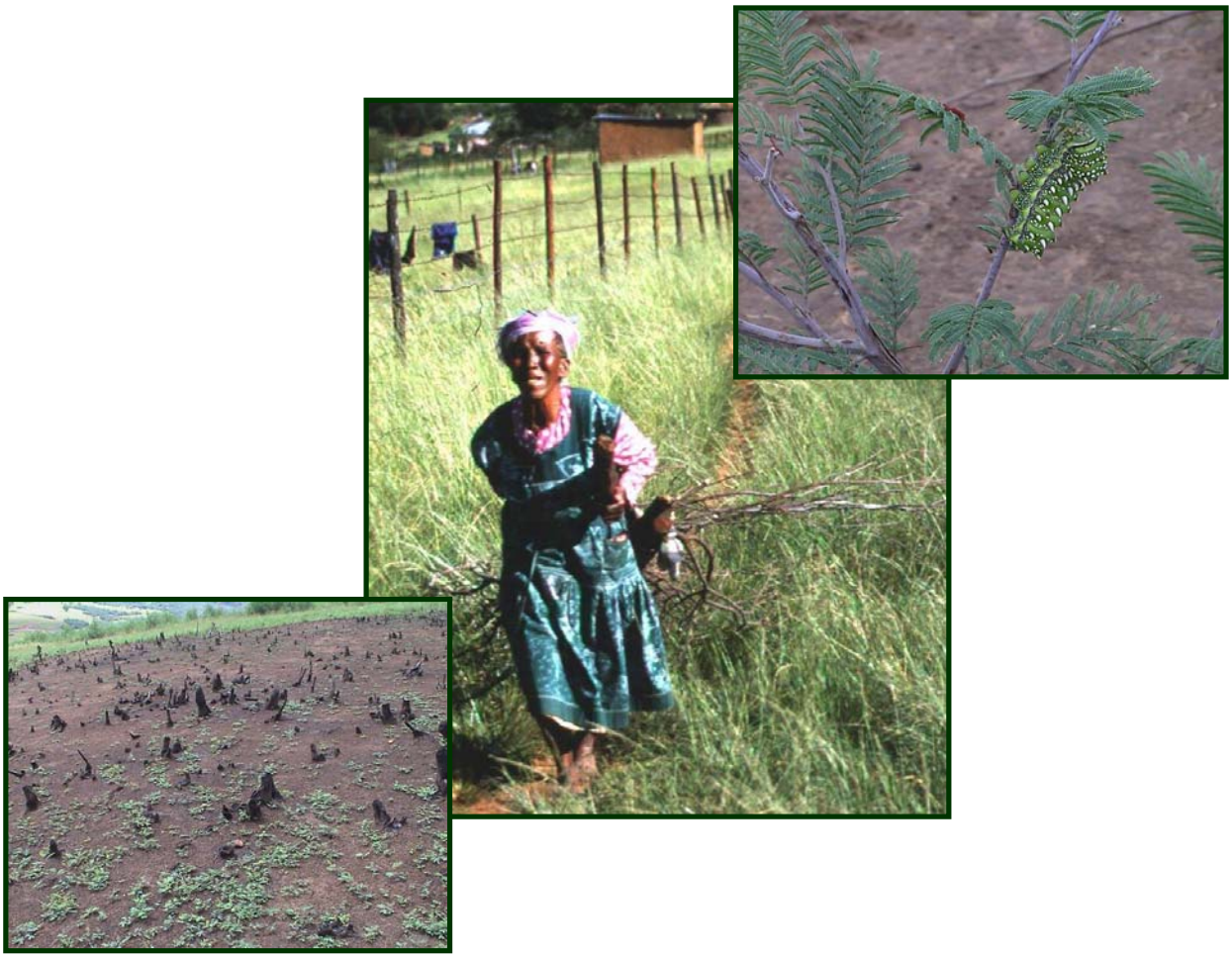
Future Prospects and Limitations for the Sustainable Management of Wattle and Its Possible Alternatives



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Pictures on front page

Branch of wattle tree with larva (de Neergaard)

Local woman collecting wattle for firewood (Moshøj)

Eradicated wattle with new sprouts in between (de Neergaard)

Table of Contents

Abstract *4*

Introduction *5*

Research Objectives *8*

Study Area *9*

Location 9

Social factors 10

Climate 10

General soil characteristics 10

Dominating vegetation 11

Methodology *12*

Participatory mapping and Transect walk 12

Semi-structured household interviews 12

Semi- and un-structured interviews with key-informants 13

Habitat analysis 14

Infiltration capacity 16

Measuring erosion 16

Soil Sampling and analysis 17

Results *19*

Participatory mapping and Transect walk 19

Semi-structured household interviews 19

Semi- and un-structured interviews with key-informants 25

Habitat analysis 31

Infiltration capacity 32

Measuring erosion 32

Soil Sampling and analysis 33

Limitations and Sources of Errors *35*

Participatory mapping and Transect walk 35

Semi-structured household interviews 36

Semi- and un-structured key-informant interviews 38

Habitat analysis 38

Infiltration capacity 39

Measuring erosion 40

Soil sampling and analysis 40
Discussion *41*
Conclusion *48*
Acknowledgements *50*
References *51*

Appendices

Appendix A: Semi-structured interview guide for the households (1st version)

Appendix B: Semi-structured interview guide for the households (2nd version)

Appendix C: Semi-structured interview guide for key-informant with academic or administrative role in relation to the WFW-project

Appendix D: Semi-structured interview guide for key-informant working with the wattle

Appendix E: Location of vegetation transects

Appendix F: Miniature reproduction of the map applied during household interviews derived from participatory mapping

Appendix G: Cross tabs made from household interview results

Appendix H: Calculation of plant diversity in each vegetation area

Appendix I: Carbon, nitrogen, phosphorous and pH-values for each vegetation area

Appendix J: Difference between timber from wild growing wattle and wattle growing in controlled plantations

Appendix K: Schedule of tasks in the field

Abstract

South Africa's recent political transformation has led to a change in the way the environment is managed, focusing more on integrated management changes. Water scarcity is one of South Africa's major environmental and social enigmas, and much emphasis is now placed on effective water use, conservation, environmental protection and sustainable water resource management. The invasion of alien species is believed to reduce catchment flows, as well as having a negative impact on the native flora and fauna and encroaching on land designated for other use. The national Working for Water Project (WFW), a multi departmental government initiative, has implemented nationwide programs to control invasive alien vegetation and address water scarcity. In the rural village of Makomereng, in Eastern Cape close to Lesotho and the KwaZulu-Natal borders, two species of wattle, silver wattle (Acacia dealbata) and black wattle (Acacia mearnsii), are considered invasive alien species and an aim for eradication under the WFW. We conducted a small scale project, the aim of which was to investigate the conditions, environmental constraints and limitations for the sustainable management of wattle under the consideration of the wishes and needs of the locals, who view the wattle not only as a liability, but also as an asset. The results indicted that wattle is an important resource for the locals, and must be conserved in certain areas for utilization. Furthermore it seemed that the locals lacked a sense of empowerment over the areas where the WFW was conducting eradication, as they were not part of the decision making process. The bio-physical environment poses some limitations for the future use of the eradicated areas. The soils are in general acidic, with low phosphorous contents, and furthermore, other vegetation may not be able to compete with reinvasion of wattle. Planting wattle in a plantation or woodlot form seemed the best alternative way to secure the locals' needs while taking bio-physical and socio-economic constraints into consideration. Furthermore, when planning for the management of the wattle and the eradicated areas communication between the different parties involved is essential, as is creating incitement for the locals' participation even when subsidization has ceased.

Introduction

South Africa's recent political transformation has also led to a change in the way the environment is being managed. This change is reflected in new legislation and focus on integrated management practices. In South Africa water scarcity is an immense environmental and social enigma. There are few major groundwater aquifers. At the same time, the natural availability of water from rainfall across the country is highly uneven, and most of the country has high within-season variability of rainfall. Thus streamflow in South African rivers is at relatively low levels most of the year, with sporadic high flows (Department of Water affairs and Forestry 2002). Due to the water scarcity, as well as economic constraints, much emphasis is now placed on effective water use, conservation management, environmental protection and sustainable water resource management (van Zyl 2000).

As a direct effect, a National Water Resource Strategy (NWRS), focusing on the sustainable use of the country's water resources has been developed. To meet the goals of the NWRS a number of projects have been initiated, among which the control of invasive alien vegetation is one. This is being done through the national Working for Water Project (WFW-project), a multi-departmental initiative led by the Departments of Water Affairs and Forestry (DWAF), Environmental Affairs and Tourism, and Agriculture, launched in 1995 (Department of Water Affairs and Forestry 2003).

According to Scott et al. (1998b) the concern about alien species as an enigma in South Africa emerged during a drought period in the 1920's. There was concern and conflict over the possible impacts of the extensive planting of trees on the amount of water in rivers and streams. This resulted in the establishment of a South African hydrological research program which showed that commercial plantations reduced the total annual runoff from catchments in proportion to the area planted and depending on tree type. Subsequently, several assessments of water flow reductions caused by alien tree species in South Africa presented by, Scott et al. (1998b) and Le Maitre (2000), amongst others have confirmed that in catchments where alien species have invaded the native vegetation

overall catchment flows are reduced. The incremental water use of alien invaders in South Africa and Lesotho is an estimated 3300 m^3/yr (6.67% of the mean annual runoff) (Le Maitre 2000). Not all alien plants use more water than the natural vegetation they replace. The greatest impacts occur when seasonally dormant vegetation is replaced by evergreen species. Hence, where grass- or shrub-lands are invaded by alien trees the overall water used by the vegetation increases (Moran et al. 2000). When alien trees do utilize more water than the native trees this could be because the latter often has smaller leaf areas, and thereby uses less water for evapo-transpiration (CSIR).

In the study area, wattle trees, silver wattle (*Acacia dealbata*) and black wattle (*Acacia mearnsii*), are considered invasive alien species and an aim for eradication under the WFW-project. These species were first introduced in South Africa about 150 years ago. They were introduced into the commercial tree-growing industry on big farms. The seeds spread fairly easily, especially by streams and rivers (Witt 2002). Out of the approximately 8.28% (10.2 mil ha) of the land area in South Africa and Lesotho which is covered by alien species about half (4.7 mil ha) consists of wattle species. Thus, as a group the wattles are considered the prime water users, accounting for 55% of the total water used by alien species. Black wattle alone in total occurs on a 2.5 mil ha area (Le Maitre 2000). Wattle though, is known for its ability to grow well in dry areas which suggests that it regulates its transpiration when water becomes limiting, as do pines (Scott 1998b). Therefore, it has not been proven that specifically wattles reduce streamflow, as it has been proven with eucalyptus and pines.

South Africa has an unusually high level of biodiversity, and besides using great amounts of water there is a concern that alien species have a negative effect on the native flora and fauna. It has been expressed by Mondlane et al. (2001) that alien species can eliminate several thousand species if spread is not controlled, seriously affecting the status of ecosystems. Increased extinction rates and loss of biodiversity from alien plant invasions, particularly from pines, eucalyptus and wattles have been reported for the species-rich Cape Floral Kingdom (Moran et al. 2000). Also, certain invasive trees have caused major modifications to the montane communities of the fynbo biome (Fox 2000).

Another environmental concern in South Africa is human-induced soil degradation, and erosion has been described as the biggest environmental problem of this country. The country's soil loss due to human-induced soil erosion is estimated to be 20 times higher than the world average. A factor underlying this problem is the large proportion of unstable soils, intense rainfall, and high temperatures causing fast decomposition of organic matter making soils quite unstable, and many areas with steep slopes (Fox 2000). Therefore, where trees are eradicated, which involves considerable disturbance and exposure of the soil surface, much care must be applied in managing these areas in order to prevent resulting damage greater than or equal to the initial problems aimed to resolve by the eradication (Scott et al. 1998a).

In Makomereng the WFW-project was implemented in 1997. The main aims of the project are twofold; to eradicate alien vegetation and to invest in the marginalized sectors of the South African society, specifically by tackling the problem of unemployment. The end goal of the project is to leave a legacy of local empowerment, social equity and legislative, institutional and technical capacity. The local non-governmental institution, the Environmental Development Agency (EDA) has additionally implemented a Community Based Land Management program (CBLM); the aim of which is to focus more on developing practical and cost effective wattle management approaches, for use by local groups without dependence on the WFW-project budget. Also, the EDA is of the opinion that wattle serves as a valuable resource in the local community (Reay-Mcleod 1999), and according to prior investigation it offers significant social services as well as income for the locals (Dahl et al. 2001). Thus, the wattle is both a liability and an asset. In compliance with the locals' wishes and needs as well as environmental conditions and limitations it needs to be clarified what the possibilities are for long-term sustainable[1] management of the wattle, how the areas where wattle is removed should be managed, and how these aims comply with the present socio-economic framework while creating a basis for future improved socio-economic development in the area.

[1] Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Mather & Chapman 1995).

Research Objectives

Main objective

Considering both wishes and needs of the locals, as well as environmental constraints and limitations, what are the conditions for the long-term sustainable management of wattle? Furthermore, what are the possible alternative types of vegetation for the areas where the wattle tree is or has been removed?

Focus questions

1) How is the present distribution and utilization of the wattle tree and other vegetation types that are perceived as resources in the village area?

