


**Assessing the values and impacts of invasive alien plants
on the livelihoods of rural land-users on the Agulhas Plain,
South Africa**

by

Samantha de la Fontaine

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(Conservation Ecology)*

at

The crest of Stellenbosch University, featuring a shield with a blue and gold design, topped with a crown and flanked by two figures. Below the shield is a banner with the Latin motto 'Pectora roburant cultus recti'.
Stellenbosch University

Supervisor: Prof. Karen J. Esler

Co-supervisor: Ms Rhoda Malgas

Faculty of AgriSciences

Department of Conservation Ecology and Entomology

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Declaration

By submitting this thesis electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

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Abstract

Invasive alien plants (IAPs) are known for their detrimental impacts on biodiversity and ecosystem goods and services. A substantial body of research has contributed to our understanding of their impacts on ecology. In comparison the socio-economic aspects of IAPs, are not well understood. Additionally, valuation practises have usually excluded the positive and the non-monetary impacts (benefits and uses) that IAPs hold for local livelihoods. Holistic valuation has been regarded as imperative for decision-making and managerial frameworks.

A study was conducted in Elim on the southern Cape coast of the Agulhas Plain, South Africa, which aimed to explore the various impacts of IAPs on the livelihoods of rural land-users. Individual qualitative interviews were conducted face to face with landholders (referred to as farmers) (N = 12) and individuals from the economically marginalized community (referred to as marginalized community) (N = 12). The grounded theory approach to data analysis was used and results of the coding method used were displayed by means of superscripts.

Results indicate that farmers were aware of broader uses of IAPs although they themselves did not utilise them as extensively as members of the marginalized communities. Invasive alien and problem plants that held value for both land-users were not perceived as being 'invasive'. Invasive alien plants were believed to have detrimental impacts on biodiversity and ecosystems goods and services which support people's livelihoods.

Alien clearing programmes such as Working for Water (WfW) and LandCare have done much to alleviate the socio-economic burden of unemployment in this marginalized community. Aside from the social development aims set out by WfW (i.e. employment of low-income communities, poverty alleviation and skills training), knock-on social development benefits (e.g. feelings of pride, responsibility and awareness as well as conflict management skills) were also realised by individuals from the marginalized community that were previously employed by the programme.

Farmers regarded alien clearing and management as a process that demands excessive time, energy and financial resources. On single occasions it was found that farmers employed

methods other than the conventional clearing and management strategies (e.g. livestock that feed on IAPs and giving refuse IAP biomass from clearing and felling to neighbouring poor communities). No clear consensus was reached about regarding alien clearing and management but more support is desired from government. Working for Water relies on private landholders for alien clearing as it is required by law.

This study emphasizes that stronger relationships between government and private landholders as well as more substantial incentives to clear IAPs on private land are prerequisites if required outcomes are to be achieved. Educating society at large about the detrimental impacts of IAPs is fundamental. Additionally, informing landholders on effective alien clearing methods and policies and legislation pertaining to it are key activities for the South African government. Finally, clearing and management programmes need to consider the benefits that local land-users obtain from IAPs when prioritising areas for the management of alien vegetation.

Opsomming

Uitheemse indringerplante (UIPe) is bekend vir die nadelige gevolge wat hulle vir biodiversiteit en ekosisteme goedere en dienste inhou. 'n Aansienlike liggaam van navorsing het bygedra tot ons begrip van die impak daarvan op ekologie. In teendeel, die sosio-ekonomiese aspekte van UIPe word egter nie goed verstaan nie. Daarbenewens, evalueringspraktyke het gewoonlik die positiewe en nie-monetêre impakte (voordele en gebruike) wat UIPe vir plaaslike lewensbestaan hou, uitgesluit. Holistiese evaluering word as noodsaaklik beskou vir besluitneming en bestuursraamwerke.

'n Studie was uitgevoer in Elim op die Suid-Kaapse kus van die Agulhas-vlakte, Suid-Afrika. Die doel was om die verskillende aspekte van UIPe impakte op die lewensbestaan van landelike grondgebruikers aan te spreek. Individuele kwalitatiewe onderhoude is van aangesig tot aangesig gevoer met grondeienaars (na wie verwys word as boere) (N = 12) en individue van die ekonomies gemarginaliseerde gemeenskap (na wie verwys word as gemarginaliseerde gemeenskap) (N = 12). Die gegronde teorie metode tot data analise was gebruik en die resultate van die kodering metode is vertoon deur middel van boskrifte.

Resultate dui daarop dat boere bewus was van 'n wyer reeks van gebruike van UIPe alhoewel hulle dit nie so ekstensief benut het soos die lede van die gemarginaliseerde gemeenskappe nie. Uitheemse en probleem plante wat waarde gehou het vir beide landgebruikers, was nie soseer beskou as 'indringers' nie. Daar was geglo dat UIPe nadelige impakte het op biodiversiteit en ekosisteme goedere en dienste wat mense se lewensbestaan ondersteun.

Programme soos Werk vir Water (WvW) en *LandCare* wat fokus op die uitroeiing van UIPe, het baie gedoen om die sosio-ekonomiese laste as 'n gevolg van werkloosheid in hierdie gemarginaliseerde gemeenskap te verlig. Benewens die sosiale ontwikkelings doelwitte uiteengesit deur WvW (o.a. indiensneming van lae-inkomste gemeenskappe, armoedeverligting en vaardighedsopleiding), is daar ook domino-voordele (bv. gevoelens van trots, verantwoordelikheid en bewustheid sowel as konflik bestuursvaardighede) aangaande sosiale ontwikkeling ervaar deur individue van die gemarginaliseerde gemeenskap wat voorheen in diens van die program was.

Boere beskou die uitroeiing en bestuur van UIPe as 'n proses wat oormatige tyd, energie en finansiële hulpbronne vereis. Op enkele geleenthede was dit gevind dat boere gebruik maak van metodes anders as die konvensionele skoonmaak-en bestuurs strategieë (bv. vee wat voed op UIPe en biomassa wat na afloop van skoonmaak aan die naburige arm gemeenskappe gegee word). Geen duidelike konsensus is bereik met betrekking tot die uitroeiing en bestuur van UIP nie, maar meer ondersteuning van die regering word verlang. Werk vir Water maak staat op private grondeienaars vir die uitroeiing van UIPe.

Hierdie studie beklemtoon dat sterker verhoudings tussen die regering en private grondeienaars sowel as meer aansienlike aansporings om UIPe op private grond skoon te maak 'n voorvereiste is as verwagte uitkomst bereik wil word. Opvoeding van die breër gemeenskap oor die nadelige impakte van UIPe is fundamenteel. Om grondeienaars in te lig oor effektiewe UIP verwyderingsmetodes asook beleide en wetgewing met betrekking daartoe, is belangrikste aktiwiteite vir die Suid-Afrikaanse regering. Ten slotte, skoonmaak-en bestuursprogramme moet oorweging skenk aan die voordele wat plaaslike landgebruikers put uit UIPe wanneer daar geprioritiseer word vir gebiede vir die bestuur van indringerplante.

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Chapter 1:

Introduction

1.1 Thesis statement

The impacts of invasive alien plants (IAPs) on biodiversity, and on ecosystem services and processes have been well documented in the literature (Richardson and Van Wilgen 2004, Pejchar and Mooney 2009). The primary focus of this type of research has been on the negative impacts associated with IAPs, however benefits have also been associated with some of these plants as they become adopted into local livelihoods (e.g. for building material, fuelwood, fodder and food source) (Kauffman 2004, De Neergaard et al. 2005, Shackleton et al. 2007, Kull et al. 2011, Shackleton et al. 2011). This has led to certain IAPs being regarded as “conflict of interest” species as they “simultaneously provide benefits and cause negative impacts” (Wise et al. 2012:80).

Limited research has addressed the issue of IAP impact on the livelihoods and well-being of local land-users* (McGarry et al. 2005, Shackleton et al. 2007, Kull et al. 2011). Resources for alien clearing and management are limited; instances where land-user needs conflict with management objectives should thus be avoided to prevent management actions from being prolonged. It is therefore critical to identify and quantify stakeholder perceptions of IAPs, and to unpack the sometimes multifaceted ways in which IAPs are integrated into local economies. In order to capture the full impacts that IAPs have on human well-being, research scoping beyond monetary costs and benefits is crucial (Pejchar and Mooney 2009).

This thesis reports on an investigation into the impacts of IAPs in the rural parts of the Agulhas Plain, Western Cape, South Africa. The purpose of this research was to provide a better understanding of the possible impacts of IAPs on the livelihoods of land-users in and around the small rural town of Elim. Perceptions, uses, costs and benefits associated with IAPs and the importance of these plants to the livelihoods of the local land-user communities were explored. This local knowledge can aid researchers and managers by providing context-

* For the purpose of this thesis, a land-user refers to an individual or group of individuals that reside in a rural setup (i.e. farm, town, etc.) and utilises the land or part thereof for subsistence, income, or any similar activity.

specific information about impacts and potential benefits of IAPs, which can then be used for prioritising clearing efforts.

