction in employment seekers observed at the road sides.

The community levy obtained from user charges will be used to build a school and clinic in the Molweni area. Concern has been expressed (KNR NCO pers. comm., 2003) over the fact that more people will be attracted to the area with greater pressure exerted on the natural environment. This project should not be seen as add-on and the school and clinic could play an important role in other management objectives like environmental education and research. Pupils at the school whose parents are unemployed and/or have ethno-botanical knowledge may be identified and funds may be allocated for pupil study bursaries, parent training or employment in areas such as surveys and inventories. This is especially important for monitoring those areas where uncontrolled access is resulting in over-exploitation of natural resources.

Low income communities should benefit from the spin-offs of tourism. The option of employing / training people as trail guides would be suitable for tourists and should be introduced.

Another opportunity offered by the nature reserve is the development of an indigenous nursery. The three formal entrances should be used as outlets, but to keep within the non-competitive spirit, craftwork (promoted by KNR Management Plan) should dominate. Due consideration to the medicinal properties of the available plants needs to be given since there is a large market for these in the Molweni area and cultivation will ensure their sustainable use. The specific focus of cultivating medicinal plants should be practised in order to compensate for some of the losses reputed to have happened in some areas of KNR. Custodians should benefit from training in propagation of protected plants like from the course offered at Silverglen Nursery. The horticultural value of plants can be used as a substitute for medicinal value and may provide an alternative group of plants for exploitation thus relieving the pressure on threatened medicinal plant species.

The market for other indigenous plants, unless they are food producing, would mainly be amongst the more affluent communities. Wholesaling to nurseries should be considered. This should not be an add on project,

but should have its growing/gathering, marketing and delivery firmly entrenched within the networking capacity of the subcatchment forum. This will ensure that nursery stock turns over. Forums need to popularise and network the availability of indigenous plants and the nursery should be a source for rehabilitation projects by the forums. For example where the riverine forest needs to be re-introduced, the nursery should provide the necessary precursor (*Bridelia* or *Macaranga*) or *Trema* for general forests or the appropriate riparian vegetation required for the enhancement of water quality and quantity. Selling plants to the public plays a role in extending the DMOSS concept as well as ensuring an indigenous choice over an exotic. The result would be that transport of seed into KNR from the surrounding communities would entail more and more indigenous seed as opposed to exotic.

Where possible, an indigenous nursery should be established together with an alien control program so that once alien invasion is under control, a funding base may continue to be made available. Areas with a reasonably large infestation should be chosen in order for there to be enough disturbance to release the nutrients to support dense patches of seedlings. The specific area chosen should be as close as possible to the community involved in the project and any fundraising may need to take transport costs into account. The operational position for such a venture should be at the forest fringes of KNR, relatively accessible, close to community areas, and close to water. At the forest fringe there is sufficient light for significant alien invasion and enough indigenous seeds and seedlings to replace the invasive vegetation.

Continuously working over these areas in follow-up operations will produce enough indigenous vegetation seedlings to help keep out alien vegetation and to establish an indigenous nursery in a sustainable way. The initiation of succession in RMUs with similar objectives should occur at different times to ensure that species at different stages of the successional cycle are available for sale from the different RMUs. Succession can be used to promote the recruitment of a species with good market value. The nursery itself will need limited outlay, mainly in the purchase of growing bags. Although soil may be harvested from sloped areas, for example in the formation of steps and paths, it is recommended that soil-building projects be included to provide holistic educational training. The soil should be obtained at the place where the nursery is to be established since the soil used for planting in growing bags should ideally come from the soil from which the seedlings are removed.

If the nursery is to be established on site where water is absent then it should be done during the rainy season, with saplings removed during their growing period. The forest itself will provide natural shade for the plants in the growing bags.

The following steps should be taken:

- a. Prepare and submit a funding proposal for an initial survey to conduct inventories and to identify and map vegetation of forest fringes that have alien infestation. The funding proposal should be submitted to the CMA, the Green Trust, WWP, and the Conservation Trust.

b. Identify and visit accessible forest fringes with significant alien invasion (April to June). This should be done in conjunction with the NCO and must be done while waiting for the funding proposal outcome. Funds for the task could come from the community levy on user charges. Proof of vehicle use should be collected e.g. speedometer readings or petrol slips during this period. The budget for vehicle running costs is low and funds need to be allocated for this task.