2) What are the locals' perceptions of the wattle tree, other vegetation types in the area and possible new alternatives? Do the locals feel that the present occurrence and distribution of available plant species fulfil their needs? Do they see any major problems? Would they like anything to be different? And how does this fit into the socio-economic framework?

3) What is the status of the local bio-physical environment? Does it pose any limitations? How is it affected by the present vegetation? Can the bio-physical environment sustain desired plant species?

Study Area

Location

The study area is in Makomereng (Figure 1), a sub-village of Madlangala. It is situated on the Drakensberg mountain slopes in the North Eastern part of Eastern Cape Province, close to the border of KwaZulu-Natal province, as well as the Lesotho border. The nearest large town is Matatiele, 40 km southeast in KwaZulu–Natal.

Figure 1: Location of Study Area (Source: Encarta World Atlas 1999)

Social factors

The area used to be part of homeland. During the Apartheid Government these were the only places where black people could get access to land. The State owned the land, but people were placed under the jurisdiction of chiefs (Adams 1999). In 1999 the Eastern Cape's share of South Africa's poverty gap (the money needed to alleviate poverty from all poor households to a minimum living level) was more than 24%, making it the province with the highest poverty gap (Adams 1999). The unemployment rate in Madlangala is 79% (SA explorer 2000); partly due to retrenchments occurring nationwide. People live off remittances and pension grants and a large part of the income to the village comes from men who are migrant workers (Bob & Banoo 2000). 28% of the population is in the working age group (SA explorer 2000). The population estimate of Madlangala is 8000 people (Reay-Mcleod pers. com.). The average illiteracy rate in rural South Africa is 50% (Underwood 2002).

Climate

The climate is temperate with well-marked seasons. The rainy season occurs from October to April where 85% of the rainfall occurs. The mean annual precipitation is 710 mm, with the median rainfall in January reaching 119 mm, while in June; the median rainfall is only 2 mm. The hottest period is from January to February, where the mean temperature is 19˚C, and the solar radiation is 31.2 MJ/m^2/day. Snow occurs in the highlands from May to September (SLUSE Homepage).

General soil characteristics

The dominating soils of this area are generally deep, highly weathered, and well drained (Fox 2000). The soils are typically leached forest soils that have relatively high native fertility or are highly weathered containing few weatherable minerals. Although most of the soils have extremely low (native) fertility, they can be extremely productive soils with

inputs of lime and fertilizers (University of Idaho & FAO-UNESCO Soil Order Map of the World). The measure of average plant available water is 75.4 mm, although the variation may be great dependant on soil zones (SLUSE Homepage).

Dominating vegetation

The vegetation around the village is mainly woodland, cultivated land, and grassland. The woodland is found east of the village. This is mostly made up of wattle trees (black and silver wattle) growing in the vicinity of the Makomorin River and its tributaries. Indigenous Protea trees (*Protea spp.*) grow at higher elevations, especially on the slopes east of the village.

Otherwise the vegetation consists of grassland, which is the dominating original vegetation according to the major biome of the area (Fox 2000). South, east and west of the village there are cultivated fields. The crops are mainly maize, sorghum, wheat, potatoes, tomatoes, onion, cabbage and pumpkin. Besides cultivating their fields, many households have homegardens, where they grow a number of different crops and fruit trees.

Methodology

Participatory mapping and Transect walk

A participatory mapping and a transect walk, were applied with the intention of attaining a map illustrating the present distribution and utilization of the wattle along with other vegetation types perceived as resources in the village area. The goal was a map illustrating the village of Makomereng and the surrounding vegetation, which was to be applied during the household interviews. The household informants were to point out which types of resources they collected in which areas. The mapping was performed twice; both times with an older man selected on the basis of his knowledge about the village, with help from the group interpreter. After the first mapping the group went for a transect walk through the village area with the group guide and interpreter in order to verify the map, and make corrections. Finally, the two maps were combined by the group into one map, where specific grass, wattle and eradicated areas were named, numbered and filled into the interview guides for the household interviews.

Semi-structured household interviews

Also for investigating the present distribution and utilization of the wattle tree and other vegetation types perceived as resources in the village area, as well as examining the locals' attitudes on the wattle tree, other vegetation types and possible new alternatives, semi-structured household interviews were conducted.

22 interviews were conducted as a sample representing the village, which consists of approximately 95 households (Dahl et al. 2001); thus about one fourth of the households were interviewed. The households were chosen by walking around the village and choosing every other or every third house depending on who was home. While it was up

to the household members initially to decide who should be interviewed, the aim was to interview an equal number of each gender. Therefore, on the second day, households where men were at home were sought out, since these were underrepresented in the interviews the previous day.

Before applying the interview guide, a trial interview was conducted with the group interpreter with the purpose of testing suitability and clarity of questions. The interview guide was partly qualitative since it contained open ended questions (Casley 1988), but it also had parts that were structured as a questionnaire, and was therefore also somewhat quantitative. The interviews were conducted over two days. After using the interview guide the first day and experiencing what worked and what did not, it was revised for the second day (Appendices A & B). Following, the interview guides were transcribed, and the results entered into a database, each interview representing a sample in the dataset, where answers to the quantitative questions could be related to gender, age and occupation, while the qualitative answers were recorded without meaning categorization (Patton 1980) as comments in the database.

Semi- and un-structured interviews with key-informants

Key-informants were interviewed for the purpose of obtaining qualitative information on the local bio-physical environment, their impressions of the locals' opinions and needs, as well as their personal opinions. While some of these interviews were planned during the initial preparation for fieldwork, several of them were set op following information that we obtained while in the village.

In general, prior to all interviews, the purpose of the interview and the topic that we wished to investigate were denoted. The extent of detail of the design of the interview guides varied between interviews. While detailed interview guides had been prepared for some of the interviews, for others, only a few key questions had been prepared. At the on-start of the interview, the purpose of the interview was presented to the respondent.

All interviews were exploratory, as it was the intent to gain as much information as possible from the respondent. The individual answers were pursued by follow-up questions. At times when the respondents seemed to focus on less significant factors, it was attempted to prompt or probe the conversation back on track. In some cases, interpreting questions had to be asked, where the respondent's statements were clarified and interpreted, and then disconfirmed or confirmed by the respondent. Subsequent to the interview, the interviews were transcribed, and analyzed. The analyses of the interviews of the key-informants were done by first writing up a summarized version, meaning condensation (Patton 1980) of each interview. The interviews were then grouped into two main groups, one group consisting of the three key-informants who had an academic or administrative role in relation to the WFW-project and wattle eradication, and one group consisting of the four key-informants, who were mainly local villagers working with the wattle at a more hands on level (Appendices C & D). The statements of the respondents were categorized under the major themes discussed during the interviews, the reliability and the validity of the information obtained were assessed, the meanings interpreted when necessary, and the results were transcribed.

Measuring the status of the biophysical environment

The following methods, habitat analysis, infiltration capacity, erosion measurements and soil sampling were all conducted at three sites; an eradicated area which had been cleared of wattle trees approximately two years previous, an area with wild growing wattle, and a grassland area which reflected the original vegetation prior to wattle invasion.

Habitat analysis

The diversity and abundance of plant species were measured in the three habitats with the objective of measuring the effect of wattle invasion on the diversity and abundance of species, as well as to identify changes in the regime of species composition and

abundance in regeneration areas in comparison to the non-encroached habitats. Plant species composition was measured along straight line transects (Figure 2). In the eradicated and grassland areas, the transects were 200 m long, while in the wattle area, logistics prevented completion of a transect longer than 100 m. The length and geographical longitudinal and latitudinal positions of the transect were recorded by use of a handheld Garmin 12 GPS navigator (Appendix E). Species abundance and diversity was measured using "pin point analysis" (Post & Bøving 1993) where a metal frame one meter long with 10 evenly spaced holes (10 cm apart) through which metal pins are fitted, was set down at evenly spaced intervals of 10 m, each of the pins dropped, and the species touched by each pin was recorded. Each subplot measured along the transect therefore represented 100 cm of habitat perpendicular to the transect line. For each pin drop, the name of the plant was recorded at species level when known, or the specimen was collected, labeled with frame and pin number and brought home for identification. Unknown species were identified by field guides (van Oudtshoorn 1992 & Pooley 1993 & Pooley 1998). When species identification was not possible, identification was done to family or genera. Consecutively, the Shannon-Weaver diversity index was calculated to give an index of the diversity of species in each area (Fog 1997).

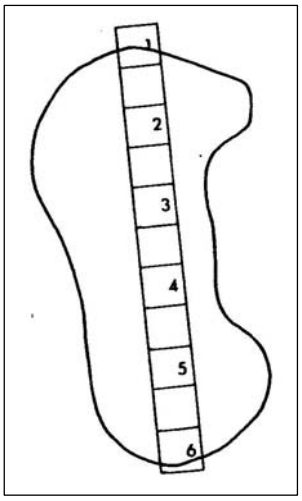

Figure 2: Sampling method applied in the field for habitat analysis (Økland 1998)

Infiltration capacity

The infiltration capacity was measured to evaluate the potential for erosion on the three sites. The infiltration capacity is the rate at which the water can enter the soil (Brady & Weil 1999). Most water that reaches the soil penetrates downward by the process of infiltration, especially if the soil surface structure is loose and open. If the rate of rainfall exceeds the infiltration capacity of the soil, the excess water unable to penetrate will begin to pond on the soil surface, and thereby causing runoff, and erosion may take place (Brady & Weil 1999). The measurements of the infiltration capacities on the three vegetation areas were done twice over two days. A metal infiltrometer with a diameter of 10 cm was pushed 5 cm into the soil, in order to prevent the water from running horizontally instead of vertically. It was filled with 600 ml water and after every one minute it was recorded how much water had infiltrated through the soil in millimeters. When the infiltration capacity had stabilized it was assumed that the point of saturation had been reached. The capacity of infiltration through saturated soil was then compared.

Measuring erosion

Direct measurements of erosion under natural rainfall conditions on all three study sites were performed, in order to determine differences between habitats. This was done by digging two plastic rainfall gutters (100 cm * 15 cm) into the ground perpendicular to the slope on each study site. Each site had one gutter placed on a low incline and a high incline. Following rainfall, all material accumulated in the gutters was collected and dried at 150 °C before weighing. Rainfall was measured using a gauge placed in an open field during the erosion measurement.

Soil Sampling and analysis

Soil samples were collected and analyzed for attaining information on the general soil status in the area, as well as for deriving knowledge on whether the pH-values and the nutrient compositions differed significantly between the areas. This could give an indication of whether the wattle has a certain effect on soil properties as compared to the grass. Furthermore, the soil status is a parameter which should be taken into consideration, when deciding what to plant on the areas where the wattle is eradicated.

Samples from top-soils were collected at the three vegetation areas and brought to Denmark for further analysis. Three soil samples were taken from each area. It is commonly recommended to take at least 10 samples on each area depending on the type of soil and size of area (Voelcker Consultants Environmental Science). However, due to limited time and space, since samples had to be brought to Denmark, only three samples from each site were collected. The samples were taken along the vegetation transects, one at each end and one in the middle.

The samples were tested for pH-values, and contents of carbon, phosphorus and nitrogen. The nutrient contents were measured as they are primary macronutrients; essential elements used by plants in relatively large amounts (Brady & Weil 1999). The carbon contents were measured for an indication of the soil organic matter (SOM) (App. 58% of SOM consists of carbon (Brady & Weil 1999)) because its presence is important for several reasons: It increases the soils water holding capacity and thereby the proportion of water available for plant growth, it is a source of plant available nutrients, helps bind small soil particles into larger aggregates, which are important for good soil structure, aeration, water infiltration and resistance to erosion (Brady & Weil 1999). The pH-values are relevant because the degree of acidity or alkalinity is a master variable affecting chemical, physical as well as biological soil properties. It controls plant nutrient availability and microbial reaction in soils, and affects which vegetation will dominate the landscape under natural conditions and determines which cultivated crops will grow well or even grow at all in a given field site (Brady & Weil 1999).

Before performing the analysis of the soil samples they were finely grounded in a mortar, and dried at 165˚C. For measuring pH-values 5 g of each soil sample was mixed with 12.42 ml of $CaCl^2$. This mixture was stirred for approximately 20 minutes. Then the pH-meter was calibrated and the pH-values of the individual suspensions were measured. When measuring the carbon and nitrogen contents approximately 30 mg of each soil sample was weighed in small aluminum capsules. These capsules were tightly closed and laced in a plastic tray. Following, the carbon and nitrogen contents were measured in an ANCA Elemental Analyzer, coupled to a 20-20 Mass spectrometer (Europe Scientific, Crewe, UK). For measuring the phosphorous contents 5 g of soil was mixed with 100 ml of 0.5 M sodium bicarbonate, and stirred in a stirring device for 30 minutes. The phosphorous was then measured.

Results

Participatory mapping and Transect walk

From the individual mapping exercises, two very similar maps were derived. Both informants used reference points like rivers and the church to draw from. They only divided the vegetation into areas for grazing, areas where wattle grows, areas where wattle has been eradicated and field areas. One of the informants mentioned that protea trees grow on the mountains, but only at certain elevations, and it is seldom used for firewood, as regulations only permit use of dead protea trees for firewood.