1.2 Motivation

The detrimental effects of IAPs on ecosystems and biodiversity, ecosystem goods and services, the economy of human enterprises, and human health have been well documented in the literature (e.g. Geesing et al. 2004, Nel et al. 2004, Shackleton et al. 2007, see examples in Pejchar and Mooney 2009). Invasion by alien species have been reported as a major threat to the biodiversity and functioning of sensitive ecosystems (Turpie et al. 2003, Richardson and Van Wilgen 2004, Van Wilgen et al. 2008). Invasive species are very successful in competing for resources with native species and can modify fuel loads and change the amount of litter fall (Behenna et al. 2008). This alters natural nutrient fluxes such as shifting nitrogen content and nitrogen fixing legumes (Behenna et al. 2008). Dense stands of acacias along the rivers in the Western Cape of South Africa replace and exclude native fynbos species (Versfeld et al. 1998, Blanchard and Holmes 2008, Marais and Wannenburg 2008). Invasive alien plants also pose one of the greatest immediate threats to floral diversity in the fynbos (Turpie et al. 2003) and have the ability to capture vast amounts of water (Le Maitre et al. 1996, Dye et al. 2001, Le Maitre et al. 2002). While much is known of their ecological impacts, research exploring the effects of IAPs on the livelihoods of local, rural communities has received little attention (McGarry et al. 2005, Shackleton et al. 2007, Kull et al. 2011).

Not all of the impacts exerted by IAPs are negative (Bardsley and Edward-Jones 2006). Various plants have been introduced to South Africa for a variety of purposes (Van Wilgen et al. 2001). These include species introduced for their use in crop production, growth of timber and firewood, production of garden ornamentals, for dune stabilisation and for use as hedge plants (Van Wilgen et al. 2001). Several of these have become naturalized* and some of the naturalized species are now invasive (Van Wilgen et al. 2001). Costs are experienced when these invasive species impede the functioning of social and ecological systems (Bardsley and Edward-Jones 2006). Benefits, on the other hand, are experienced when the same traits (such as hardiness and high fecundity) that lead to these species becoming invasives, contribute to their usefulness (Bardsley and Edward-Jones 2006).

* Exotic species become naturalized once established populations spread and reproduce unaided. This process is also referred to as naturalization (Richardson et al. 2000, Emerton and Howard 2008).

Rural communities are exposed to IAPs in different ways (Shackleton et al. 2007). The outcome is that these communities have to weigh up the trade-offs between the possible positive benefits of IAPs as a natural resource and the negative impacts exercised by these species on ecosystem goods and services, and in turn, on human livelihood (Shackleton et al. 2007). It is generally accepted that the negative effects of IAPs on ecosystem goods and services are transferred directly to human well-being (Shackleton et al. 2007). This has been disputed by researchers such as De Neergaard and others (2005), Shackleton and others (2007, 2011) and Kull and others (2011) who illustrated that IAPs can be integrated into the lifestyles and livelihoods of local communities as a source of tannins and timber, for firewood, for building material, as well as for medicinal extractions and financial income from selling firewood.

Working for Water (WfW), a nation-wide South African IAP clearing and management programme, was launched in 1995 with the aim of restoring natural capital by controlling invading species and enhancing water security (Van Wilgen et al. 1998, De Neergaard et al. 2005). Simultaneously, the programme aims to alleviate poverty by providing employment to underprivileged communities (Van Wilgen et al. 1998, De Neergaard et al. 2005). To date, the WfW programme has developed into one of the biggest conservation projects in Africa with regard to manpower, costs and impact (Hosking and du Preez 2002, Hobbs 2004). Significant amounts of government funding (R 4 951 909 spent by 2010, WFWP 2013) have contributed towards extensive areas being cleared (~2 269 955 ha cleared by 2010, WFWP 2013) and a large numbers of individuals being employed (Binns et al. 2001, Turpie et al. 2008). However, the socio-economic benefits and possible impacts of the WfW programme have not been wholly assessed (Binns et al. 2001, Kepe et al. 2004, Magadlela and Mdzeke 2004, Turpie et al. 2008, Buch and Dixon 2009, Hough and Prozesky 2012). The use of these plants by rural communities is not well understood and an understanding of the consequences of clearing programmes on livelihoods is seldom integrated into alien clearing programmes (De Neergaard et al. 2005, Shackleton et al. 2007, Peter 2009).

Identifying and capturing land-user's perception on the impacts of IAPs is essential in order to effectively control and manage these species (Peter 2009). While ecological knowledge of invasives is critical to comprehend anthropogenic impacts on ecosystems an enhanced and more nuanced understanding of the social issues related to invasives is just as vital to advise species management as well as conservation policies (Shackleton and Gambiza 2008, Peter

2009). There is currently a lack of information concerning the socio-economic impact of invasive alien species in South Africa. The range of invasive plant impacts (both socio-economic and ecological) is not well understood even in well researched areas such as the Cape Floristic Region (CFR). Consequently, there is a need for comprehensive research that investigates the holistic impacts (both negative and positive) and values of IAPs on the livelihoods and well-being of local communities.

1.3 Goals and Objectives

Considering the above, the objective of this study was to assess the effects and impacts of IAP infestation on human well-being, with the focus on the effects of IAPs on the livelihoods of rural land-users in the Western Cape, South Africa. The main research question* that directed the study is as follows: *What are the impacts of invasive alien plants on the livelihoods of rural land-users?* This research question was broken down in to eight key questions. These key questions were adapted from the literature (see McGarry et al. 2005).

1.3.1 Key Questions

- i. What are people's attitudes towards and perceptions of IAPs?
- ii. How important are IAPs for human well-being and livelihoods?
 - Are the IAPs used for sustenance, or for domestic requirements?
 - Are IAPs sold to provide an income?
 - Does the local community perceive IAPs as having a positive or negative impact on spirituality, culture and/or aesthetics?
- iii. What is the significance of the natural environment to the community?
- iv. How do IAPs in the area affect the supply of (other) ecosystem goods and services which are important to people's livelihoods?
- v. What is the impact of IAP distribution on land-use practices?
- vi. What are people's attitudes towards IAP management?

* Qualitative research is mostly guided by one or more research questions and is in contrast to a hypothesis as stated by Willig (2001). Firstly, a hypothesis is a claim which is a result of existing theory and can be tested against empirical evidence. Secondly, a hypothesis can also either be rejected or accepted. By contrast, a research question is open-ended and cannot be answered with a simple 'yes' or 'no'. A research question thus requests for an answer which portrays detailed descriptions.

- vii. What are the impacts of IAP clearing programmes on livelihoods?
- viii. What are the trade-offs that rural land-users make with regard to their attitudes, uses and management of IAPs?

Key questions i – vii were addressed in chapters 3 and 4, the primary difference between the two chapters being the target land-user group focused on (i.e. marginalized community and farmers). Question viii was addressed in the final chapter 5.

By addressing these questions, plausible and empirical data can emerge, giving environmental managers in the area an enhanced understanding of the social perspective and valuation of IAPs (*cf.* Richardson et al. 2011). To answer these questions, study site selection was critical. The study site needed to be an area where rural communities are still highly reliant on generating an income from the land and where invasion was prominent. The Agulhas Plain, situated within the Cape Floristic Region (CFR), was selected as the focus area for this study as it met the above mentioned criteria.

1.4 Study area

The Agulhas Plain is located between 19°30' and 20°15' south, and 34°30' and 34°50' east within the CFR which is internationally known as a global biodiversity hotspot (Turpie et al. 2003). The CFR, known for its Mediterranean type climate, is the most floristically rich of the nine diverse biomes allocated in South Africa with an estimated 9600 plant species of which 70% are endemic (Richardson and Sekhran 2009). The Agulhas Plain, comprising an area of 270 000 ha, is located at the southern-most tip of South Africa and is known for its fire-prone coastal lowland fynbos and infertile soils (Richardson and Sekhran 2009). Rainfall on the Agulhas Plain is the highest in the mountainous regions located in the southwest where mean annual precipitation has been recorded as high as 3 000 mm per annum. It is internationally recognised as a “centre for endemism” (Turpie et al. 2003).

This area is however increasingly threatened by habitat transformation and alien plant invasion (Heydenrych et al. 1999, Privett et al. 2002, Turpie et al. 2003), the latter being the focal point of this study. Fynbos wildflower farming and harvesting, particularly from natural vegetation, forms an integral part of this area's economic activity and contributes immensely to the region's agricultural sector (Treurnicht 2010). This has been shown by Turpie and

others (2003) who stated that natural fynbos vegetation is estimated to be accountable for 57.6% of the CFR's financial turnover, estimated to be R90.5 million in the year 2000. The Agulhas Plain is responsible for the largest part of this turnover.

1.5 Study limitations

Due to the time limitation of this study as well as the large area covered by the Agulhas Plain (~2 160 km²), it was not possible to conduct a systematic and exhaustive research in all the areas on the Agulhas Plain where IAP infestation occurs. It was thus decided to focus on a detailed case study on the socio-economic impacts of IAPs for a particular community of land-users and to gather as much information as possible through interviews with key stakeholder (i.e. land-user) groups. Accordingly, land-users in the rural town of Elim and the surrounding farming communities were selected as the study group.