The education and training of the stakeholders involved in this project with regard to the identification of and distinction between alien and indigenous vegetation, and the conducting of surveys and inventories, development of criteria and indicators, should be done during this period.

Conservancies in the respective areas and other NGOs and people with indigenous knowledge should play a role in this education. Training in tree felling practice and in the use of petrol-driven and bow saws could take place as well as the art of plant cultivation.

c. Prepare and submit an alien removal funding proposal to the stated potential funders, based on the findings in b.. Costs of labour and tools and materials development and printing need to be included. It is recommended that, where possible, while the outcome of the proposal is being waited for, allocated community levies be channeled into training, tools and labour required for the identified areas. Once again a record needs to be kept in order to reclaim the finances. Hopefully much of the training will be offered free by the community-based organisations.

d. Between June and September, again visit the identified target area, note the type and extent of invasion and decide on the method of alien removal required for each particular area. Tree felling and the preparation of bundles of firewood can take place at this time. Also do inventories (hopefully funding would now be available), making notes on the diversity of the indigenous vegetation and determine that which is most prominent and which has the most potential to be removed sustainably.

e. Purchase the growing bags suitable for the particular identified plants. A percentage of the funding for labour costs could be used if the funding is available.

f. From October to November, during the start of the rainy season when the earth is soft, remove the aliens (hopefully funding would now be available), take another inventory of the indigenous vegetation and remove sustainably that which is of a saleable size. Leave the area for a period of 2 - 3 months to give it a chance to rehabilitate. During the period of removal and rehabilitation, the indigenous nursery should be established and further education and inspections of other areas can also take place.

g. One year later (March), remove the newly formed alien seedlings, observe which other indigenous seedlings have grown (repeat inventory) and place in growing bags that which is in excess.

h. In winter limited clearing may be necessary due to slow growth rates and new areas may be dealt with. By Spring some of the nursery plants will be available for sale, and may be removed directly from the ground whenever they have reached saleable size. It is recommended that indigenous groundcovers and shrubs and some trees should be sold during their flowering period as they become more saleable.

Although the KNR nursery does supply popular plants, plants with low “gardening” value are also grown from seed. Stock with known retail value should be concentrated on and, where possible removed from the ground at saleable size, otherwise water could be wasted on “non-saleable” stock and/or time to reach “customer” maturity, especially when growing from seed. Small *Bridelia micrantha* trees were observed in the KNR nursery, too small for an easy sale to customers. Close to the nursery a *Bridelia micrantha* sapling had become established, outside the grass cutting area, and reached “customer” size, but was left untouched. The recommendation is that fewer of the less popular trees like *Croton sylvaticus* should be grown from seed and that a greater variety of trees should be introduced especially those that have been shown to be popular from the marketing study. Where possible, trees should be taken out of the ground where they are unwanted and placed in a bag for sale when they reach between 1 and 2 meters high. A slightly bigger bag is recommended in order for trees to get to a more saleable height. Laws against removing vegetation from nature reserves will have to be circumvented or revised to reach stock of saleable size. This should not be much of a stumbling block since this practice is more beneficial than that of fire and herbicidal application that kills indigenous vegetation. Popular sellers should be established in the landscaping additions of recreational areas in order that a continual supply of stock is available. The use of *Clivia miniata* around the nursery has been noticed. The addition of *Scadoxus puniceus* should be considered.

Schools all along the catchment areas and near the forest fringes should be encouraged to participate in the described projects, hopefully representing all the surrounding communities. Schools in the Outer West should be approached to involve themselves in researching the extent of alien invasion within KNR and within the surrounding community. Educational budgets have also been cut and schools are short of cash. If some of the alien control responsibility is transferred to schools in the form of a funding proposal then they could also benefit financially. The capacity amongst forum members to write up the proposals should be assessed as well as their ability to transfer this knowledge to schools and other community members.