It was made clear from all the people involved in the mapping and the transect walk that the boundaries of Makomereng village are made up of, to the North the Drakensberg Mountains, to the East the Makomorin River, to the West the Nguga River and to the South it is the Kinira River. When doing the transect walk only minor corrections had to be made in relation to the map. From the maps and the transect walk the group made a final map where it was decided to divide the vegetation around the village into two wattle areas, four grass areas, one field area and one eradicated area (Appendix F).

Semi-structured household interviews

Of the 22 household interviews 13 respondents were female (59%) and nine were male (41%). The overrepresentation of women may be due to many men being migrant workers (Dahl et al. 2001). 12 of the informants were above 50 (55%). Six were between 40 and 50 (27%), and four were between 30 and 40 (18%); an overrepresentation of elders. Following are the results from the interviews in broad outline:

Opinions on the wattle and possible alternatives

Positive aspects of the wattle as expressed by the informants were that it is a useful resource, good for firewood and building materials. Also, the bark is used for medicine; it can protect against the wind and provide shade as well as shelter for animals.

The negative views were mainly that wattle uses too much water and spreads too fast inhibiting growth of other plants. Locals knew this because people from the WFW-project and the EDA had told them. In Table 1 others reasons for their negative attitudes are listed according to number of respondents offering each reason.

Table 1: Ranking of villagers' negative attitudes

Reasons behind the villagers' negative attitudes on wattle as stated in household interviews	**No. of respondents that offered this as a reason for their negative attitude**
Wattle uses more water than other tree species.	10
Cattle thieves and other criminals hide in the wattle.	9
When growing wild, wattle is hard to control.	6
Wattle prevents indigenous species from spreading.	4
Wattle encroaches on grazing lands and fields.	4
When eradicated using chemicals, the chemicals harm other non-target species.	4
Spreading of wattle roots destroys the structure of houses and water pipes.	2
Wild animals that predate upon livestock and graze on crops utilise the wattle habitats.	2
Wattle is not strong and straight enough for some building purposes.	1

The informants were asked to what extent they wanted wattle in the area. They could chose between “completely removed”, “less”, “same”, “more” and “everywhere”. The majority of the informants (86%) said they wanted less (Figure 3).

Figure 3: Villagers’ attitudes on future extent of wattle

When asked what the locals wanted on the eradicated areas most answered fruit orchards (73%) or plantations with others trees (59%). From the cross tabulation it appears that women have a higher tendency than men to mention fruit orchards The men on the other hand, mentioned settlements and grazing to a higher degree than women, and in general men had more suggestions than women for the utilisation of the eradicated areas. When correlated to age groups, people that were pensioned had more suggestions for the usage than people of working age (Appendix G). According to the cross tabulation 62% of the women, and 56% of the men mentioned plantations with other trees. No one suggested wattle trees for plantations.

Generally the impression is that it is important for the locals that what is planted on the eradicated areas generate income to the community. Other suggestions were grazing areas, recreational areas and areas for new settlement and cultivation (Figure 4).

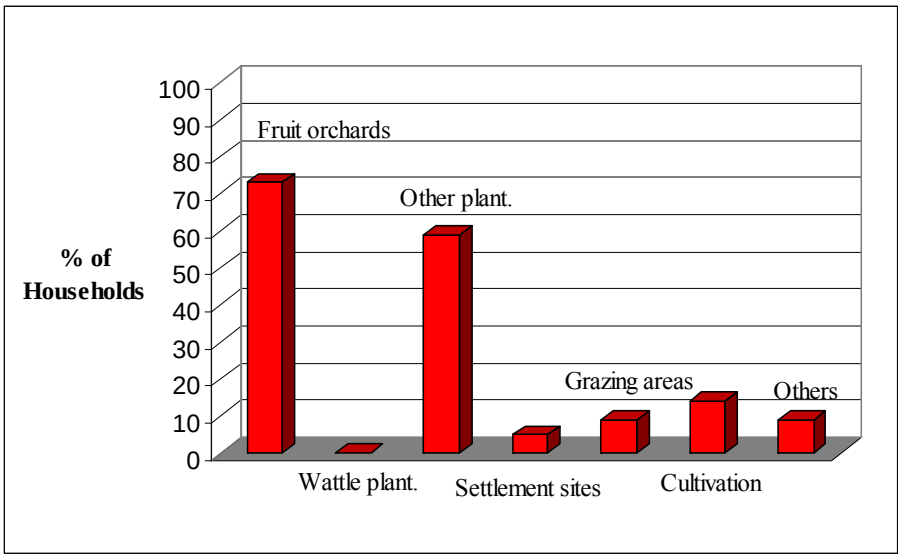

Figure 4: Villagers' suggestions for alternatives to wattle

Utilization of the wattle and other vegetation areas

Wattle areas are used for firewood, grazing, medicine, building materials, compost, handicrafts and income generation (by selling firewood or items made from materials from this area). Everybody said they use it for firewood. Many (59%) said they use it for building material, and medicine (46%). The other uses were not as prevalent. Grass areas are mainly used for grazing. Other uses mentioned were collection of medicines, food, and materials for building and handicrafts; the collection of medicines being the most prevalent use (32%). Only 64% of the informants acquire food from their fields. No one said they acquired income from their fields. The only other thing derived from the fields is thatch grass for roofing (32%). The river/riverside areas are used to collect medicines,

food, and materials for building and handicrafts. The most prevalent use is rocks and stones for building (36%).

Knowledge about and opinions on vegetation fires

All informants answered that vegetation fires occur in the winter, and the majority said they occur most often in the mountains. A few people mentioned that there are fires on the grasslands close to the village. They either did not know who sets off the fires or said that it was youths or cattle thieves, the former since they like to watch the fire and the latter because they want to promote green grass for luring the cattle. Some mentioned that it is prohibited by law to start vegetation fires. However, a few informants affirmed that with permission from the headman the villagers can organize fires for regeneration of the grasses. Another reason behind organised vegetation fires was stated to be eradication of an insect which is common in the tall grasses, but lethal to cattle if eaten,

It was expressed that fires are bad because they destroy grazing areas, burn medicinal plants, promote soil erosion and can burn houses and kraals. However, few claimed that as long as fire belts are created fires are good for the regeneration of grasses for the livestock.

Tenure systems' effects on utilization of vegetation areas

From the answers given the impression was that anyone can use the unfenced grass area within the village for grazing their livestock. Moreover, livestock are allowed to graze on fields that are not cultivated. However, there is a rule that the animals must be herded to the mountains for grazing in the summer. In winter grazing is supposed to be concentrated on the areas south of the village; towards the Kinira River.

There are restrictions when collecting wattle. Only people from the community are allowed to collect unlimited for own use without paying. If people from the community collect for selling or people from outside the village collect wattle, they need to get

permission from a person appointed for this task by the headman. They also have to pay an amount for the community. This amount allows for unlimited collection for one day. If people are caught violating these rules the headman decides what the punishment will be, but violating the rules did not seem to be something that happens very often.

If villagers want to expand their fields or attain other fields they must go to the headman and get his permission for this.

Knowledge about and opinions on local wild life

Some informants claimed that animals do not live in the wattle areas, and therefore did not see the eradication as a problem for the wild animal life. Others gave the expression that they thought it would be a problem for the birds when eradicating the wattle, in that they build nests in the wattle trees. Some also saw a problem for the animals in need of the wattle areas for shelter. However, generally the informants did not think that the animals would be affected greatly when the wattle is eradicated, as they would then move to other forest areas. None of the informants responded that they wanted to have specific animal species in the area for spiritual reasons. For aesthetical reasons only the beautiful birds were mentioned; and for consumption reasons few said that they would occasionally eat hares/rabbits.

Marketing possibilities of local products

People mainly grow crops, vegetables and fruits for their own consumption. They only sell if they produce surplus, and if there at the same time are any one in the community who will/can buy. No one sells outside the community; except from few occasions when selling to people from Mabua. If the possibilities for commercialisation were improved, most of the informants would like to produce more. One of the main problems mentioned hindering commercialisation possibilities was the lack of infrastructure

Semi- and un-structured interviews with key-informants

The following are the results of a transcription and analysis of three interviews given by key-informants with academic or administrative backgrounds and knowledge on or affiliated to the WFW-projects and the wattle eradication scheme.

Background and main aim of the WFW-project and its implementation in Makomereng

The theoretical background of the concept of the WFW-project, as surmised by the key-informants, was based on the following issues; In the Western Cape, which is one of worlds largest biome reserves, (Underwood pers. com.) with a huge species diversity of mainly semi arid species, many species of pine were encroaching native species in the area. Furthermore, the conservation and agricultural resources act (CARA) was passed in 1983, prohibiting or restricting invasive alien species dependent on their classification. Wattle, a commercial plant, belongs to category two, and may therefore be grown in demarcated areas, but when it grows wild, it becomes a category one plant, which is classified as prohibited and should be controlled.

Another main aim of the project seems to concern empowerment of local people. Locals need to gain skills in management, and the specific skills gained could then be utilised in other land use practices. On a larger scale, the belief seems to be that this will lead to poverty relief and availability of land to the people. On a more local scale, the arguments for implementing the WFW-project in Makomereng is the widespread distribution of wattle in the catchment area, and the belief that eradicating the wild growing wattle and replacing it with managed stands would greatly improve the commercial value of the wattle, thereby generating income. While there was overall agreement between the informants on many of the background concepts of the WFW-projects implementation, the informants emphasised the aspects that were in accord with their affiliations to the project.

The view on the locals peoples role and influence in the decision making

The views on the local peoples' role in the WFW-project, and their influence on what the cleared areas are to be used for, as well as their insight into the cogency of the possible alternatives to wattle varied. The informants that were actually involved or linked to the WFW-project showed more knowledge (or at least gave more information) on the villagers' involvement and the influence they had in the actual decision making than informants not themselves involved, while the informant representing the non-governmental organization seemed more able to express a variety of views, positive as well as negative on the real potential of the villagers' influence in the decision making, than the informant who was hired by the Department of Water Affairs and Forestry (DWAF).

So while the viewpoints varied from the point where local villagers were only to be viewed as hired workers, who would have no personal incitement or would lack time to do unpaid work once the payment stopped, to the view that the planned woodlot project would be self sustainable, and that the villagers would volunteer with free labor, such as for making fire belts and planting wattle, the most detailed and perhaps non-biased view (stated by the NGO-informant) expressed the future plans for a steering committee, that should receive training and knowledge for protecting the objectives of the program. This steering committee should be the representatives choosing the local personnel to be hired, and should play the role as middle man safe-guarding the interest of the contractor who has won the tender.

On the point of the villagers' influence in the decision making, specifically on what the cleared areas were to be used for, it seems that although it is mentioned that sites were put out for other land use practices than forestry, these practices seemingly clashed with the land rights. This e.g. was the case when people who had formerly lived on what were now cleared areas, stated that they wished to move back to these ancestral areas and thereby utilize the land for homesteads. It was also mentioned that the villagers had expressed the wish for grazing land and for orchards, but none of these alternatives

seemed to be on the future agenda for the cleared areas. A proposal for an orchard had been filed, but the applier had not linked his proposal to the WFW-project. Also hindering the plans for use of the eradicated areas for orchards or grazing lands was the fact that while the DWAF would finance fencing for woodlots, they were said to have stated that for grazing lands to be well managed, they should be fenced, and the eventual financing of such a venture should be maintained by the Department of Agriculture. Likewise, for orchards to be well managed, livestock and wild animals should be kept out by fencing, also not supported by DWAF.

Future plans for the cleared areas

As already suggested in the above section, the informants all stated wattle plantations as the main if not only alternative use for the eradicated areas. One informant stated that productive, well managed trees with commercial value were the best alternative, and that this should be planted and managed as a plantation. But even this informant seemed to view wattle as the primary alternative, as the informant later stated that since the villagers used wattle for many purposes, wattle plantations were a good idea. Other than the aforementioned, the main incentive for the focus on the wattle plantations seemed to be the fact that projection of funding from DWAF seemingly is conditional to the areas transformation into wattle plantations/woodlots.

Furthermore, while one informant stated that converting into plantations was easier than establishing new plantations due to the length of time given for permits for new established plantations to be issued, and that no efforts or financing as yet had been put into the proposed plantations, another informant stated that the plantations would be new established and that planting had already been initiated. Henceforth, there was a lack of agreement in the actual time frame of the proposed woodlot scheme, as well as on the future success of the project.

Main enigmas of the WFW-project

Several differing reasons were given for why the project may not be living up to its projected goals; although the concept is to eradicate alien species, there is no evidence whatsoever that this will work on a longer time basis, given the fact that wattle e.g. has seeds that can be viable for up to 40 years. At the same time, while a large amount of money was spent promoting the working for water project and on eradication of the alien species, nothing as yet has been spent on following up with replacement species or alternative land use plans. Supposedly, the government tendering system is very unworkable and the fact that the implementing agency for the program changes frequently, hinders the process. Also one informant stated that government imposes the management practices, and therefore does not allow for the utilisation of local knowledge.

Furthermore, the clearing of wattle in the Makomereng area, implemented by DWAF is seemingly based on the fact that wattle, consumes a lot more water than a plant of indigenous species, something though that according to one informant has not been scientifically proved. Finally, while more than one of the informants stated that it would be detrimental to leave the eradicated areas bare for long; this nonetheless seemed to be what was happening.