1.6 Case in point: a rural town on the Agulhas Plain

The rural town of Elim, a Moravian mission station located on the Agulhas Plain, was selected as the focus area of this research project. Elim was founded in 1824 when the Moravian Church bought the farm Vogelstruyskraal (Killian 1996). The farm had an excellent perennial water supply and was therefore renamed after the biblical oasis (found in Exodus 15:27) (Killian 1996). The town is currently home to approximately 2 500 individuals and is situated 46 kilometres from Cape Agulhas, the southernmost tip of Africa (Van der Hoven 2001).

Elim and the surrounding area comprise the endemic Elim fynbos which can be categorized into four groups i.e. asteraceous fynbos, acid sand proteoid fynbos, renosterveld and wetlands (Killian 1996, Van der Hoven 2001). The more recent vegetation classification associates Elim and the surrounding area with Elim Ferricrete Fynbos (Mucina and Rutherford 2006) (see Figure 3.1, page 59). This vegetation type spans an area of approximately 66 556 ha and is listed as endangered, with only 5.5% currently under protection (SynBioSyS Fynbos 2011). A total of 315 indigenous plant species are found in Elim of which seventeen are listed as Red Data species and fifteen are endemic to the Agulhas Plain (Killian 1996). Adjacent to the town of Elim lies the private nature reserve *Geelkop* (Eng. Yellow head), which is home to

some of the most rare indigenous fynbos species (Wolfart 2006) and covers an area of 450 ha (Van der Hoven 2001). The name is derived from the picturesque yellow-flowering plants that the hill is enveloped with during spring (Van der Hoven 2001). Various farming practices occur in Elim and the surrounding area which include grain farming, animal husbandry and the more recent cultivation of rooibos and honeybush (own observation) (see also Appendix A, page 139). Vegetable gardens are kept by the community members with the plots mainly situated on the edge of the town to the north (own observation).

Thirty non-indigenous plants are identified in the Agulhas National Park's Management plan (2009:11), a conservancy close to Elim. Of these, several are IAPs known to invade Elim and the surrounding farms to varying degrees (Killian 1996).

The Table Mountain Sandstone and Bokkeveld ranges are the two most important geological formations in Elim (Van der Hoven 2001). The former is made out of thin layers of highly erosion resistant sandstone while the eroded Bokkeveld range gives rise to the rolling landscape which surrounds the town (Van der Hoven 2001). The soils occurring in this region have higher concentrations of phosphorous and nitrogen compared to the surrounding Bredasdorp mountain soil types (Van der Hoven 2001).

The Moravian church presently owns about 6 500 hectares of land on the Agulhas Plain that is managed by twelve community leaders (Killian 1996, Van der Hoven 2001). This group, called the Overseer's Council (Afr. *Opsienersraad*), is democratically elected by the inhabitants of Elim and is the active legitimate local authority in charge of a variety of institutional functions (Killian 1996, Van der Hoven 2001). The land is administered for the benefit of both the Church and the community (Killian 1996). Elim and the surrounding farms fall under the jurisdiction of the Overberg District Municipality in accordance with the national and provincial authorities (UN-Habitat 2012). The town and the surrounding farms fall within the Nuwejaars Wetland Special Management Area (NWSMA) which extends across the boundaries of the local Overstrand and Cape Agulhas municipalities and is located within the Overberg District Municipality (Paige 2012). Unique wetlands occur in the area (Paige 2012:84) and the special management area's (SMA) goals and objectives include the restoration and sustainable use of wetlands and natural habitats associated with it (Paige 2012:12). The Breede-Overberg Catchment Management area (BOCMA) is responsible for strict enforcement of water use regulations in the area (BOCMA 2012). Farmers have to

apply for the use of water for irrigation purposes and depending on the availability of water, they have to make use of groundwater sources through bore holes (BOCMA 2012).

The community also receives its water from a new reservoir which was completed in the year 2000 through the collaborative work of the Overseer's Council, the community, the Overberg District Municipality as well as the then National Monuments Council (now South African Heritage Resource Agency, SAHRA) (UN-Habitat 2012). "Sewer outfalls and oxidation ponds" as well as "a water reticulation system and ringfeed" were also constructed and completed in 1999 (UN-Habitat 2012:4). Before then, the local inhabitants had no proper sanitation and drainage system and still had to make use of the unhygienic latrine and bucket system (UN-Habitat 2012).

One of the major social problems facing the town is the high unemployment rate (Killian 1996). Detailed census data from 2008 illustrated that approximately 27.4% of the total economic population (114 923 individuals) in the Overberg District lived on a monthly income ranging between R 801 and R 1 600 (Statistics SA 2008). Approximately 25.5% of the total economic population were then recorded as unemployed (Statistics SA 2008). Census data of the year 2011 (not as detailed as that of 2008) illustrated the Overberg District's poverty rate* at 29.6 % (the district's total population size is 258 176) (Western Cape Government Provincial Treasury 2011). The WfW programme has been active in Elim since 1996 (Ibsen 2002) and has provided jobs that have eased much of the socio-economic tension as a result of unemployment (UN-Habitat 2012). Amongst the supporters for alien clearing was the Norwegian Government who funded the Elim WfW programme for three years (Ibsen 2002). This funding was primarily directed towards project running costs and wages (Ibsen 2002:117). The South African nationwide LandCare programme (under the national Department of Agriculture, Forestry and Fisheries, DAFF) also assisted with alien clearing initiatives in Elim and the surrounding farming areas in the past (Cloete, pers. comm.†) as well as the upgrading of arable land in Elim (UN-Habitat 2012). This land (approximately 4 111 hectares), is leased out by the Overseer's Council to aid with sustainable income used for the benefit of the community (UN-Habitat 2012).

* The poverty rate represents the percentage of people living in households with total earnings less than the poverty income. The latter is defined as the minimum monthly income needed to support a household. The monthly income necessary to keep a single person household out of poverty in SA was estimated at R 1 315; R 2 544 for a four person household and R 4 729 for an eight or more person household.

†Sustainable economic development officer, Elim.

1.7 Study site selection

Elim and the surrounding farming communities were chosen as a suitable study site for the following reasons:

- i. It was established during the visits prior and during a pilot study (May and July 2012) that this rural settlement and its neighbouring farms use woody IAPs as source of energy. The various uses of IAPs within and around the study were however only further explored during the formal research periods.
- ii. It was noted during field visits that the areas surround the settlement of Elim as well as the neighbouring farms are heavily invaded with *Acacia saligna*, *Acacia longifolia*, *Leptospermum laevigatum* and *Pinus* species.
- iii. Alien clearing and management programmes have been active in the area on various occasions since 1996 i.e. WfW as well as Landcare under the auspices of the Department Water Affairs (DWA; now under the Department of Environmental Affairs, DEA) and DAFF respectively.

Elim is thus a site which is still heavily invaded, despite several clearing and management efforts in the past, and in which people seem to have found positive use for what could otherwise be perceived as a negative set of circumstances.

1.8 Thesis outline

The thesis comprises of the following parts: an introduction (this chapter), literature review (Chapter 2), two research chapters (Chapters 3 and 4) and a conclusion with proposed implications for conservation management (Chapter 5). Chapters 3 and 4 were written as individual research papers thus one can expect some degree of overlap in content between these chapters. This is as these two chapters are intended to be submitted as research articles between myself and my supervisors. Comments and suggestions were made by my supervisors to enhance the draft chapters for final submission. The various chapters of this thesis consist of the following:

Chapter 1: Introduction

This chapter includes the thesis statement, the underlying motivation for the study as well as the study aims and questions that the researcher wishes to address through the study. It also includes a background of the study area, limitations which formed the research design and ultimately led to the selection of the study site.

Chapter 2: Literature Review

A review of the literature on IAPs in South Africa, their impacts on biodiversity, ecosystem goods and services as well as IAP valuation and how it links with livelihood and human well-being.

Chapter 3: Invasive alien plant value and impact – a marginalized community’s perspective

Two land-user groups were interviewed for this research project i.e. a marginalized community and the adjacent farming community. Using a qualitative research design based on a grounded theory approach to data analysis, this chapter addresses the impacts (both positive and negative) and values of invasive alien plants for the first group.

Chapter 4: Invasive alien plant value and impact as perceived by farmers on the Agulhas Plain

This research chapter addresses the perceived values and impacts of invasive alien plants on a farming community on the Agulhas Plain. A qualitative research design based on a grounded theory approach to data analysis was followed.

Chapter 5: Key findings, recommendations and conclusion

This chapter synthesizes the key findings of the data chapters and presents an overall conclusion including recommendations and points for consideration in management practice and future research endeavours. The chapter also includes a reflection on the methodology used to conduct the research with (Chapters 3 and 4).