The provision of employment plays an essential role in protecting the value of KNR (reduces crime and produces income, relieving pressure on the reserve resources). The unemployed, specifically, should be targeted for involvement in management projects since they may be the ones gathering forest produce to fill an economic need. Granting of custodianship to “neighbors” and the incentives or rewards offered for active participation in management activities will help with the broadening of stakeholder involvement and

representation and the channeling of funds to the needy. Keeping in mind the broader subcatchment, there is a need to base the custodianship and active participation, not only in and around KNR, but from the source of the Molweni river (Hillcrest) and associated streams to the point where it enters the Umgeni, i.e. right throughout the subcatchment area.

For example, custodians should have “policing” rights within their particular RMU to ensure that property owners whose vegetation may impact negatively are made aware of this influence and may be approached to have their property area controlled. In order to develop “policing” rights the forum would have to be elevated to committee status. Already formed “street committees” play a similar role which could possibly extend to the next “streets”.

Custodians should also be given the “freedom of the Reserve” (as opposed to street committees given freedom of the “city”) which would entail measuring and maintaining the ecological integrity of the allocated area. They should be exempt from paying user charges and should be given the opportunity to carry out research and make available their findings to the media and academia.

Their activities should lie within the overall CMS and inspections by the management from time to time could lead to the granting of a certificate and the possibility of expanding the area of control (include another RMU). The responsibility bestowed upon these stakeholders will ensure that they also clean up their own house and educate other community members (parents and neighbors).

The ESF should take over the responsibility of plot clearing if notice is given and the plot owner fails to respond since the methods used by the local council are not long term effective. Specially trained people can then assist in recommending the most cost-effective removal and best management practice. Furthermore, the ESF should assist the local council in identifying RMUs, for example, those of particular ecological significance, in terms of conservation cells or corridors and unique habitats etc. This can be done in conjunction with a training program for the recognition of invading plants and valuable indigenous plants.

Community needs should be researched to facilitate the appropriate allocation of the community levy to various projects. Future community levies should be prioritized for employment and training. For example, part of the user charge could be allocated to community development projects for the training and purchasing of equipment required for tree felling, alien removal and research activities. Vehicle running costs will need increased allocation. Funds for subsidies to promote the fulfillment of certain management objectives should be considered.

#### 6.4.2. Alien invader control

Monitoring of RMUs and reporting on alien invasion pockets will provide information on the extent of alien invasion in areas outside KNR. This will help in monitoring the source of invasion into KNR. Household

owners can be reached through surveys conducted by schools. Property owners bordering KNR could be offered subsidies on their rates as an incentive to alien plant removal.

This type of research can then be presented to the forum that can provide the necessary expertise to deal with the particular problem. Conservancies and the council could report to the same forum on the extent of alien invasion in public areas.

Funding for the alien invader control program can be obtained from user charges. Although support from WWP would be helpful, the loss in indigenous plants in areas where they have worked and their limited recruitment of local gardeners makes the other option, training and development of alien control specialists amongst local people better since besides providing local income and using local knowledge, the skills may be carried back to the community. Payment for piece work that depends also on sensitivity to the damage of indigenous flora should be considered.

Print media coverage on the alien vegetation problem is extensive and does a lot to educate the public. However, the focus is mainly on the adult reader and may or may not filter down to the children who are our future custodians.

The adult reader is generally white of upper or middle economic status and falls short of the Molweni and Wyebank communities. Thus there is a large proportion of people who are not educated about the threat of alien vegetation who need to be reached. Many of these people are illiterate and print media would not suffice.

Funding allocation for multilingual materials development projects at schools aimed at alien invader education would further advance the educational cause amongst the youth and hopefully filtering through to adult audiences, who often participate in school projects. Competitions should be organized with indigenous plants or a "season ticket" to KNR as prizes.

Envirokids magazine, published by WESSA, is the mouthpiece of conservation for the youth and should be utilized more at schools. Pull-out worksheets for teachers are included and the publishers cleverly introduce this to teachers by requesting the purchaser of the magazine to give the worksheet to the teacher. Articles on alien vegetation control could well be emphasized.

The recommendation is that the local community be reached through their children through the schools. Children, especially need to be targeted as they need the basic grounding to act as future custodians. Alien identification and removal, indigenous and medicinal identification, life cycle study and cultivation could provide the practical base to realize certain outcomes in the school life sciences curriculum. The local conservancies could play a part in imparting some of this knowledge.