The following are the results of a transcription and analysis of four interviews given by key-informants whose affiliation to the WFW-project was based on their local usage of wattle or on their employment as local laborers in the WFW-project.

Attitudes towards wattle

All the local key-informants had views that were primarily negative towards wattle and expressed desire for wattle to be eradicated and the remaining stands controlled. Reasons given were the minimization of agricultural areas, the reduction of water resources and its invasive nature. One informant furthermore mentioned that thieves hide in the dense

wattle vegetation. The informant who was a buyer of wattle from another village stated the view that wattle should be eradicated completely. He did not believe in the idea of wattle woodlots, as he thought it would be too hard to manage, but he expressed in compliance with the other key-informants that wattle was useful for a variety of purposes; firewood, grass, building material as well as a source of income generation which is contradictory to his wish of total eradication. He was satisfied with the amount of money that he spent on wattle, compared to his expenditure and gains and the fact that the money benefits the community who sells the wattle.

Where the belief that wattle reduces water sources came from was only stated in one case; a local employee eradicating wattle stated that when you cut a wattle tree which grows along the riverbank, then more water pours from the stem than from wattle growing away from the river, thereby building his belief upon his own experience. It is therefore presumable that the other informants based their views on this issue on another source.

Alternatives to wattle

While the local key-informants were in agreement concerning their wish that replacement tree species should have a potential income generation, the specific species and plantation forms mentioned varied. While one just mentioned that they should have income generating potential, for example to sell as poles, another informant who was an entrepreneur, buying wattle from one community and selling it to another at a substantial gain, expressed a wish for pine tree plantations. Two of the informants stated a wish for fruit orchards, one of them expressing knowledge on the fact that this could only be possible if the soil was suitable. Protea trees were mentioned as being suitable for firewood, but also that they were protected.

Knowledge on future management scheme

The overall knowledge of what the scheme and management plans were for the future eradicated areas was very scarce. All four informants stated that they did not know at present what the actual plans for the eradicated areas were! One informant stated that managing the plantations (in this particular case the informant meant fruit trees) would be the responsibility of a community project group, but that there was a possibility that they would request assistance in the form of financial, material and technical aid. The same informant stated that probably some voluntary work would be necessary, without specifying how the incitement to work for free should arise.

The knowledge on the present management situation was a bit more detailed. All informants knew that at the moment, they were free to harvest anywhere except for the areas which are covered by the WFW-project. They had no idea how a potential product from wattle plantations or fruit orchards would be marketed, but sought some guidelines, one informant mentioned that several villages, like Tsita, Thutaneng, Mapfontein, Moloseng and Khoapa were potential markets. While two of the four informants had employment which directly involved wattle, this did not seem to make their knowledge on the future of the wattle areas more sound than the other two informants (buyer of wattle, and villager cutting wattle for own use). Only their knowledge on the present management and practical eradication was a degree more detailed, as they had insight in the technicalities of the techniques used on the eradication sites, although their knowledge on the impact that eradication and in particular the application of chemicals to the soil might have on the environment seemed limited to what they had been told, and not based on own observation. When asked, one respondent replied that he did not believe that the chemicals had any detrimental effects on the environment, as it was only applied on the wattle stumps.

Habitat analysis

The number of different species occurring in each habitat is illustrated in Table 2.

Table 2: Occurrence of species in each vegetation area

	Wattle	Grass	Eradicated
Grasses	3	8	4
Flowers	1	4	0
Sedges	0	4	0
Wattle shoots	0	1	1

The Shannon-Weaver diversity index was calculated to give an index of the diversity of species in each area (Fog 1997):

$$- \Sigma p (1.4427 * \ln p)$$

See Table 3 for the results of these calculations. The specific calculations for the biodiversity as well as the specific species found in each area are in Appendix H.

Table 3: Diversity index for each vegetation area

Wattle	Grass	Eradicated
1,489	3,449	2,005

Infiltration capacity

The infiltration capacities for each of the three areas are presented in Table 4.

Table 4: Infiltration capacity for each vegetation area

	Wattle (mm/min)	Grass (mm/min)	Eradicated (mm/min)
Day 1	3	1	Not available
Day 2	6	3	4

The capacity for the eradicated area on day 1 is not available due to methodical complications. The infiltration rate on the wattle area was the fastest. On grass and eradicated area the infiltration rates were approximately the same, but comparatively slower than in the wattle area.

Measuring erosion

The amounts of eroded material collected in the gutters after a rainfall of 108 mm in six hours (18 mm/hr) are presented in Table 5.

Table 5: Erosion on each vegetation area related to slope

	Erosion (g/m^2)	Slope
Grass 1	0.94	11°10
Grass 2	0.54	9°50
Wattle 1	39.59	12°40
Wattle 2	45.73	8°
Eradicated 1	260.49	7°30
Eradicated 2	145.06	10°40

The greatest amount of erosion occurred on the eradicated area; approximately 5 times more than what was measured on the wattle area, and approximately 300 times more than on the grass area. While there is a direct relationship between the amount of erosion and the magnitude of the slope on the grassy areas, the relationship between slope and amount of erosion is according to our measurements inversely related in the two other areas.

Soil Sampling and analysis

Below are the results from the soil analysis in average for each vegetation area. The raw data is found in Appendix I.

Table 6: Average pH-values

	pH	Std. D.
Grass	4.36	0.113
Wattle	3.83	0.183
Eradicated	3.84	0.191

Table 7: Average carbon content

	Carbon (%)	Std. D.
Grass	2.1	0.451
Wattle	3.1	0.929
Eradicated	1.9	0.656

Table 8: Average nitrogen content

	Nitrogen (%)	Std. D.
Grass	0.14	0.038
Wattle	0.23	0.078
Eradicated	0.15	0.047

Table 9: Average phosphorous content

	Phosphorous (ppm)	Std. D.
Grass	0.026	0.011
Wattle	0.058	0.029
Eradicated	0.051	0.034

Limitations and Sources of Errors

Participatory mapping and Transect walk

Since the intention was to use the map for the household interviews, it had to be finished within the first two days in the field. It was originally planned that a group of villagers (three to four people) should perform the mapping in order to achieve greater accuracy (Defoer 2000). Unfortunately, it was not possible to find more than two people who would like to participate in the exercise within this short time period. Also, it was not possible to have them draw it jointly. Moreover, both of the informants were older men which may have caused a bias, the original intention being that both female and male informants be used as each gender often has a different understanding of resource use patterns and use rights (Jackson 1994).

For the first mapping the whole group was gathered around a table with the informant doing the drawing while the group asked questions. During the second mapping session, the informant initiated the map in conjunction with the group, but upon realising that he had misunderstood the task, he was embarrassed, and went outside to redraw the map. Apparently he felt uncomfortable with the group members watching him while he was drawing. Although the group asked him more questions when he came inside, to enhance the details of the map the circumstances may have had a negative effect on the quality of the final map. The final map was drawn from our perceptions of the two maps made by the informants. A better result may have been attained by using the sketch made by the first informant, for the second informant to make adjustments by adding new information and discarding information considered inaccurate (Jackson 1994).

The group interpreter and the guide were assigned the task of guiding and informing during the transect walk. The interpreter lived in the neighbouring village Pepela I and the guide lived even further away. Though they both claimed they knew the area very

well, this might have been a source of error. Using people actually living in the village may have produced a more accurate map.

Semi-structured household interviews

The first day when the interviewer started out by presenting the map to the respondent the important basis for easy communication with the respondent (Casley 1988) was often altered, as people were easily put off and felt embarrassed when not comprehending it. A possible explanation for this could be high illiteracy. We felt it affected the quality of the interview, and it worked somewhat better when the map was presented later on during the interview, but in spite of that, for some respondents the interviewer was still not able to explain the idea of the map, and when the map was completely discarded the interviews appeared to get a better flow. This does not imply that the procedure should never be utilized; rather it shows that one should be aware that what has been prepared from home might not work in the field and the interviewer should be prepared to adjust according to experiences gained during the initial trials.

The table where different tenure rights were to be filled in according to different vegetation areas was abandoned for the second day, since apparently there is not a difference between separate wattle areas, grass areas, etc. This also applies to the table used for the utilisation of different vegetation areas for natural resources and instead of asking into different wattle and grass areas solely “wattle” and “grass” in general were referred to. Also, an area called “river” was added, since it was realized that many resources were collected there. Since these parts were changed it must be born in mind that this may have caused a difference in the answers attained the first and the second day. This refers to all changes made between the first and the second day, and adds to the difficulty of categorizing answers.

We realised that the questions on marketing possibilities should have been supplemented or replaced by more upon ended questions, as we would have gained more by more in

depth descriptions and explanations. When the questions were not understood by the respondent the interviewer would offer explanations and thereby asking the respondent to agree or disagree. This may invalidate the interview, in that words are partly being put into the informant's mouth (Casley, 1988). As a result the knowledge gained on the aspects concerning present and potential marketing possibilities is limited. Furthermore, phrasings such as "spiritual" and "aesthetics" appeared to be too abstract to the respondents, and had to be rephrased.

On some occasions the guide was used for translation. Unfortunately he often voiced his own personal opinions before translating. This subjectivity from the guide brings doubt to whether the answers given to the interviewer were actually the informant's or the translator's, which could strongly have affected the quality of the interview.

The interview guide containing qualitative questions had some general limitations. They do not generate quantitative data that can be summarized and categorized, and accordingly used for general estimates (Casley, 1988). While the close-ended questions made statistical analysis and quantification possible, the individual in-depth knowledge of the respondent's opinions may be restricted by the categorical choice of answers (Kvale 1996).

Finally, the fact that several interviewers and interpreters were used for the household interviews can have led to the enrichment of the analysis by including multiple perspectives, which may add to conceptual clarification and refinement of the issues in question (Kvale 1996). On the other hand, this makes it difficult to categorise answers as the questions have been posed by different people in different ways.

Semi- and un-structured key-informant interviews

For the key-informant interviews, it was found that the exploratory method (the less structured interviews) where the issue and problem complex was introduced primarily, and then the respondents' answers were followed up on and new angles of questions were found, gave more information and led to more new discoveries than the interviews where most of the interview questions had been predetermined. On one occasion we chose to tape an interview, which seemed to have a negative effect on the interview's outcome. This may be partly due to the tape recorder giving the respondent "performance anxieties" and so instead of answering the questions we posed, the respondent quickly brought the subjects on a line of talk that the respondent seemingly had prepared for in advance. This of course made the interview, the live version as well as the one on tape, very animated as it was a continuous stream of prepared answers, but they were not really answers to any of our relevant questions. Also, leading the respondent back on track was in this incident confounded by the fact that the respondent had asked us to pose all the questions at the initiation of the interview, and then chose to answer them all in one go, alleviating losing track of focus.

Habitat analysis

The main limitations to the habitat analysis are in relation to the sampling on site. When sampling a habitat, irrespective of which sampling method is used, a small part of the study area is selected for detailed analysis, and the sample thus created should be representative of the area. Due to limited time, it was only possible to accomplish one transect on each site, and this limits the extent of representation of the sample plots to the area as a whole. The sampling plots were placed along the transect in an open form, (Figure 2) and the transect was chosen perpendicular to the slope. Although this method most probably was the best given the amount of time, since the vegetation plots were placed at different slopes, increasing the average extent of representation, systematic sampling in a two dimensional grid would have increased the extent of representation of

the plots to the area as a whole. Alternatively, explanatory environmental variables could have been recorded on more appropriate scales, than the three per transect slope and soil measurements (Økland 1998).

Besides the placement of the plot, the choice of plot size and plot number also influences the sampling (Økland 1990). Here it is crucial to point out that since the transect length and thereby the number of sample plots in the wattle area was only half the length and number of the transects and plots executed in the two other areas, this complicates comparison of diversity indexes between the areas.

Further limitations may be relative to the determination of plant species, which was done by a field guide. Our prior knowledge to the species in the area was scarce, and when plants were collected in the field and brought back for species identification, the specimens were sometimes damaged, or flowering parts missing, confounding determination attempts.

Infiltration capacity

The soil that the infiltrometer was pushed into was quite hard and it was difficult to do this properly. This resulted in the water surface not always being perfectly even with the measuring band inside the infiltrometer, from where the changes in water height were read, hence adding to inaccuracies of these readings.

Also, a single ring infiltrometer was used, and although it was pushed 5 cm into the soil it is not an assurance that the water has only infiltrated vertically, thereby staying within the area of soil on which the water was applied. The horizontal infiltration might have been mitigated by using a double ring infiltrometer where water in the outer cylinder is used to ensure that the movement of water from the middle cylinder will be principally vertical (Brady & Weil 1999).

When it was judged that the saturation point had been reached, this may not have been the case, which will then be another factor affecting the accuracy of the results. Finally, on day 1 the one minute intervals in between the readings were timed by using a regular wrist watch with a second hand. On day 2 this was done by using a stop watch; presumably resulting in these timings being more precise than on the previous day.