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Chapter 2:

Literature Review

2.1 Ecosystems, ecosystem services, human well-being and livelihoods

2.1.1 The link between ecosystems and human well-being

An **ecosystem** collectively refers to all microorganism, plant and animal communities (i.e. biotic components) that interact with their immediate non-living environment (abiotic components) (MEA 2003a, 2005). Examples of some of the primary ecosystems found worldwide include coastal areas, marine and inland water regions, forests, islands as well as deserts (MEA 2003a, 2005). These and other ecosystems are essential for human survival as the benefits and support supplied by ecosystems contribute towards human well-being (MEA 2005, WWF 2010). The benefits and support referred to here are commonly known as **ecosystem services** and can be both tangible and intangible (Costanza et al. 1997). The Millennium Ecosystem Assessment (MEA) which was established by the United Nations, divided ecosystem services into four distinctive groups i.e. **regulating**, **provisioning**, **supporting** (also habitat) and **cultural services** (MEA 2003a).

When products and material goods are obtained from ecosystems in the form of benefits, for example food and water, these are referred to as **provisioning services**. **Regulating services** are attained once processes regulate an ecosystem (e.g. water purification through wetlands). The intangible services of an ecosystem that supply human beings with e.g. religious, spiritual, educational and recreational benefits are grouped under **cultural services**. Services such as the photosynthetic production of oxygen by green plants and nutrient cycling fall are categorized under **supporting services** (also habitat services). The latter service is deemed the most important component necessary for the production of the other ecosystem services (see De Groot et al. 2010:263 for a detailed outline of these respective groups and their associated examples). Ecosystems also contribute **disservices** i.e. the facilitation of species or services that contribute to negative impacts on others e.g. the spread of invasive alien propagules through water systems (Sukhdev et al. 2010). Disservices must be considered

when trade-off analyses (benefits and costs) are being conducted (Sukhdev et al. 2010). Research on ecosystem services has strongly increased in the past decade (Sukhdev et al. 2010). This has contributed towards the scientific robustness and credibility of ecosystem services research as well as information for decision-makers in both the public and private sector (Sukhdev et al. 2010).

The decisions that humans make can lead to actions that have impacts on the natural environment which can change ecosystem structure and functioning (Sukhdev et al. 2010). These changes can then affect ecosystem services which in turn can have impacts on human well-being (Sukhdev et al. 2010).

2.1.2 Human well-being

Human **well-being** has been defined as a “condition in which every individual of a society is able to determine and meet their needs with a large range of choices to meet their potential” (Prescott-Allen 2001:13). Ecosystem services are linked to human well-being either directly or indirectly (Costanza et al. 1997, MEA 2003b, De Groot et al. 2010). The definition for human well-being was further developed by the MEA (2003b:71) and states its five interlinked components as “the basic material needs for a good life, freedom and choice, health, good social relations and personal security”. A person’s well-being is also dependant on various factors which include the individual’s surrounding environment and geography as well as gender, age and culture (MEA 2003b). Above all, ecosystems and the services they provide remain a major contribution towards human well-being (MEA 2003b, Ring et al. 2010, see also Box 1.1 of the MEA 2005:19) as supported by The Economics of Ecosystems and Biodiversity’s (TEEB) definition (i.e. “the direct and indirect contributions of ecosystems to human well-being”, Sukhdev et al. 2010).

Human well-being and ecosystems are indivisibly linked and a better understanding of these links can contribute to information necessary for decision-making and the upkeep of the natural environment (Sukhdev et al. 2010).

2.1.3 Livelihoods and livelihood strategies

Livelihood has been defined as the congregation of **assets** (basic materials and social wealth at people’s disposal), **capabilities** (abilities to cope with stress) and **activities** (use of assets

and capabilities) necessary for people to sustain their life (Scoones 1998, Babulo et al. 2008). An individual's livelihood is regarded as sustainable when the individual can manage to deal with and recuperate from stress, while assets are maintained and improved on without degrading the natural environment (Babulo et al. 2008). In addition, **livelihood strategies** refers to the variety and combination of decisions that people make and activities they carry out in order to accomplish (livelihood) goals (Babulo et al. 2008). According to the Department for International Development (DFID 1999:1), livelihood goals aspired to by most people are increased income, enhanced well-being, low level in vulnerability, enhanced security as well as sustainable use of available natural resources.

Marginalized groups make use of and are dependent on a variety of livelihood strategies in order to fulfil livelihood goals (Hajdu 2006) and often these are derived from products as well as services provided by natural areas and resources (Petheram et al. 2006). Examples include livestock farming and agricultural activities as well as harvesting from wild resources (De Neergaard et al. 2005, Shackleton et al. 2007a, Shackleton et al. 2007b). Households pursue different livelihood strategies based upon the assets that are available to them and the livelihood goals they wish to achieve (Hajdu 2006). Households within rural areas of developing countries such as South Africa, depend daily on free access to available resources for subsistence and also as a source of income (Petheram et al. 2006). In many instances it is the only option for survival (Petheram et al. 2006).

A variety of livelihood strategies are undertaken by rural land-users on the Agulhas Plain, on the southern Cape coast of South Africa (and the region within which this study was undertaken). The availability of resources is a key criterion for diversifying livelihood strategies and various means of income generation (DFID 1999). This, in turn, allows for livelihood flexibility, and people with flexible livelihood options are thus less susceptible and vulnerable to change (i.e. stresses) (DFID 1999). In the context of the present study invasive alien plants are considered from the livelihood perspective of rural land-users on the Agulhas Plain.

2.1.3.1 Livelihoods and livelihood strategies on the Agulhas Plain

Rural settlements and small towns on the Agulhas Plain are mostly inhabited by descendants from the indigenous Khoen-Khoen or Khoi tribes (Killian 1996, Van der Hoven 2001). These communities are regarded as marginalized as they were disadvantaged by the former

apartheid government of South Africa (Heydenrych et al. 1999, Privett et al. 2002). The majority of private land on the Agulhas Plain is under white ownership and is mainly utilized for commercial agricultural purposes (Heydenrych 1999, Heydenrych et al. 1999, Privett et al. 2002). Of the agricultural activities practised in the area, nearly 50% is under livestock production followed by fynbos flower farms which covers approximately 28% of the Agulhas Plain (Heydenrych 1999). Heydenrych (1999) established that harvesting from natural fynbos for the wildflower market is the largest agricultural sector on the Agulhas Plain. This is followed by the cultivated fynbos sector which is also on the increase (Heydenrych 1999). Several farmers also practice mixed farming methods with a small number of farms focused on game farming or set aside for conservation purposes (Heydenrych 1999). As a result of the erratic nature of employment within certain parts of the agricultural sector, the industry offers limited and infrequent income. Unemployment in the region is thus substantially high. The area has experienced an increase in immigration by potential job seekers from the Eastern Cape Province thereby increasing unemployment in the region (Heydenrych et al. 1999, Privett et al. 2002). To sustain livelihoods, individuals from marginalized communities in this region make use of a combination of livelihood strategies which include wildflower picking, seasonal work from different agricultural sectors and part-time land rehabilitation and management through government initiated enterprises (Conradie 2010). In addition, wood is cut and sold for economic gain by local wood merchants. For livelihoods in this rural context to exist, access to resources is vital for land-users.

2.1.3.2 *Accessibility to resources and property rights*

It is a common phenomenon worldwide that resources are limited and can only support a certain portion of the population adequately. Land is increasingly being placed under pressure as human populations grow. This is a result of increased land usage for purposes such as accommodation, grazing and crop production. Garrett Hardin (1968) referred to the overexploitation of resources on a single piece of land as the ‘tragedy of the commons’ (Feeny et al. 1990). His conclusion therefore was the need for the development of property rights with regards to land ownership (Feeny et al. 1990). Property rights instil owners with the ability to utilise their land to get financial support through either lease agreements or selling it to another party (Feeny et al. 1990). Crucial to the property rights regime is that owners have the right to prohibit others from utilising the land (Feeny et al. 1990).

The Moravian church in Elim on the Agulhas Plain is the current legal rights holder of an area which spans approximately 6 500 ha (Van der Hoven 2001, UN-Habitat 2012). This system, referred to by the general English term usufruct, is similar to the traditional *ejido* system in Mexico, where individuals or groups are allowed to utilise and gain profit from a property legally owned by another individual or group of individuals (De Vany and Sanchez 1979). Elim is thus a corporate property that is surrounded by land that is privately owned by farmers for subsistence as well as commercial farming. As a result, people are excluded and restricted in accessing natural resources which fall within the boundaries of a property owned by another individual e.g. wood merchants in Elim can only freely access wood on the land owned by the Moravian church and are restricted from freely accessing wood on the surrounding privately owned land.

Four known property rights regimes exist in the literature i.e. state, open-access, common as well as private property (Demsetz 1967, Feeny et al. 1990). For the purpose of this thesis, focus was on the private property rights regime as both Elim and the surrounding farms are privately owned (i.e. corporate property is also a form of private ownership).

Private property regimes came to pass due to increased pressure on land where resources access was open to all (Demsetz 1967, Feeny et al. 1990). To further prevent the loss of open-access resources, land and commonages were divided amongst users to ensure individual private rights. The latter led to exclusivity and allowed the owners to keep individuals of their property and search for alternative land (Demsetz 1967, Smith 1981, Feeny et al. 1990).