KNR contact with two schools in Molweni have taken place. The one attracting pupils from Wyebank and Clermont should be pursued and the introduction of the alien problem into the curriculum negotiated. The same must be done for the schools in the other surrounding communities.

The alien “invader” vegetation theme can lend itself to cartoon strips and other forms of popularisation and materials development that could be taken home, e.g. in art or creative class. However, careful consideration should be given to the type of information supplied in this theme as it may lead to false impressions of the true nature of alien invaders and control methods.

Networking amongst groups of people involved in various educational functions and the mapping of outreach programmes are essential for providing strategic, quality, up to date, provincial (or national) education for schools or local communities on environmental awareness.

The education on alien invader control should not be dramatized as done in some print media, but should be taught scientifically, firmly imbedded in the school curriculum. The image of swinging pangas and spraying herbicide as the dominant training program takes something away from the subtle art of alien control and may impact severely on the management of the intertwined indigenous vegetation since these are generally uprooted with the invaders. Destruction of indigenous plants will result in less vegetation available for use and less available to compete with re-invading alien plants. Thomas Berry has this to say about the way which man should approach nature (Berry, 1988), i.e. “The spontaneities of nature should be fostered and not extinguished”.

The use value of alien invaders has not been neglected and has been written into management plans. Whether for subsistence use, cash for goods and/or employment opportunities, these proposals will play an important role in the control of alien vegetation. The ESF could co-ordinate activities that would see eradication of invaders on private and on public land. Larger exotics may require tree felling and possible poison application. Bundles of firewood from the larger alien trees like gums, pine and black wattle that are felled in clean-up operations should be purchased from the community involved in the alien control program and sold to the public at the main entrances (together with plants and crafts) or provided free as compensation for user charges. Persistent aliens with roots unable to be removed might need chemical treatment. Large gum and pine trees may be sold to people who do on-site planking or the equipment and training for this skill may be provided. In particular, the unemployed could involve themselves in exotic tree felling, the cutting and bundling of firewood and sale of the produce, together with the development of a nursery for muthi and other sale plants.

A comparison must be done between the costs of mechanical vs chemical control. The comparative costs can be estimated for different RMUs, and the appropriate technique or combination employed, supported by

management objectives. Mechanical control is labour intensive and has been shown in one study to be twice the economic cost of herbicidal control for densely infected areas. The high cost is *labour*, but a national problem is *unemployment*. Furthermore, the opportunity of returns from nature during successional processes from mechanical disturbance can offset some of these extra costs as this study has shown. The cost of environmental degradation following herbicidal application should also be considered.

The use of fire as a control technique should be based on the objectives of a particular RMU. Fire should be more frequent (annual or biennial, Spring), with herbicidal back-up, where the objective in the RMU is to promote grassland and less frequent, +/- 12 years, with mechanical control back-up, allowing ecological systems to reach a natural climax. Fire may be used to initiate succession in RMUs or large-scale mechanical disturbance should be used. The financial returns from plants generated by mechanical disturbance where handpicking dominates should be included where the costs of herbicidal control of a similar area is compared.

If handpicking is used as a mechanical control, workers must ensure that whole plants with their roots are removed from the ground. The removed vegetation should be stacked in one area to prevent dispersion of root/stem and seed over too large an area. The area for stacking should be first cleared of any alien vegetation that could grow into the stack and the place for stacking should be mostly devoid of any indigenous vegetation that could be smothered (except large grasses). The removed vegetation should be allowed to dry out and break down and will eventually return to the ground. Drying racks for removed invaders could be built to maintain the roots/stems in an aerial position. The same area worked on needs to be continually serviced with follow-up operations. The area covered per worker should be manageable and fall within the work-rate pattern, and workers need to be trained in distinguishing indigenous plants and trees from alien invaders. The distinction should be made from seedling to mature plant stage. The ongoing nature of this project should provide continuous employment for a particular designated area over a few years.

Many of the public open spaces are invaded and this takes away the little bit of muscle that the council has over landowners with invaders. Knowledge of invaders in public areas surrounding KNR may be provided by verge cutters if they get the necessary recognition training. Some of these workers may also be trained to do alien removal work or other alien control specialists can be brought in once the report has gone through the forum.

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