Measuring erosion

When collecting sediment from the eradicated area, it was flowing over the edges; indicating that the results can only be used to obtain comparative information (Hudson 1993). Also, the sizes of the catchment areas above each gutter were estimated and measured by the group members, which is a possible source of error for the results when presented as sediment load related to area. This is most probably the explanation for the slope and amount of erosion being inversely related on the wattle and eradicated areas. Other sources of inaccuracies could derive from emptying the gutters into polythene bags, again emptying the bags into beakers for drying the soil.

Soil sampling and analysis

The soil auger used for taking soil samples was 20 cm long. In the eradicated area it was possible to push the auger all the way down into the soil, but on the other two areas it was only possible to push it down approximately 8-10 cm. Thus the soil samples from the eradicated area do not represent the same soil horizons as the samples taken from the grass and the wattle areas. As a result, the eradicated area may underestimate the organic matter content in relation to the other areas. Only cautious conclusions can be derived from the analysis, because just three samples were collected from each area. Taking more samples might have resulted in greater extent of representation of the soil characteristics of the area, and the results given can therefore only be used for a general indication of soil characteristics.

Discussion

The locals' requirements, wishes and opinions concerning wattle utilization and future management

The locals had both negative and positive opinions of the wattle, and the majority wanted less wattle than presently. The main reasons for the negative views were due to the wattle being invasive and consequently reducing land areas for other uses; as well as their belief that wattle depletes the water resources which is a very important part of their daily lives. However, from our research material we are not able to make conclusions on whether their concern about water depletion originates from outsiders imposing their views. Even if this is the case, it has not been scientifically proven that specifically wattle reduces streamflow, as it has been proven with eucalyptus and pines (Scott et al. 1998b). One informant told us he had observed that wattle growing by the river uses more water than wattle growing on the mountain slopes. This is supported by Scott et al. (1998b) and Scott (1999) whose research showed that clearing plantations in riparian zones resulted in up to triple the water yield gains that resulted from clearing the same area of similar vegetation on an up-slope portion for the catchment. Therefore, maybe the focus should be more on clearing the riparian areas, as well as keeping grazing areas, fields and other areas of important local resource use free from wattle. The positive views stemmed from its value as a resource and as an income generating asset. Especially income generation is important for the locals, as there is low employment rate in the area and they feel that there are limited ways of selling locally produced products.

Where the wattle is removed the locals suggested other types of plantations species, e.g. fruit trees, pine trees, and gum trees. Some also suggested the establishment of new homesteads or reestablishment of homesteads which have previously been moved down to the main village area. This could be based on the importance of land ownership to the people, as social and economic power in the community can be determined by the status that ownership of land accords (Bob & Banoo 2000). The areas where wattle grows are at

present determined communal rangeland, but they are owned by the state. However, the chief has jurisdiction to give the locals permission to use these areas, but solely for rangeland purposes. If they are to be utilized for other purposes, e.g. woodlots, houses or fields the locals need to attain a PTO (permission to occupy) by going through the chief who applies for this permission from the Department of Land Affairs (Land Use Group pers. com.). From this, and the information achieved during household interviews, we do not see that there persist any land tenure conflicts in the community. There are clear rules and procedures for what to do when a party wants to utilize the eradicated wattle areas for a certain purpose.

The gender and age group of the informants seemed to influence their choice of future alternatives for the eradicated area. While the fact that people that were pensioned had more suggestions than people that were employed, may reflect that excess time or the experience of age makes more possibilities plausible to this age group, the suggestions given by each gender reflected the experience that women and men respectively have in e.g. growing produces in their garden, and tending the livestock, or enterprising. Common for all suggestions were that they were income generating, indicating that, which products generate this income is not as relevant as the income itself.

The bio-physical state of the environment

The fact that the grass area has a slightly higher pH-value than the other two areas may indicate that wattle acidifies the soil. The low pH-values in general can mainly be explained by the fact that in humid regions soils tend to be quite acid because of rainfall leaching out much of the base-forming cations. These low pH-values indicate that only limited types of vegetation can grow in the area without applying fertilizer; many trees and shrubs need pH-values at least above 5 (Brady & Weil 1999). Applying fertilizer would be an additional cost and labor requirement; thereby minimizing, possibly eliminating, a potential profit.

Insofar as soil organic matter (SOM) contributes to improved soil physical properties (e.g. aggregation, moisture holding capacity and resistance to erosion) increasing SOM will generally result in increased soil productivity. Yet on many soils, suitable soil physical properties occur at relatively low levels of organic matter (2-4%). A level of SOM higher than what is required to produce suitable physical properties is beneficial in that the soil has a greater buffering and nutrient holding capacity, but it does not contribute directly to soil productivity. If soils are managed so SOM is not declining (steady-state), soils higher in organic matter (e.g. 8%) are not inherently more productive or fertile than those that have less organic matter (e.g. 5%) (Alberta Agriculture, Food and Rural Development). Therefore, from our average SOM results from the three vegetation areas being between 3.3-5.4% (1.9-3.1% carbon) our immediate conclusion is that the present carbon contents are not a constraint.

For optimal fertility levels the, the amount of plant available phosphorous needed is approximately 1.5 ppm (de Neergaard pers. com.). The fact that all three vegetation areas have values much lower than this (0.019-0.090 ppm) indicates that phosphorous will definitely be a limiting factor for many types of plant growth.

Soils containing 0.15% nitrogen are representative for cultivated soils (Brady & Weil 1999). The grass area and the eradicated area have values very close to this, and the wattle area has even higher values (probably due to its ability to fixate nitrogen from the air (Kevin 2000), and accordingly nitrogen will not be as great a limitation as phosphorous.

In the eradicated area the biodiversity is lower than in the grass area. However, it is higher than in the wattle area. This could indicate that wattle greatly eliminates the growth of other species, either by shading or by inhibition caused by the dense root network of wattle trees. There is a clear indication that wattle does reduce the biodiversity, and if the wattle continues to spread further this will be a major threat to e.g. the occurrence of medicinal plants in the area. The fact that the biodiversity in the eradicated area is lower than in the grass area even after two years of potential regrowth

predicts that, first of all it will most probably crave a substantial length of time before, if at all, the area returns to its original status and can be used for grazing. Furthermore, it is our assessment that the potential effects of the chemicals left in the soil is unknown, despite several informants stating that the chemicals have no negative effects on the environment, and that the chemicals therefore might have a negative effect on the soil and the plants growing there. Therefore, these constraints taken into consideration it is also difficult to predict the viability of alternative species planted in this area; there might be a need for major soil reclamation. An added constraint is the fact that wattle seeds are able to germinate up to 40 years after seed fall (Underwood pers. com.), which is furthermore enhanced by the fact that vegetation fires, which are common in the area, trigger the spread of alien trees (Mondlane et al. 2001).

Natural habitats not only include flora, also fauna is important for ecosystem functioning. From the household interviews we can not conclude that there is a strong concern amongst the villagers that the wild life will disappear when the wattle is eradicated. However, there is an indication that they are aware that changes in the wild life distribution and abundance, and therefore changes in the local ecosystem will happen; which is something that should not be ignored when managing vegetation areas in the area.

From the infiltration rates the immediate conclusion is that the potential for erosion is higher on the grass area than the wattle area, in that the infiltration capacity is higher on the wattle area. However, the erosion measurement showed that there was more erosion from the wattle area than the grass area. This illustrates the importance of vegetation cover for preventing erosion, and in this case grass has superior capabilities of binding the soil particles than the wattle trees. It must therefore be kept in mind that whenever grass is substituted by tree cover there will more than likely be an increased degree of erosion, which speaks for grazing areas instead of tree plantations. Otherwise management practices should be applied in order to mitigate erosion, e.g. by mulching. The erosion measured in the field was accumulated after just one heavy rainfall, and the

magnitude of erosion on the eradicated area (approximately 300 times more than on the grass area) clearly shows the extreme importance of establishing a vegetation cover immediately after clearance. Especially in summer (when the field work was done) since this is the time when 85% of the annual rainfall occurs. While there is a direct relationship between the amount of erosion and the magnitude of the slope on the grassy areas, the relationship between slope and amount of erosion is according to our measurements inversely related in the two other areas. This could be an indication that not only slope but also vegetation cover and pattern effects extent of erosion.

Another possible constraint which is not only induced by bio-physical conditions, but also partly human-induced is that in the winter time many vegetation fires are uncontrolled. These may be a constraint for the management of e.g. woodlots, in that they can invade and thereby damage these areas. This is something which must be included in the planning for the future management of the eradicated wattle areas. At the same time, it appears that for regeneration to occur there is a need for burning the grass areas occasionally, and seemingly there are already plans agreed upon by the community for the management of these fires, with e.g. fire belts.

Socio-economic framework

Under the management of the CBLM-project (EDA), several suggestions for the future use of the eradicated areas are posed; vegetable production area, replanting of non-invasive tree species or regrassing for rangeland. However, during the interview with the EDA informant, it was stated that replanting of wattle trees in woodlots is the only plausible alternative when economic incentives and social considerations and needs are taken into account. This was further supported by Michael Underwood from the Forestry Department of the University of Durban-Westville, based on the fact that the economic gains of harvesting wattle would be much greater than what could be gained by harvesting an area with indigenous natural growing trees (Appendix J).

This complies with the fact, stated by the EDA, that economic support for replanting on the eradicated areas, is conditional to the replanting of wattle in woodlots. Therefore it seems in accordance with the wishes of both the governmental and non-governmental institutions that wattle is to be planted. The status and effect on the biophysical environment though seems an aspect not taken into account.

For the long term sustainability of the wattle control and future woodlot management, focus should be on creating community controlled wattle management without the capital input from the WFW-project. This craves that the villagers perceive that there are other benefits to be gained than the short term employment and financial subsidizing that seems to be the main incitement for their present participation in project. The key to this may be empowerment of the community by clarification of land ownership, and by training and mediating planning, management and income generating skills (Reay-Mcleod 1999), as well as ensuring that they obtain value-added benefits gained from the sale or processing of these resources (Ojwang 2000), and that public participation is effective.

The importance of encompassing these key elements is supported not only by theory, but by experience from within the community, of factors that have been crucial for success in previous community projects. Ensuring capacity building skills of the locals involved, mediating the main underlying concepts of the projects to the locals and ensuring that these are culturally acceptable, networking with outside agencies, and ensuring that participation is gained throughout the community and involves all age groups, are some of the most important aspects found to ensure the success of the existing projects in the community (Community Project Group pers. com.). Also, trust, communication, opportunity and flexibility are crucial elements determining effective participation (Mitchell 2002). In this case it appears that there is a limited amount of communication between different organizational levels as well as between these and the locals. This was shown by local informants and key-informants giving contradicting information on the future plans for the eradicated wattle areas. The communication between local villagers, extension officers and government officials at differing levels is essential in order to

secure that the aims and goals of development programs is understood and agreed upon by all parties. In general, the villagers seem to have confidence and rely on what is recommended from the involved authorities. However they also indicated that they expect assistance from outside organizations. They do not feel it is their decision as to what is to be done with the eradicated areas. At the same time, whether there is equity in the community by all having the opportunity to voice their opinions and having a say in final decision making can not be judged from our limited research material.

Many different circumstances point to the fact that what is planted on the eradicated areas should at least be something which can generate income to the community. This must be supported by well-functioning infrastructure and marketing possibilities for products produced from these areas. If it is decided that wattle is to be planted as woodlots, we know that there is already a local market for selling wattle as firewood, as many neighboring villages lack firewood resources. Also, there is a large industry in South Africa processing wattle bark, which is used for tannin, and exporting it to e.g. Australia (Kevin 2000). However, it has to be economically viable for the wattle products to be transported to the processing industries, which is a point where the government should be supportive. This would also apply if there was to be produced fruits or vegetables on the cleared areas. The locals said that even if they produced a surplus of vegetables or fruits there was not always someone in the community or in Mabua who wanted to or was able to buy these. However, while staying in the village fruits and vegetables produced as far away as Cape Town were bought for our consumption. These might as well have been produced and bought locally, thereby supporting the local economy.

Conclusion

Our main objective was to investigate the possibilities for the long-term sustainable management of wattle in the study area, as well as the areas where it is decided to eradicate the wattle. This we have done within the framework of the present bio-physical and socio-economic conditions and limitations. Although we are not commissioned to present an exact plan for how this management should be performed, we will however state which aspects must be taken into consideration when making plans for the wattle.

Wattle needs to be conserved in certain areas in order for the locals to be able to utilize it as the important resource it is for them. Yet, the locals must also be trained and made confident that they have the abilities to control the wattle, so that it is no longer a liability to them, but solely an asset. When planning for the management of the wattle and the eradicated areas communication between the different parties involved is momentous and it should be a co-operation between outside agencies and the local community, not something which is implemented from outside. For the long-term sustainability it is important the locals have empowerment, a sense of responsibility, and that they are part of the decision making process. Even if proper incitement is established it is a poor community, and aid from outside is needed. However, this should rather be in the form of e.g. subsidies, loans, improved marketing possibilities, instruction on regulations and rights (e.g. in relation to tenure systems), training, and education in appropriate skills, than by employing the locals on governmental projects.