As a result of private property rights, the following applies: less users, a reduced amount of externalities thus fewer control costs and less disorganization (Demsetz 1967, Smith 1981, Feeny et al. 1990). A lower number of consumers contribute to reduced pressure on resources, and this allows for regeneration and nominal occurrence of exploitation (Demsetz 1967, Smith 1981, Feeny et al. 1990). This is true if consumers only utilize a certain portion of the land under private ownership (Demsetz 1967). Private property owners also work for their own income (i.e. commercialization), the land is also taken care of and this increases its value i.e. there is a motive of profit attached to it. Thus, the close relationship which private property regimes allow between owners' actions and the effects thereof enables them to learn from and incorporate externalities better as opposed to land under little or no governance (Demsetz 1967, Smith 1981, Feeny et al. 1990).

There are also potential costs associated with privatisation. The land shortages worldwide are because a large percentage of land is under ownership of a small proportion of individuals that can afford it (Feeny et al. 1990). The end result is that people are excluded from areas that could potentially provide a basis for livelihood options (Feeny et al. 1990). Additionally, large portions of land that are of higher quality are normally under private ownership and used for purposes such as grazing while crop farming by the marginalised is often practised on land of poor quality (Demsetz 1967). Capitalism, in for example Thailand, is a display of this scenario i.e. the more money you have the better arable land you can afford which means the better quality yield and production, whereas the poor, such as rice farmers, can only afford what their pockets can offer (i.e. limited finances, inferior land) (Cornia 1985). This thesis focuses on private property only, to avoid complications associated with comparisons.

Apart from the restrictions brought about by private property regimes, invasive alien plants (IAPs) can cause further constraints on livelihood options.

2.2 Invasive alien plants

2.2.1 Definitions

Exotic species were intentionally introduced to areas outside their indigenous ranges during the early colonial era around the 19th century (Carruthers et al. 2011). The driving forces behind the global cross-continental human mediated movement of exotic species included production (e.g. plants for timber and crop production) and aesthetic sensibility (Mack et al. 2000, Kowarik 2003, Carruthers et al. 2011). The term **alien** has been assigned to such species, serving as a reminder that these are non-indigenous organisms located outside their native ecological context (Emerton and Howard 2008). When the characteristics (e.g. ability to survive, reproduce and spread unaided at vast rates across ecosystems) that had once made them favourable were found to be problematic they were deemed **invasive** (Van Wilgen and Van Wyk 1999, Richardson et al. 2000, Van Wilgen et al. 2001). Invasive alien species are now widely known for their detrimental economic and ecological impacts (Richardson 1998, CBD 2002, Kunwar 2003), and are rarely regarded positively in the literature, or in practice.

Species become invasive through processes which include (a) introduction to an area, (b) establishment, (c) spread and (d) naturalization, whether intentional (human-mediated) or

unintentional (accidental) (CBD 2002, Perrings et al. 2002, Emerton and Howard 2008). The movement of people and goods as well as the transformation and fragmentation of habitats have been shown to contribute toward the **introduction** of exotic species to an area (Mack et al. 2000). **Establishment** is the survival of alien species in their new found environment (Emerton and Howard 2008). **Naturalization** occurs when established populations spread and reproduce unaided yet they do not excessively inhabit ecosystems (Richardson et al. 2000, Emerton and Howard 2008). **Invasion** follows when naturalized species spread unaided beyond sites of introduction, normally to the disadvantage of other naturalized or indigenous species (Richardson et al. 2000, Emerton and Howard 2008).

The notion of **transformer** species arose more recently. Transformer species have been recognised as the most damaging invasive species as they possess characteristics (i.e. consume vast amounts of resources, add undesired resources (such as nitrogen) and endorse or inhibit fire which can lead to soil erosion) capable of changing the nature or form of considerable parts of an ecosystem in relation to the extent of that ecosystem (Vitousek et al. 1997, Emerton and Howard 2008). These transformer species also have the ability to alter abiotic resources such as habitat availability, light as well as water (Vitousek et al. 1997). This has resulted in transformer species being regarded as **ecosystem re-engineers** (Richardson and Van Wilgen 2004).

2.2.2 Invasive alien plants in South Africa and the Western Cape Province

2.2.2.1 *History and spread*

Many alien plants have been introduced to South Africa for a range of purposes, which include crop production, sources of timber, firewood, ornamentals, as well as for use in dune stabilization and as structural barriers and as hedge plants (Stirton 1978, Avis 1989, Van Wilgen et al. 2001, Nyoka 2003, Kull et al. 2011). A large number of these plants have become naturalized and some have become invasive (Van Wilgen et al. 2001). It was reported in 1999 that there are approximately 750 tree and 8 000 shrubby, succulent and herbaceous species that have been introduced to South Africa (Van Wilgen and Van Wyk 1999). Of these, 38 herbaceous, 13 succulent and 110 woody species (a total of 161 species) are regarded as serious invaders and these figures have been estimated to increase in the future (Van Wilgen and Van Wyk 1999).

Consciousness with regard to invasive alien plant (IAP) impact on South African ecology dates back as early as the late 1800's (Turpie 2004, Carruthers et al. 2011). Strong opinions were raised as early as 1894 by botanist Peter McOwan against the planting of *Acacia mearnsii* (black wattle) that was encouraged by the colonial botanist, Ferdinand von Mueller (Stirton 1978, Carruthers et al. 2011). Von Mueller (1853 – 1896), a Government botanist from Victoria, Australia, was promoting Australian plants as he believed “that it was his duty to spread useful plants around the world” (Carruthers et al. 2011:812). The promotion of IAPs in South Africa was also strongly discouraged by Charles Lane Poole (in the early 20th century), E. Hutchins (in 1902) and Rudolf Marloth (in 1908) (Stirton 1978, Van Wilgen 2009, Carruthers et al. 2011). Yet despite their efforts, the South African government of that time still actively pursued the planting of non-native species by providing seeds to farmers to promote large scale cultivations, mainly because of some use or perceived benefit. Examples of such species include *A. mearnsii* (Carruthers et al. 2011), *Prosopis* species (Zimmerman 1991) and *Acacia* species along the coast of South Africa (Avis 1989). During the late twentieth century it was realised that these species were becoming invasive and were having serious detrimental impacts on the unique floral diversity in the Cape (Van Wilgen et al. 1997, Carruthers et al. 2011). It was only then that the need for clearing of IAPs became apparent (Van Wilgen et al. 1997, Carruthers et al. 2011).

Invasive alien plant species been estimated to occupy more than 10 million ha totalling 8% of land coverage across South Africa (Versfeld et al. 1998, Wynberg 2003, Macdonald 2004). Of these areas, most invasions are concentrated in the south-western and eastern coastal areas as well as the adjacent interior (Henderson 2007). This includes the fynbos and forest biomes of South Africa, as well as the more moist regions of the grassland and savannah biomes (Henderson 2007, see Figure 2.1 (page 25) for a display of the nine biomes of South Africa). Amongst these biomes, fynbos was reported as being the most extensively invaded indigenous vegetation type (Henderson 2007). The Fabaceae family are regarded as the most extensive invaders across the nine biomes of South Africa with *A. mearnsii* considered the most conspicuous invader (Henderson 2007). In addition to *A. mearnsii*, *Acacia saligna* (Port Jackson) and *Acacia cyclops* (Rooikrans) are the most prominent invaders in the fynbos biome (Henderson 2007). Henderson (2007:218) listed 20 IAPs as the most serious invaders found in the fynbos biome.

2.2.2.2 Impacts of invasive alien plants on biodiversity

South Africa is one of the most species rich and biologically diverse countries in the world (Cowling et al. 1996, Turpie et al. 2008). The country represents just over 1% (1.1 million km²) of the earth's total land surface, yet it encompasses 10% of the known plant, bird and fish species and well over 6% of identified mammal and reptile species. This exceptional biodiversity is, however, threatened by expanding human populations, urbanization and land transformation with regard to agricultural expansion and invasive alien species (Heydenrych et al. 1999, Privett et al. 2002, Turpie et al. 2008).