Furthermore, bio-physical restrictions must as well be taken into consideration. Some of these could in theory be overcome by capital and technical investment, but it can not be assumed that this is always viable or even possible. Main restrictions which must be taken into consideration, besides the climatic conditions, are that the soils in general are acidic and have low contents of phosphorous, and if alternative vegetation than wattle is to be planted on the eradicated areas fertilizer will most probably be needed. Also, this vegetation may not be able to compete with reinvasion of wattle, partly due to seeds left

in the ground and also from vegetations fires which tends to promote the invasion of alien species. Having wattle instead of the natural biome of grass does lower the diversity of plant species, and it must also be taken into consideration how the changes in vegetation cover affect the wild animal life. Moreover, areas where wattle grows are more prone to erosion than where grass grows; indicating that tree cover does not prevent erosion to the same extent as grass. However, erosion on the wattle areas is very small compared to the magnitude of erosion measured from the eradicated area, and extreme care must be applied in managing the cleared areas in order to prevent resulting damage greater than or equal to the initial problems aimed to resolve by the eradication.

Acknowledgements

We want to give thanks to Heinz Beckedahl from the University of Natal for helping us identify which methods to use for measuring erosion potential in the field. Special thanks goes to Siziwe Kuboni and Mr. Simon Lesia for being our trustworthy interpreter and guide, respectively, while doing field work. We are very grateful for Miles, from the University of Durban-Westville, helping us use the oven in the chemistry lab. Trevor Hill from the University of Natal was a great help assisting in the identification of plant species that we could not identify ourselves, especially sedges and flowers; thank you for that. Thanks also goes to all the informants who where willing to devote time for answering our questions. Finally, we want to thank our supervisors for their advice and assistance.

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Appendix A (a)

Semi-structured interview guide for the households

(First version)

- Presentation and introduction to what we will talk about

Utilization of the wattle and other vegetation areas in relation to resources

Vegetation units / Resource	Wattle 1	Wattle 2	Grass 1	Grass 2	Grass 3	Grass 4	Fields	Cleared
Firewood								
Grazing								
Fodder								
Medicines								
Food								

Appendix A (b)

Opinions on the wattle and possible alternatives

Wattle - Positive →
- Negative →

Desired extent of wattle

Completely removed	Less	Same as present	More	Everywhere

Alternatives to Wattle

Knowledge about and opinions on vegetation fires

Why →

When →

Where →

Who →

What →

Opinions on fires →

Appendix A (c)

Tenure systems' effects on utilization of vegetation areas

Tenure/ownership-people with certain user rights / Vegetation Units							
Wattle 1							
Wattle 2							
Grass 1							
Grass 2							
Grass 3							
Grass 4							
Fields							
Cleared							

Knowledge about and opinions on local wild life

Value of wild life dependent on wattle-habitats

- Consumption →
- Spiritual →
- Aesthetics →

Knowledge on whether changing the vegetation cover will have any effect on wild animal life

Appendix A (d)

Basic Information

Sex: Male ☐ Female ☐

Age: < 20 ☐ 20-29 ☐ 30-39 ☐ 40-49 ☐ >50 ☐

Occupation: _____

Size of household: Adult males ☐ Adult females ☐ Children ☐

Domestic Animals (write number of animals in Box):

Cattle ☐ Pig ☐ Poultry ☐ Goat/Sheep ☐ Horse ☐ Others,

Specify_____

_____

Marketing possibilities of local products

Dependent on resources from outside the community: No ☐ Partially ☐ Entirely ☐

Specify: _____

Commercialisation of locally produced/collected products: Yes ☐ No ☐

Is expansion of commercialisation wanted: Yes ☐ No ☐

If yes, which products? : _____

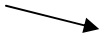
Appendix B (a)

Semi structured interview guide for the households

(Second version)

- Presentation and introduction to what we will talk about

Opinions on the wattle and possible alternatives

Wattle - Positive 
- Negative 

Desired extent of wattle

Completely removed	Less	Same as present	More	Everywhere

Where the wattle is removed what would you like to have instead? Why?

Do you think that the soil is good for this?

Appendix B (b)

Utilization of the wattle and other vegetation areas in relation to resources

Vegetation units / Resource	Wattle	Grass	Fields	Cleared	River
Firewood					
Grazing					
Fodder					
Medicines					
Food					

Knowledge about and opinions on vegetation fires

Why ⟶

When ⟶

Where ⟶

Who ⟶

What ⟶

Opinions on fires ⟶

Appendix B (c)

Tenure systems effects on utilization of vegetation areas

What are the rules for the areas where the wattle trees are growing?

Who made these rules? Why?

What are the rules for the grazing areas?

Who made these rules? Why?

Are there rules for the areas around the river?

Who made these rules? Why?

What are the rules for getting and expanding fields?

Who made these rules? Why?

Knowledge about and opinions on local wild life

Do you use any of the wild animals and birds that live in the areas where the wattle grows?

Will removing the wattle be bad for the wild animals and birds?

Appendix B (d)

Basic Information

Sex: Male ☐ Female ☐

Age: < 20 ☐ 20-29 ☐ 30-39 ☐ 40-49 ☐ >50 ☐

What work do you do to earn money? : _____

What is the size of your household? : ☐

Adult males ☐ Adult females ☐ Children ☐

Domestic Animals (write number of animals in Box):

Cattle ☐ Pig ☐ Poultry ☐ Goat/Sheep ☐ Horse ☐ Others,

Specify: _____

_____

Marketing possibilities of local products

Dependent on resources from outside the community: No ☐ Partially ☐ Entirely ☐

Specify: _____

Commercialisation of locally produced/collected products: Yes ☐ No ☐

Is expansion of commercialisation wanted: Yes ☐ No ☐

If yes, which products? : _____

Appendix C

Semi-structured interview guide for informants with academic or administrative role in relation to the WFW-project

Environmental impacts of wattle

Impact of wattle on the ground water – evidence?

Does it use more water than the other tree species in the area? – evidence?

Does the wattle use more water when it is growing in the riparian areas than it actually needs? – evidence?

What do you know about the wattle affecting the water supply in the adjoining communities? – evidence?

What impacts does the wattle have on erosion? – evidence?

Are there any problems with the wattle suppressing the growth of the other plant species? – evidence?

Wattle in the future and possible alternatives

Do you feel the wattle should be kept in order to provide resources to the local people?

If yes, to what extent and in which areas?

If no, what do you think should be the alternative species planted on the areas where the wattle is removed, keeping in mind that they should fulfil the local needs and wishes?

Do you only think species already growing in the area should be considered, or do you think there is possibility of introducing new exotic species?

Appendix D

Semi-structured interview guide for local key-informants working with the wattle

Local attitudes towards wattle and other vegetation

Do you know whether the locals want to keep or remove the wattle?

Do you think there is any other vegetation species that can be planted as an alternative to the wattle and still provide the same resources for the locals?

Do you think the locals would like to have new exotic species to be introduced into their area?

Biophysical Environment

Impacts of the wattle tree

- Positive →
- Negative →

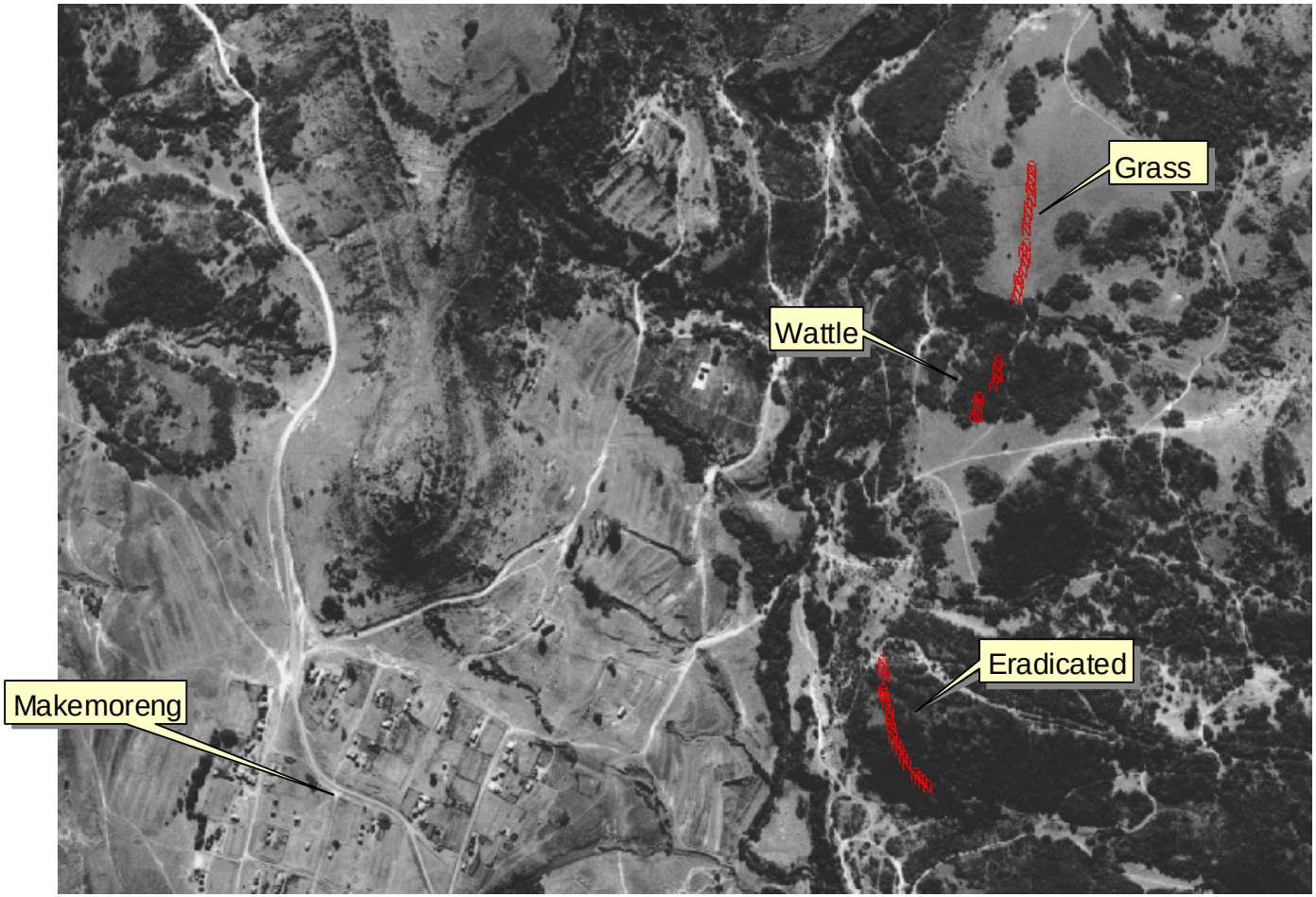
Vegetation fires

- Knowledge →
- Opinion →

Effects of eradicating wattle

- Wild life →
- Soil quality →
- Erosion →

Location of Vegetation Transects



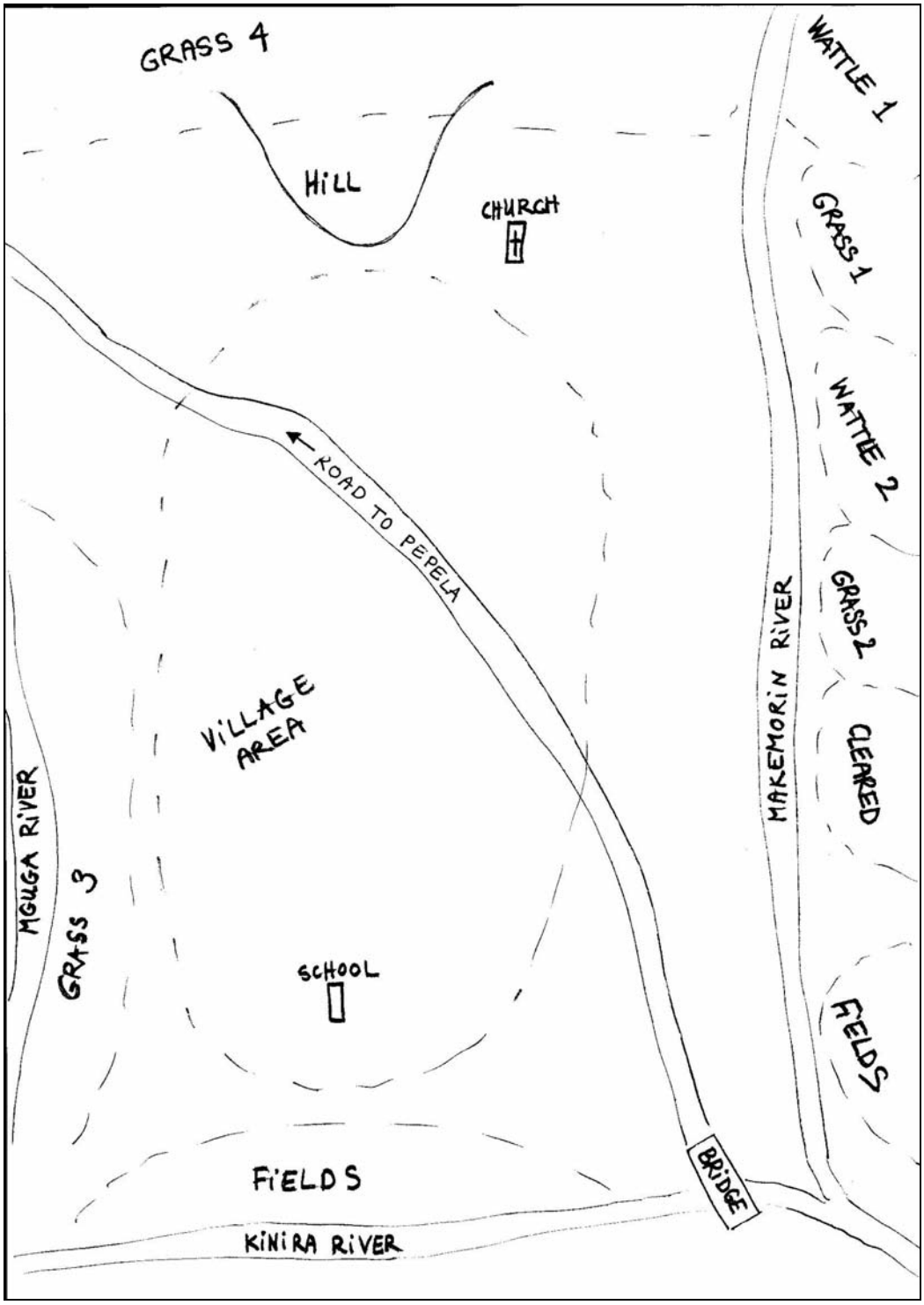
N

100 0 100 200 300 400 500 600 Meters

Appendix E

Appendix F

Miniature reproduction of the map applied during household interviews derived from participatory mapping