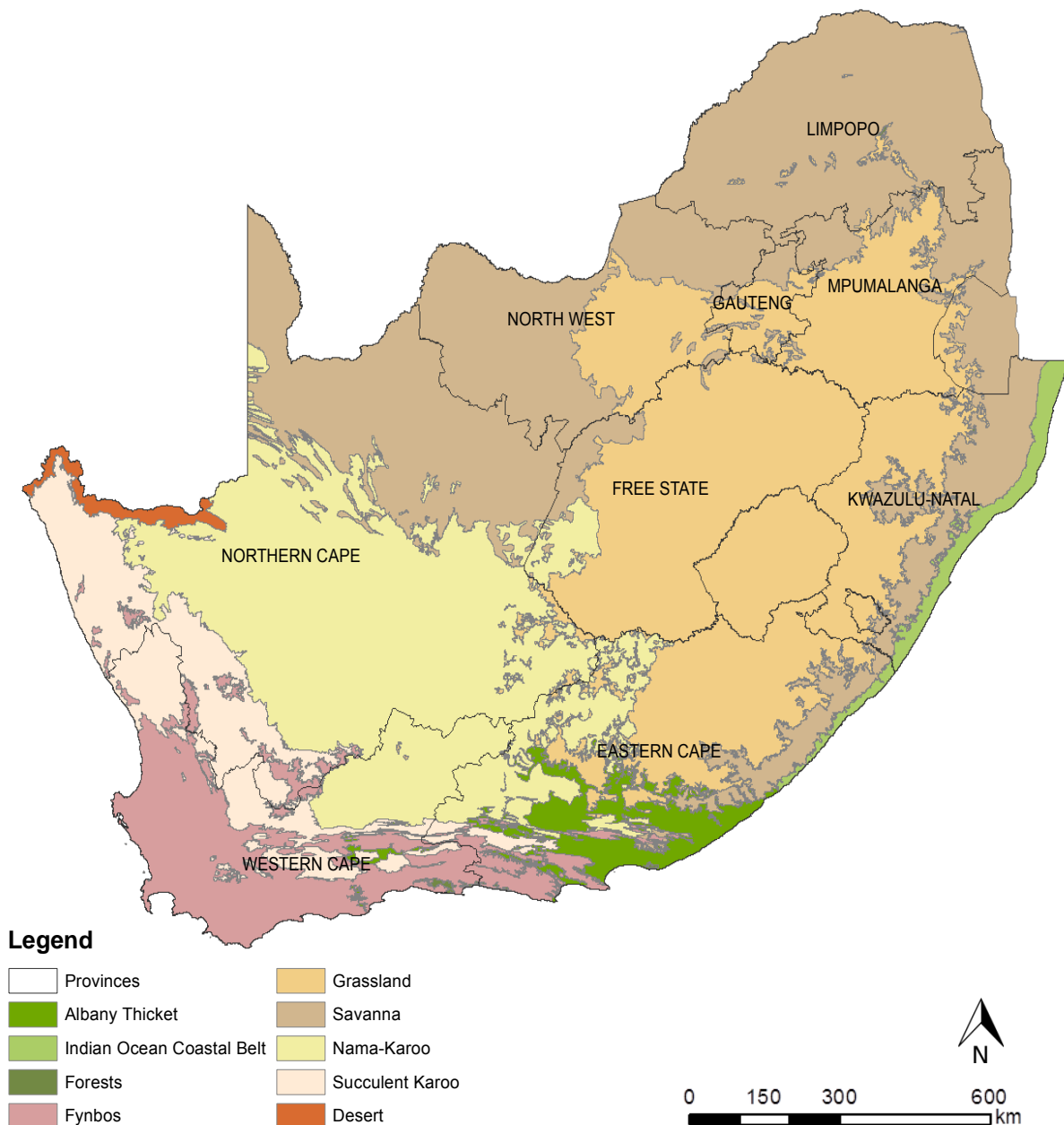


Figure 2.1: The nine biomes and provinces of South Africa (Mucina and Rutherford 2006). (Source: Megan Nowell)

A vast area (~10 million ha) of South Africa's land surface has been invaded by IAPs (Versfeld et al. 1998, Wynberg 2003, Macdonald 2004). While their impacts have not been wholly assessed, these impacts cannot be disregarded (Van Wilgen and Richardson 2012). Research thus far has indicated that the costs of these impacts are significant (Holmes and Cowling 1997, Richardson and Van Wilgen 2004, Behenna et al. 2008). Richardson and Van Wilgen (2004) have stated that indigenous fynbos species' abundance and diversity can be vastly reduced by dense stands of alien trees and shrubs. As an example, Holmes and Cowling (1997) illustrated that dense stands of *A. saligna* have the potential to reduce the seed bank of indigenous fynbos plants which can potentially lead to the local extinction of the latter. Biodiversity forms an integral part of ecosystem goods and services on which human livelihood is centred and negative IAP have the ability to undermine livelihoods.

2.2.2.3 *Impacts of invasive alien plants on water resources*

South Africa is considered a water scarce country with an average rainfall of 450 mm per annum (SA Government Online 2012). Water availability per capita per annum is between 500 m³ and 1000 m³ (Turpie et al. 2008). An increase in population size (Falkenmark 1990, Smakhtin et al. 2001) parallel to the abolishment of *apartheid* in South Africa in the early 1990's, gave rise to an increase in water demand and supply. This was as the new democratic constitution included equal and sustainable water availability to all (The Constitution of the Republic of South Africa, Act 108 of 1996, Section 27). Water that is imported from neighbouring countries as surface water is heavily relied upon, and groundwater holds inadequate resources for meeting the country's water demands (Turpie et al. 2008). The increase in water demands have generally been met by engineered systems that make it possible for water to be transferred throughout immense distances (Smakhtin et al. 2001, Savenije and van der Zaag 2002, Turpie et al. 2008). Rising costs as a result of increase in supply and diminishing options for dam placements have made these solutions less viable. Accordingly, 11 (previously 12) of the 19 water catchment areas in South Africa have to receive water from transfer schemes as they are short of water (Turpie et al. 2008, DWA 2013). Supplementary solutions to enhance water availability have therefore been highlighted (Turpie et al. 2008).

Some alien plants have been found to consume excessive amounts of water in contrast to indigenous vegetation (Le Maitre et al. 1996, Dye et al. 2001, Le Maitre et al. 2002, Le

Maitre et al. 2007). Given its prevalence (Versfeld et al. 1998, Wynberg 2003, Macdonald 2004), invasion by alien species has increased substantially within just two decades in riparian zones (see Table 2.1).

Invasion by alien plants in riparian zones, river courses and catchment areas is regarded as a significant problem as they can alter stream flow through an increase in biomass (Versfeld et al. 1998, Marais and Wannenburg 2008).

Table 2.1: An indication of the substantial increase in riparian invasions from 1998 to the year 2008.

Publication	Year information was released	Total riparian area invaded in South Africa
Versfeld, Le Maitre and Chapman	1998	460 000 ha
Marais and Wannenburg	2008	857 200 ha

The Western Cape's water catchment areas have been heavily invaded (Le Maitre et al. 2000, Marais and Wannenburg 2008). Le Maitre and others (2000) estimated that invasive aliens utilize up to 3 300 million m³ of water annually which accounts for up to 6.7% of the country's mean annual runoff. In the Western Cape alone this totals to one third of the total water consumption (Le Maitre et al. 2000). In a study done by Nowell (2011), where remote sensing techniques were used to determine the hydrological benefits that IAP removal might have on the Agulhas Plain, it was established that IAP clearing could increase total water availability by approximately 36 million m³. Water is critical for economic growth and development, yet IAPs have the ability to impose upon, stem and undermine human improvement (Le Maitre et al. 1996, Dye et al. 2001, Le Maitre et al. 2002). An understanding of how IAPs impact rural livelihoods and well-being is crucial, as it is these individuals' land and water supply that are most affected (Shackleton et al. 2007a).

2.3 Valuation, invasive alien plants and human livelihoods

2.3.1 Valuation

Valuation is defined as “the process of expressing a value for a particular good or service in a certain context (e.g. of decision-making) usually in terms of something that can be counted, often money, but also through methods and measures from other disciplines (sociology, ecology, and so on)” (MEA 2003a).

The Economics of Ecosystems and Biodiversity (TEEB) study states that valuation has the ability to project people’s traditions, their “relationship with the environment and reflects particular perceived realities, worldviews, mind sets and belief systems”. Valuation can also help to render human beings to reflect on their relationship with the environment and thus aid towards knowledge regarding “consumption, choices and behaviour” and the consequences thereof (Sukhdev et al. 2010). As a result of the deep rooted social aspect of valuation, any act of valuation is normally individual or group specific (Sukhdev et al. 2010).

Both the Millennium Ecosystem Assessment (MEA 2003a) and TEEB (Sukhdev et al. 2010) study makes a clear distinction between ecological, socio-cultural and economic benefits and values. Value is defined in the Millennium Ecosystem Assessment (MEA) as “the contribution of an action or object to user-specified goals, objectives, or conditions”. When specific needs of people are met and fulfilled, this is referred to as benefits (Sukhdev et al. 2010). How people value these benefits are specific to each individual and people can value the same benefit differently e.g. some people may value their religion higher than their social connections (both are social benefits, Sukhdev et al. 2010).

2.3.1.1 *Economic valuation*

Ecosystems are regarded as commodities owing to the goods and services they provide (Costanza et al. 1997, MEA 2003a). **Goods** refer to the tangible products derived from ecosystems i.e. timber, firewood, etc. while **services** denotes the benefits derived from ecosystem functioning i.e. water regulation, pollination, nutrient cycling, etc. (Costanza et al. 1997, MEA 2003a, Turpie et al. 2003). Human society can benefit from these ecosystem goods and services either directly or indirectly (**use values**) or value these benefits for their potential future use or gain (**non-use values**) (MEA 2003b). Together, they constitute what is

known as **total economic value** (TEV) of ecosystems goods and services (MEA 2003b, Sukhdev et al. 2010).

According to the TEV framework described in the Millennium Ecosystem Assessment (2003b), use value can be split into direct use value, indirect use value and **option value** with the latter referring to the future values that ecosystems may hold (see Figure 2.2). The **direct use** value of ecosystems are further categorised into consumptive and non-consumptive groups according to their purposes. **Consumptive direct use** values include uses for activities such as livestock grazing or resource harvesting (such as cutting and collecting wood for firewood). **Non-consumptive direct use** values on the other hand, includes ecosystems valued for cultural and recreational services, such as aesthetics of ornamental plants. **Indirect use** values refer to services such as regulation and support provided by ecosystems. Examples include the purification of water by wetlands, and enhanced soil nutrition through soil microbe actions. **Non-use values** are referred to as **existence value** which normally incorporates aspects such as intrinsic valuation.

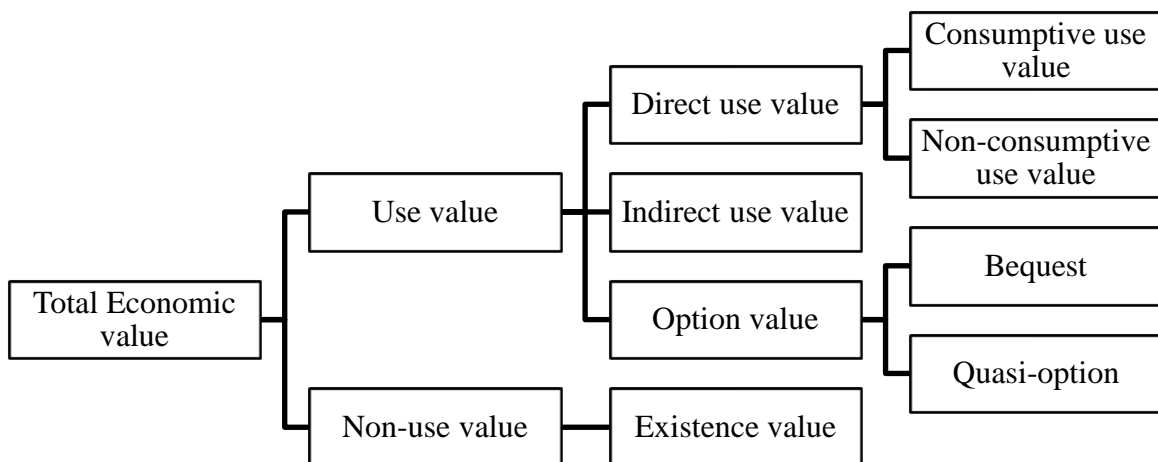


Figure 2.2: Total economic value framework (adapted from MEA 2003b).

It is essential to take into account that ecosystem goods hold economic value for humans. This is especially so for the consumptive direct use value category. Goods and services sold for economic gain are defined as those that hold economic value i.e. **marketed** or marketable **consumptive direct use values**. Examples include wood, fruit and vegetables sold as a

means of income. Products used for household consumption and not sold for economic gain fall within the non-marketed consumptive direct use value category.

The TEEB study stipulates that one can measure most of these values (i.e. direct, indirect, option, existence and their respective subdivisions) in monetary terms. Techniques include market pricing, shadow pricing and questionnaire based data collection each with varying degrees of accuracy (Sukhdev et al. 2010). Monetary valuation is the most common metric in economics yet it fails to incorporate values to display the “relationship between society and nature” i.e. values that cannot be measured in monetary terms (Sukhdev et al. 2010). These include human well-being (e.g. freedom of choice, intrinsic values and human rights) as well as ecosystem services and benefits of non-use value (existence i.e. cultural, philosophical, spiritual, etc., Sukhdev et al. 2010). Other techniques to analyse the significance of ecosystem services in order to incorporate values that cannot be measured in monetary terms include livelihood and vulnerability assessments as well as capabilities approaches (Sukhdev et al. 2010). The TEEB (Sukhdev et al. 2010) study states that even though monetary valuation can only partially capture the full value of ecosystem services, the results thereof are crucial with regard to “decision-making at all levels”. The TEV framework was however only designed for the monetary valuation of natural ecosystem goods and services and does not incorporate benefits and uses obtained from invasive alien plants (IAPs) as this study aims to do. The researcher did however draw on the terminology used for the different categories found within the TEV framework to illustrate how the impacts and values of IAPs interlink with the TEV framework (see Chapters 3 and 4), despite their negative impacts natural ecosystems, human health and livelihoods.

2.3.1.2 *Ecological benefits and values*

Ecosystems and their various components worldwide play an important role with regard to the upkeep of vital life support processes (e.g. photosynthesis for the conversion of light energy) (MEA 2003a, Sukhdev et al. 2010). Scientists have depicted the ecological value of ecosystems by means of the relationship of its underlying parts, e.g. the importance of one species for the survival of another species or even for the entire ecosystem (Sukhdev et al. 2010).

Indicators used to measure ecological value include ‘integrity’, ‘health’ and ‘resilience’ (Sukhdev et al. 2010). These indicators are important in assessing the critical threshold as

well as the minimum requirements necessary for ecosystem service delivery (Sukhdev et al. 2010). Valuation of ecosystems is described as the “importance people attach to a healthy, ecologically stable environment” that contributes both to human survival and intrinsic importance (Sukhdev et al. 2010).

Ecological value is still highly debated and it has been argued that the measurements thereof is too complex to be added to economic valuation and can therefore not be used to express individual preferences (Sukhdev et al. 2010). Natural ecosystems is however critical for human survival and the importance thereof should be recognized (Sukhdev et al. 2010).

2.3.1.3 *Social values and benefits*

Natural ecosystems and the biodiversity that it constitutes have long been a non-material source of well-being because of their spiritual, religious, ethical and historical (intrinsic) value (Sukhdev et al. 2010). Methodologies and frameworks within economic valuation have managed to capture a wide range of values (see the TEV framework as example, page 29), yet social values cannot be fully encapsulated by economic valuation techniques (Sukhdev et al. 2010). Other means of measurements have been developed (such as the Human Well-being Index) in order to inform decision-making processes, yet it has been argued that these are very complex and not readily available (Sukhdev et al. 2010).

2.3.1.4 *Valuation: Practical examples from South Africa and invasive alien plant valuation*

Ecosystems provide valuable goods and services. The Cape Floristic Region’s (CFR) total economic value for instance has been estimated at R 10 000 million per year (R 7 = ca. US\$ 1 in 2000) (Turpie et al. 2003). This is equivalent to more than 10% of the region’s Gross Geographic Product (GGP^{*}) (Turpie et al. 2003). Detrimental impacts imposed by IAPs have the ability to undermine these benefits. The value of fynbos ecosystems has been reduced by invasion to such an extent that costs are estimated at approximately US\$ 11.75 billion with the cost a single invasive species, *A. mearnsii*, estimated at US\$ 1.4 billion (Van Wilgen et al. 2001). Turpie and others (2003) estimated net loss of fynbos due to IAPs at R 684 million per

^{*}The Gross Geographic Product (GGP) is used as an income indicator. The GGP is equivalent to the income received through the production factors’ (i.e. entrepreneurship, labour, land and capital) contribution in each province (Statistics SA 1998:2).

year (~US\$ 77 million; R 8.9 = ca. US\$ 1 in November 2012). On the Agulhas Plain alone, total costs of invasion have been estimated at US\$ 3.2 billion (Van Wilgen et al. 2001).

Invasive alien plants may also provide benefits to the functioning of ecosystems and to human populations. Acacias have been well integrated into local livelihoods (Kull et al. 2007, Kull et al. 2011). *Acacia mearnsii* is culturally integrated into the native Xhosa tradition and used to build *abakweta* huts for the initiation process of young males (Shackleton et al. 2007a). The prickly pear *Opuntia ficus-indica* is used as a form of subsistence and for medicinal purposes by local communities in the Eastern Cape Province of South Africa (Shackleton et al. 2007a, Shackleton et al. 2011). The turnover of firewood and poles used for construction material by underprivileged household on the Cape flats in the Western Cape Province was estimated in 1992 at US\$ 1 and US\$ 7 million respectively (Kull et al 2011). The average net income from firewood harvested in areas in the fynbos densely invaded with *A. cyclops* was estimated at R 148 ha per year (Turpie et al. 2003). These businesses are normally small and operated at a local level. National and sub-national scale assessments hardly take them into account (Shackleton et al. 2007a) and these operations are not always accounted for in the country's Gross Domestic Product (GDP) (Turpie et al. 2003). This is a frequent problem in valuation studies (McGarry et al. 2005, Shackleton et al. 2007a) as relatively few studies have measured household income attributed to goods and services obtained from woodlands (Shackleton et al. 2007b). It is therefore regarded that officials at regional and national scale bear little knowledge of the benefits that rural communities obtain from IAPs (McGarry et al. 2005, Shackleton et al. 2007a) and hence IAP control programmes rarely incorporate the current needs of rural communities (Pimentel 2002, Rouget et al. 2002, Olson 2006, Pejchar and Mooney 2009).