Appendix G (a)

Cross tabs made from household interview results

1. Suggested alternatives in relation to gender:

FRUIT ORCHARDS* SEX

Count

		SEX		
		Female	Male	Total
FRUIT	n	2	4	6
	y	11	5	16
Total		13	9	22

WATTLE * SEX Crosstabulation

Count

		SEX		
		Female	Male	Total
WATTLE	n	13	9	22
Total		13	9	22

SETTLEMENT * SEX Crosstabulation

Count

		SEX		
		Female	Male	Total
SETTLEME	n	13	7	20
	y		2	2
Total		13	9	22

GRAZING * SEX Crosstabulation

Count

		SEX		
		Female	Male	Total
GRAZING	n	13	6	19
	y		3	3
Total		13	9	22

Appendix G (b)

CULTIVATION * SEX Crosstabulation

Count

		SEX		
		Female	Male	Total
CULTIVAT	n	12	7	19
	y	1	2	3
Total		13	9	22

OTHER PLANTIONS * SEX Crosstabulation

Count

		SEX		
		Female	Male	Total
OTHPLANT	n	5	4	9
	y	8	5	13
Total		13	9	22

2. Suggested alternatives in relation to age group

Age groups: 3 = 30-39, 4 = 40-49, 5 = >50

FRUIT ORCHARDS * AGE Crosstabulation

Count

		AGE			
		3	4	5	Total
FRUIT	n	1	2	3	6
	y	2	5	9	16
Total		3	7	12	22

Appendix G (c)

SETTLEMENT * AGE Crosstabulation

Count

		AGE			
		3	4	5	Total
SETTLEME	n	2	7	11	20
	y	1		1	2
Total		3	7	12	22

GRAZING * AGE Crosstabulation

Count

		AGE			
		3	4	5	Total
GRAZING	n	3	7	9	19
	y			3	3
Total		3	7	12	22

CULTIVATION * AGE Crosstabulation

Count

		AGE			
		3	4	5	Total
CULTIVAT	n	3	7	9	19
	y			3	3
Total		3	7	12	22

OTHER PLANTIONS * AGE Crosstabulation

Count

		AGE			
		3	4	5	Total
OTHPLANT	n	1	4	4	9
	y	2	3	8	13
Total		3	7	12	22

Appendix H

Calculations of plant diversity in each vegetation area:

Wattle	No. of each species	p	- p (1.4427 * ln p)
E. racemosa	8	0,615	0,431
A. junciformis	1	0,077	0,285
Tristachya	3	0,231	0,488
Lobelia	1	0,077	0,285
Total	13	1	**1,489**

Grass	No. of each species	p	- p (1.4427 * ln p)
Acacia	1	0,011	0,072
M. caffra	14	0,154	0,416
E. chloromelas	2	0,022	0,121
E. curvula	3	0,033	0,162
E. racemosa	8	0,088	0,309
C. plurinodes	13	0,143	0,401
A. bukerious	3	0,033	0,162
A. junciformis	7	0,077	0,285
Helichrysum	3	0,033	0,162
Corex	3	0,033	0,162
Juncus	22	0,242	0,495
Bulbinia	1	0,011	0,072
Hypoxis	3	0,033	0,162
Aspalathus	3	0,033	0,162
Trachopogon	1	0,011	0,072
Isopteris	1	0,011	0,072
F. costota	3	0,033	0,162
Total	91	1	**3,449**

Eradicated	No. of each species	p	- p (1.4427 * ln p)
Acacia	20	0,408	0,528
E. curvula	11	0,224	0,483
S. pyramidalis	12	0,245	0,502
A. junciformis	3	0,061	0,246
E. racemosa	3	0,061	0,246
Total	49	1	**2,005**

Appendix I

Carbon, nitrogen, phosphorous and pH-values for each vegetation area

Area	pH	Carbon (%)	Nitrogen (%)	Phosphorous (ppm)
Grass 1	4.23	2.6	0.18	0.039
Grass 2	4.43	2.1	0.12	0.020
Grass 3	4.42	1.7	0.11	0.019
Wattle 1	4.03	2.1	0.14	0.025
Wattle 2	3.79	3.9	0.29	0.069
Wattle 3	3.67	3.4	0.25	0.080
Eradicated 1	3.68	2.6	0.20	0.090
Eradicated 2	3.78	1.8	0.13	0.036
Eradicated 3	4.05	1.3	0.11	0.028

Difference between timber from wild growing wattle and wattle growing in controlled plantations

To illustrate the stated differences between wild growing unmanaged wattle, and wattle from managed plantations, the pictures below show the difference in straightness of the trunks. The amount of biomass that can grow on a plantation may be 33-53% more than when the trees grow in the wild (Underwood pers.com.).

Plate 1: Timber from wild growing wattle

Plate 2: Timber from wattle in controlled plantations

The pictures are kindly donated by Patrick Dlamini from the EDA.

Appendix K

Schedule of tasks in the Field

<table>
<tr><th>Date</th><th colspan="2">Fieldwork</th></tr>
<tr><td>Monday 13/1-03</td><td colspan="2">Arrival at Pietermaritzburg.</td></tr>
<tr><td>Tuesday 14/1-03</td><td rowspan="4">.

Shahzad, Eddie and Charlotte interviewed Mike Underwood.
Esther and Marianne had a meeting with Heinz Beckedahl about which methods to use for erosion measurement.</td><td rowspan="4">The whole group worked on preparation for fieldwork.</td></tr>
<tr><td>Wednesday 15/1-03</td></tr>
<tr><td>Thursday 16/1-03</td></tr>
<tr><td>Friday 17/1-03</td></tr>
<tr><td>Saturday 18/1-03</td><td colspan="2">Transfer to Madlangala.</td></tr>
<tr><td>Sunday 19/1-03</td><td colspan="2">The whole group did Participatory Mapping with one informant and afterwards a transect walk with the interpreter and the guide.</td></tr>
<tr><td>Monday 20/1-03</td><td colspan="2">Shahzad, Esther and Charlotte did Participatory Mapping with one informant, and tested the interview guides with the interpreter.
Eddie and Marianne went to observe the workshop on Working For Water, and did some informal interviews.
The whole group combined the two maps into one final showing different vegetation areas which were then written into the interview guides.
At night there were preliminary presentations from all the groups. Charlotte represented the group.</td></tr>
<tr><td>Tuesday 21/1-03</td><td colspan="2">Eddie and Charlotte put in gutters for erosion measurement, did vegetation transect and collected soil samples in the eradicated area. Also GPS points were marked along the transect, and plants which could not be identified in the field they brought home for later identification.
Shahzad, Esther and Marianne did household interviews.
In the afternoon Charlotte identified grassed collected in the field.
At night the whole group worked on revising the interview guide for the next day.</td></tr>
<tr><td>Wednesday 22/1-03</td><td colspan="2">Shahzad and Marianne did vegetation transects in the grass area and the wattle area. GPS points were marked along the transects and unidentifiable plants where brought home.</td></tr>
</table>

	Eddie, Charlotte and Esther did household interviews. In the late afternoon, Charlotte and Eddie worked on the plant identification and in the evening everybody continued this work.
Thursday 23/1-03	Shahzad and Marianne collected soil samples and did infiltration measurements in the grass and the wattle area. They also set up a gauge for measuring rainfall, and emptied it four times during the day, in between identifying plants. Charlotte and Eddie went to Matetiele to interview Patrick Dlamini from the NGO EDA. In the afternoon Charlotte and Eddie worked on plant identification Esther did interviews with people buying and selling wattle for firewood. In the evening the whole group prepared the preliminary presentation for the next day.
Friday 24/1-03	Eddie, Esther and Marianne collected soil in the gutters. Charlotte and Shahzad did an interview in Pepela with a contractor from the Working for Water program. Charlotte Interviewed Mr Simon, nature guide, on the wildlife in the area, having him identify species of birds and insects from field guides, and stressing differences in species found in the wattle and non wattle areas. The whole group interviewed a person working for the Working for Water program. At night Marianne represented the group for the preliminary presentations.
Saturday 25/1-03	Eddie, Shahzad and Marianne walked to Pepela to observe wattle growing along the river and the road. Met a person cutting wattle for selling and had an informal interview with him. Esther managed drying of soil from gutters in the sun. Charlotte did infiltration tests on all three areas, and took overview photos of the distribution of wattle in the catchment area, as well as the protea trees growing on the upper slopes.
Sunday 26/1-03	Transfer to Durban
Monday 27/1-03	The whole group analyzed the results and prepared the presentation for Thursday.
Tuesday 28/1-03	
Wednesday 29/1-03	
Thursday 30/1-03	Group presentation of results at the University of Durban-Westville
Friday 31/1-03	
1/2-03	Departure

The Wattle Tree and Its Alternatives

Synopsis for Sluse Joint Course ILUNRM

2002-2003

South African Group

Shahzad Ahmad

Charlotte Moshøj

Marianne Lisborg

The Wattle Tree and Its Alternatives

Objectives and research questions

In Makomerang the wattle tree (*Acacia spp.),* a non-native species has encroached the communities unused land. Supposedly the tree depletes the groundwater in the area, and may have negative impacts on valuable resources, such as indigenous flora and fauna. Therefore the program "Working for Water" implemented by the Department of Water Affairs and Forestry has aimed at eradication of the wattle tree (E.D.A.T). These cleared areas have not been replanted with alternative trees or grasses (Dahl et al 2001), which may induce erosion (Brady 1999) Furthermore, since the wattle has seed banks left in the soil it easily spreads again (Neergaard pers.com.)

On the other hand the wattle serves as a valuable resource in the local community (Dahl et al 2001). It is utilized for fire wood, building material etc. (Dahl et al 2001), and according to prior investigation (Dahl et al 2001), it offers significant social services and income for the local community. This may be an incitement to retain wattle to a certain extent.

Based on the above, our main question is as follows:

Considering both the wishes and needs of the locals, as well as environmental conditions and limitations, to what extent, and in which areas, should the wattle plantations be kept and managed? Furthermore, what are the possible alternative types of vegetation for the areas where the wattle tree is or has been removed?

Our main focus questions will be:

1) How is the present distribution and utilization of the wattle tree and other vegetation types that are perceived as resources in the village area?

2) What are the locals´ perceptions of the wattle tree, other vegetation types in the area and possible new alternatives? Do the locals feel that the present occurrence and distribution of available plant species fulfil their needs? Do they see any major problems? Would they like anything to be different?

3) What is the status of the local biophysical environment? How is it affected by the present vegetation? Can the biophysical environment sustain desired plant species?

Methodology

In order for us to find answers to our three focus questions we will be using both social- and natural scientific methods. The methods that apply to the first focus question are, participatory mapping, transect walk, and semi-structured interviews with the local villagers - preferably in that order, so that the map drawn during the participatory mapping can be utilised during the interviews. To answer the second focus question we will ask the villagers to rank the tree species according to their value as differing resources. We will also be using the semi-structured interviews with the villagers, as well as an interview with an informant from the Working for Water Project. The same informant will be interviewed to provide information in relation to the last focus question and an interview will also be conducted with Michael Underwood from the Forestry Dept. at the University of Natal. Furthermore, we will attempt to measure soil erosion potential and diversity and abundance of vegetational cover, as well as sampling soil from three different areas, to compare nutrient status, vegetative cover and erosion of areas with wattle, eradicated of wattle, and prior to wattle invasion. We will also examine the wattle leaves for their content of nitrogen.
Additional basic information on the area, e.g. infrastructure and market access, will be obtained from the other groups.

Following are specific details of each method:

Social scientific:

Participatory Mapping – From this exercise we would like to derive a map of the village and the surroundings; illustrating the distribution of the different types of vegetation, which areas that are used for what kinds of resources, the locals´ knowledge of the soil quality in the different areas, and the tenure rights. Moreover it can give us an idea of how far away the locals walk to utilize the different resources.
There should be two people from the group involved in the exercise; one to ask questions and the other to draw the map. We need three to four local villagers to participate in this exercise. They should be selected on the basis of their knowledge about the village territory and its soils. We expect this to last for about two hours (Detailed field tools for PLAR, p. 16). We want to make this map before doing the interviews with the households, since this will give us information on the vegetation pattern on the local land units, and which natural resources that are collected. This will make it quicker for us to ask the household informants about their utilization of natural resources.

Transect Walk – This can help us verify the village map, and maybe corrections will need to be done making it more accurate (Detailed field tools for PLAR, p. 24). Also by comparing it with the aerial photo and the satellite picture of the area, we can make corrections.

Semi-structured interview with local households – Here we will examine the villagers' utilization of and attitudes to the wattle, other vegetation present in the area, and new alternatives.

Semi-structured interview with a informant from the Working For Water Project. From this interview we hope to obtain information on the impact of the wattle, on the biophysical as well as the socio-economic environment.

Semi-structured interview with Mike Underwood from the Department of Forestry –
We expect this interview to provide us with a more scientific base to evaluate the impact of wattle on its surrounding environment, i.e. water supply, erosion, nutrient status, and socio-economic effects. We also hope to gain some knowledge on which species could be perceived as suitable alternatives to wattle.

Natural scientific methods:

Soil erosion measurement – We will be using two or more methods. E.g. infiltration measurement, A-horizon depth, table-values…. We want to investigate the erosion potential under different types of vegetation, and on different slopes. Exactly where the erosion should be measured might be clearer after the village map is made.

Soil sampling – We need to know about soil characteristics and nutrient composition of the differing areas. Soil samples should be taken in wattle areas, to determine the nutrient status of soil in the wattle areas, and furthermore in areas of natural vegetation where wattle has not yet encroached, to determine what effect the invasion of wattle has on the soil quality of the natural habitat/grazing land. Finally soil samples should be taken in natural occurrence areas of vegetation/species that may be planted in replacement of wattle in areas where wattle is removed, to assess whether the nutrient requirements of these plants are compatible with the nutrient status in the wattle eradicated areas. In each area there should be collected at least three samples from which we take an average, in order to minimize errors. It is important that

the samples are representative of the area from which they are taken. Samples will be taken from top soils and a core sampler/auger will be used (Voelcker 2002)

Measurement of nitrogen content in wattle leaves – Since the wattle tree supposedly is nitrogen fixing, (Bellamy 2002) we want to investigate whether there is an unexploited potential of nitrogen content in the leaves of the wattle tree, which then could be used as a fertilizer on the cropped fields/home gardens. This will be tested in the lab, prior to fieldwork. If the result shows high contents of nitrogen, we will ask the locals whether they are already utilizing this natural resource.

Vegetation-transect: Measuring occurrence and abundance of differing plant species.

We wish to measure the occurrence (diversity) and abundance of plant species in the three same areas where soil samples were measured; namely in an area invaded by wattle, an area where wattle has been eradicated, and one where wattle has not yet encroached. The objective of this is to compare the effect of wattle invasion on the diversity and abundance of species, as well as to identify changes in the regime of species composition and abundance in regeneration areas in comparison to the unincroached habitats. We will measure diversity and abundance of plant species by utilising pin point analysis, a method where a metal frame containing 10 evenly spaced pins, is placed over the vegetation at given intervals on a predetermined transect line, and all species touching one pin are recorded. Abundance of the species is the frequency of occurrence by "touch" (Økland 1990). The lengths of transects, number and distance between individual plots measured along transects will be determined when on site, although these variables must be identical for all three transects. An average of 20 plots per transect should be aspired for representative and statistical purposes. Plant species identification is done by use of a regional field guide.

Literature review

Forestry

Forest law in Eastern and Southern Africa: Moving towards a community-based forest future? (Wily, 2000).

Implications of co-management for benefits from natural resources for rural households in North-western Zimbabwe (Grundy et. al, 2000).

Company-community forestry partnerships: A growing phenomenon (Mayers, 2000).

Forest-product SMMEs in the Wild Coast spatial development initiative (Ndabeni, 2001).

Small-scale planted forests in Zululand**,** South Africa: An opportunity for appropriate development. (Cellier, 1999).

Forestry and streamflow reductions in South Africa: A reference system for assessing extent and distribution Scott, 1998).

Potential stimulation of local rural economies by harvesting secondary products: a case study of the central Transvaal Lowveld, South Africa **(**Shackleton, 1996).

Fruit Trees

An ethnobotanical study of indigenous fruit trees in Northern Cameroon (Tchiegang, 2001).

The use of and trade in indigenous edible fruits in the bushbuckridge Savanna Region, South Africa **(**Shackleton, 2000).

Invasive Species (e.g. Wattle)

A compensatory forestry approach to clearing alien invasive vegetation from riparian zones in a South African basin (Jewitt, 2002).

Soil and Water

Soil wettability in forested catchments in South Africa; as measured by different methods and as affected by vegetation cover and soil characteristics (Scott, 2000).

Managing riparian zone vegetation to sustain stream flow: Results of paired catchment experiments in South Africa.(Scott, 1999).

Erosion and sediment yield in relation to afforestation and fire in the mountains of the Western Cape Province, South Africa (Scott, 1997).

The Nature and Properties of Soils (12th Ed.) (Brady, 1999).

Methods for Assessment of Soil Degradation. (Lal, 1998).

Timber and fuel wood

Fuel woods used in rural South Africa **(**Dyre, 1996).

Basic information

The Geography of South Africa in a changing World (Fox 2000).

Previous SLUSE reports.

References

Brady, N. C. & Weil, R. R. (1999): **The Nature and Properties of Soils**. Prentice-Hall, Inc. New Jersey, United States.

Bellamy, D (2002): So what´s interesting about the common black wattle? http://www.backyardorganicgardening.com/native/wattle.html

Dahl, H; Jakobsen J; Raitzer D.A (2001): **Wattle eradication via the working for water programme, compared with wattle utilisation and management for Makomerang, South Africa.** Sluse report 2001.

Environmental and Development Agency Trust (E.D.A.T.): **Working for Water Improves Livelihoods**. http://www.eda.org.za/Annreprt99/wfw.html (Cited 27/l11-02).

Voelcker Consultants Environmental Science: Taking Soil Samples For Analysis:General http://www.voelckerscience.co.uk/soilsci/tssfag.html (cited 30-10-2002)

Appendix I

Semi structured interview with the households

Basic Information

Sex Male ☐ Female ☐

Age < 20 ☐ 20-30 ☐ 30-40 ☐ 40-50 ☐ 50+ ☐

Occupation: _____

Size of household: Adult males ☐ Adult females ☐ Children ☐

Domestic Animals (Write number of animals in Box)

Cattle ☐ Pig ☐ Poultry ☐ Goat/Sheep ☐ Horse ☐ Others, Specify_____ ☐

Sole dependence on local resources: Yes ☐ No ☐ if no specify,

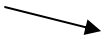
_____

Commercialisation of locally produced/collected products Yes ☐ No ☐

Distribution and utilization of local resources

Vegetation units / Resource							
Firewood							
Grazing							
Fodder							
Medicines							
Food							

Attitude on wattle and other vegetation

Wattle -positive 
-negative 

Desired extent of wattle:

Completely removed	Less	Same as present	More	Everywhere

Alternatives to wattle
- native 
- exotic 

Is expansion of commercialisation wanted? Yes ☐ No ☐

If yes, what products? _____

Vegetation fires

Why →

When →

Where →

Who →

What →

Opinions on fires →

Tenure system

Tenure/ownership / Vegetation	Private	Public	Gender	Age	Education/ Occupation	Clan	
Wattle							

Animals

Domestic animals – fodder
- grazing

Wild animals as resources – consumption
- spiritual
- aesthetics

Do you know whether changing the vegetation cover will have any effect on wild animal life?

_____

Appendix II

Semi-structured interview guide for informant from Working for Water Project

Local attitudes towards wattle and other vegetation

Do you know whether the locals want to keep or remove the wattle?

Do you think there is any other vegetation species that can be planted as an alternative to the wattle and still provide the same resources for the locals?

Do you think the locals would like to have new exotic species to be introduced into their area?

Biophysical Environment

Impacts of the wattle tree

- Positive →
- Negative →

Vegetation fires

- Knowledge →
- Opinion →

Effects of eradicating wattle

- Wild life →
- Soil quality →
- Erosion →

Appendix III

Semi-structured interview with Michael Underwood

Environmental impacts of wattle

Impact of wattle on the ground water – evidence?

Does it use more water than the other tree species in the area? – evidence?

Does the wattle use more water when it is growing in the riparian areas than it actually needs? – evidence?

What do you know about the wattle affecting the water supply in the adjoining communities? – evidence?

What impacts does the wattle have on erosion? – evidence?

Are there any problems with the wattle suppressing the growth of the other plant species? – evidence?

Wattle in the future and possible alternatives

Do you feel the wattle should be kept in order to provide resources to the local people?

If yes, to what extent and in which areas?

If no, what do you think should be the alternative species planted on the areas where the wattle is removed, keeping in mind that they should fulfil the local needs and wishes?

Do you only think species already growing in the area should be considered, or do you think there is possibility of introducing new exotic species?

Appendix V

Themes	Raw data	Sources of data	Methods	Analysis
Status of wattle and other vegetation	- Identification of present species. - Distribution of present species	- Local villagers - Aerial photo and satellite picture	- Participatory Mapping - Transect Walk - Direct observation	
Management of wattle and other vegetation	- Resources used from wattle - Resources used from other species - Land use - Tenure relations	- Local villagers	- Semi-structured interviews - Participatory Mapping - Transect Walk	
Locals´ opinions on wattle and other vegetation	- Local knowledge, wishes and needs	- Local villagers - Informant from WFW-project.	- Semi-structured interviews	
Biophysical impacts of wattle and other vegetation	- Identification of erosion potential. - Identification of water depletion by wattle - Identification of nutrient status. -The impact of wattle on species diversity and abundance	- Person from the Uni. Forestry Dept. - Literature	- Semi-structured interviews - Erosion measurement -Vegetation transect	
Possible alternatives to wattle	- Identification of species fit for the biophysical environment - Identification of species that fulfil local wishes and needs	- Michael Underwood - Literature - Local villagers - Soil quality	- Semi-structured interviews - Soil sampling	- Analysis of soil samples in the field or in laboratory in Denmark

Time Schedule

<table>
<tr><th>Date</th><th colspan="2">Fieldwork</th></tr>
<tr><td>Monday 13/1-03</td><td colspan="2">Arrival of Danish, Swazi and Durban group to Pietermaritzburg (afternoon). Lodging at Rehoboth Chalets. Briefing at Rehoboth.</td></tr>
<tr><td>Tuesday 14/1-03</td><td rowspan="4">Interview with Michael Underwood.</td><td rowspan="4">Joint preparation and consolidation of field study plan in Pietermaritzburg.

Introduction lectures to region and excursions to surroundings.</td></tr>
<tr><td>Wednesday 15/1-03</td></tr>
<tr><td>Thursday 16/1-03</td></tr>
<tr><td>Friday 17/1-03</td></tr>
<tr><td>Saturday 18/1-03</td><td colspan="2">Transfer to Madlangala (3-4 hours drive in minibusses). Accommodation and briefing - afternoon walk in villages and surroundings. Evening meeting.</td></tr>
<tr><td>Sunday 19/1-03</td><td colspan="2">Participatory Mapping & ranking (2 pers.). Soil erosion measurement (4 pers.)</td></tr>
<tr><td>Monday 20/1-03</td><td colspan="2">Transect Walk & testing of interview guides with translator (2 pers.). Soil erosion measurement (4 pers.).</td></tr>
<tr><td>Tuesday 21/1-03</td><td colspan="2">Interviews with households (2 groups with 3 pers.).</td></tr>
<tr><td>Wednesday 22/1-03</td><td colspan="2">Finishing interviews with households (2 groups with 3 pers.) – expect about 10 interviews total. Group discussion of general interview results.</td></tr>
<tr><td>Thursday 23/1-03</td><td colspan="2">Interview with informant from WFW-programme (3 pers.) (the necessarily this day, depends on informant´s availability). “Vegetation Transect” & soil sampling (3 pers.)</td></tr>
<tr><td>Friday 24/1-03</td><td colspan="2">Continue “Vegetation Transects & soil sampling” (3 pers.). Remaining task needed to be followed up on from the previous days.</td></tr>
<tr><td>Saturday 25/1-03</td><td colspan="2">Open to doing important missing tasks.</td></tr>
<tr><td>Sunday 26/1-03</td><td colspan="2">Open to doing important missing tasks.</td></tr>
<tr><td>Monday 27/1-03</td><td colspan="2">Return from Madlangala to Durban, Accomodation and briefing.</td></tr>
<tr><td>Tuesday 28/1-03</td><td colspan="2">Preparation of debriefing</td></tr>
<tr><td>Wednesday 29/1-03</td><td colspan="2">Preparation of debriefing</td></tr>
<tr><td>Thursday 30/1-03</td><td colspan="2">Preparation of debriefing - Debriefing at UDW</td></tr>
<tr><td>Friday 31/1-03</td><td colspan="2">Informative excursion to surrounding area
Farewell dinner for all staff and students</td></tr>
<tr><td>1/2-03</td><td colspan="2">Departure Pietermaritzburg</td></tr>
</table>