It is essential to take into account the “direct production impacts and secondary/tertiary effects” as well as the positive (beneficial) and negative (costs) of invasives during ecosystem valuation procedures (Emerton and Howard 2008:44). Emerton and Howard (2008) proposed a framework that focuses on the direct and indirect, positive and negative, **economic impacts** of invasive species (see page 44 of Emerton and Howard 2008). The framework mainly focuses on impacts of invasive species on agricultural and land production services as well as the impacts of IAP management. It does however not incorporate either use values or non-use values gained from invasive species (as with the TEV framework for ecosystem valuation)

(compare with Figure 2.2, page 29). In this regard, the positive role of IAPs seems to have been neglected.

Valuation has been regarded as imperative concerning decision making as trade-offs can play an important role in the outcomes of the decision making process (Winpenny 1991, Grimble and Wellard 1997, Siges et al. 2005, Hein et al. 2006, de Groot et al. 2010). Decision-makers at private, corporate as well as government level are confronted with balancing social, ecological as well as economic values (Sukhdev et al. 2010). The TEEB study suggests that due to these values' complex valuation nature, each component should be valued and analysed on its own (Sukhdev et al. 2010). Hence, the complex nature of decision-making requires robust valuation methods which are not necessarily readily available.

It has also been stipulated that when valuation is applied, one must clearly distinguish between the direct use and the indirect use values as well as benefits derived from ecosystem services (Sukhdev et al. 2010). Valuation should also aim to include the total value of the ecosystem and not only marginal values (Sukhdev et al. 2010).

Also, management, research and policy in the past have usually only focussed on economic valuation, not taking into account the ecological and social valuation that might exist for land-users (De Neergaard et al. 2005, McGarry et al. 2005, Shackleton et al. 2007a, Peter 2009, Ring et al. 2010). This is also evident in invasion biology* which normally excludes the holistic valuation of invasive species i.e. the costs as well as benefits brought about by these species on the livelihoods of local land-users (Emerton and Howard 2008).

This thesis thus draws on the categories used within Emerton and Howard's (2008) framework that aims to illustrate the economic impacts of IAPs. The term "economic" as it occurs within the categories of the above mentioned framework is used, though this thesis does not focus on monetary values. The gaps and links within the TEV and the Direct and Indirect Economic Impact frameworks (Emerton and Howard 2008) with regards to IAPs will be drawn upon in order to construct a framework that aims to illustrate the values and impacts (negative and positive) of IAPs as perceived by rural land-users (see page 135).

* Research focussing on invasive alien species (Kueffer and Hirsch Hadorn 2008, Richardson and Pyšek 2008).

2.4 Invasive alien plant management in South Africa

2.4.1 The dynamics of eradication, prevention, control and management of invasive alien plants

The **eradication** of invasive species has been defined as “the complete and permanent removal of all wild populations of an alien plant or animal from a defined area, by means of a time-limited campaign” (Genovesi 2007:385). While **control** refers to the “the reduction of population density and abundance in order to keep damage at an acceptable level”, **containment** actions are aimed at “limiting the spread of a species by containing its presence within defined geographical boundaries” (Genovesi 2007:385). Genovesi (2007:389) stipulates that eradication is only possible when the entire entities of the population of interest that are capable of reproduction can be removed with no possibility of future reinvasions. The eradication of invasive plant species is regarded as particularly challenging since these species normally have dormant life cycle stages (soil seed banks) as well as high reproductive and dispersal rates (Genovesi 2007, Emerton and Howard 2008). The complete successful eradication of invasive plant species have however been reported in single cases (e.g. Soria et al. 2002, Waterhouse and Zeimer 2002, Wotherspoon and Wotherspoon 2002). It should be noted that these cases reported of eradications that were done in remote areas (mainly on islands) or where infestations were in its early stages. The eradication of an established invasive alien species is exceptionally difficult and in most cases virtually impossible (Rejmánek and Pitcairn 2002). Yet, the management and control of invasive alien plant species is of great importance as there are clear instances where these species are responsible for losses in biodiversity, with detrimental changes to ecosystem structure and functioning as well as to the delivery of ecosystem services (see pages 23 – 27 for examples).

The financial costs of invasive species management are, however, huge and funds are not always readily available (Le Maitre et al. 2000, Van Wilgen et al. 2012b). Infestations are rarely detected during the beginning phases of invasion when population numbers are still low, and this contributes to alien clearing and management being such a costly process (Shine et al. 2000). Invasion control is thus mainly practised when alien plants have spread extensively and have become well-established within ecosystems (Shine et al. 2000, Genovesi 2007). Long-term control and even containment must be taken into account when eradication is impractical (Shine et al. 2000, Genovesi 2007, Emerton and Howard 2008).

Several methods to control invasive alien plants (IAPs) exist in South Africa. These include manual and mechanised removal, burning and the application of herbicide (i.e. chemical control) (Van Wilgen et al. 2012a). Additionally, biological control agents as well as integrated pest management have also been invested in so as to target specific alien plant species (Van Wilgen et al. 2012a). These methods do however have their limitations, and careful planning is deemed necessary in order to reach the desired outcome (i.e. enhancement of biodiversity, ecosystem services and human livelihood) (Shine et al. 2000). Hence, an integrated approach whereby all of the above-mentioned methods are utilised, with the focus on control instead of eradication is currently underway in South Africa (Cock 2003).

South Africa has been aware of the issues pertaining to IAPs as early as the early 1800's (Avis 1989, Van Wilgen et al. 1997, Turpie 2004, Van Wilgen 2009, Carruthers et al. 2011). The first policy in South Africa which directly addressed IAP clearing and management transpired under the regulations of the Conservation of Agricultural Resources Act (CARA, Act No. 43 of 1983). Accordingly, 57 IAPs were then affirmed as "noxious weeds" (Van Wilgen 2012). The Act was amended in 2001 and now comprises 198 species listed under "declared weeds and invader plants" that are divided into three categories (Van Wilgen 2012, see also Table 3 of CARA for more detail). The National Environment Management Biodiversity Act (NEMBA, Act No. 10 of 2004) that came into force on the seventh of June 2004, also includes a chapter (Chapter 5) that deals with alien and invasive species (Van Wilgen 2012). The regulations with regard to this specific chapter have only recently been finalized and are in the process of being implemented (see DEA 2013).

Subsequent the first democratic elections in 1994, South Africa became one of the countries (193 Parties, as of December 2009) party to the Convention on Biodiversity (CBD) in November 1995 (Van Wilgen 2012). Article 8(h) of the CBD stipulates that "Parties to the Convention are required, as far as possible and as appropriate, to prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species" (CBD 2008:11).

The above-mentioned illustrates that the South African government has accordingly devoted itself to the management of invasive alien species. This is embodied through legislative instruments such as CARA and NEMBA that provide the framework against which invasive alien management must take place within the country (Van Wilgen 2012). This commitment is also displayed through the post-apartheid government's obligation to the CBD. An IAP

clearing programme, known as the Working for Water programme, has since been brought to light in South Africa with a widespread alien clearing approach on a national-scale (Van Wilgen et al. 1998, Van Wilgen et al. 2012a, Van Wilgen et al. 2012b).

2.4.2 The Working for Water programme

The Working for Water (WfW) programme was launched in 1995 by the South African Government, and endorsed by the then Minister of Water Affairs and Forestry, Prof. Kader Asmal (WFWP 2003, Hobbs 2004, Turpie et al. 2008). The programme's initial proposal was as follows:

Pilot projects for the eradication of invasive alien plants in water catchment areas: A plan to increase the water availability in a way that strongly promotes the goals of the RDP (WFWP 2003:13).

The programme formed part of the Reconstruction and Development Programme (RDP) initiated in 1994 by the South African Government as part of a number of initiatives to address the socio-economic matters in order to develop the country's living conditions (WFWP 2003). Amid the country's growing concerns around environmental degradation, the post-apartheid government sought to jointly address the issue of poverty alleviation and biodiversity conservation (Kepe et al. 2004). The WfW programme has since evolved to become an effective and efficient poverty relief instrument (WFWP 2000) and additionally "one of the most successful integrated land management programmes in the world" (Hobbs 2004:501). The programme's objectives (WFWP 2000:2, WFWP 2003:30) have been developed to include the following:

- i. Enhance water security.*
- ii. Improve the ecological integrity of natural systems.*
- iii. Restore the productive potential of the land.*
- iv. Invest in the most marginalized sectors in South Africa and enhance their quality of life through job creation.*
- v. Develop economic benefits from wood, land, water and trained people.*

Accordingly, the programme is aimed at employing individuals from marginalised low-income communities to clear IAPs from river catchment areas and water courses in order to restore natural capital and enhance water security (Van Wilgen et al. 1998, De Neergaard et al. 2005). The programme was launched with an annual budget of R 25 million in 1995 (Magadlela and Mdzeke 2004, Turpie et al. 2008) and a substantial amount of money allocated to the programme is retrieved from the government's Poverty Relief Fund (Binns et al. 2001). Working for Water has expanded rapidly and by 2005 it was running on an annual budget of more than R 400 000 million (Turpie et al. 2008). By then the programme has employed 32 000 people and cleared around 1.2 million ha of estimated area invaded in South Africa (Macdonald 2004). As of 1995, 3.2 billion rands (approximately 457 million US\$) has been spent by WfW on alien clearing and management (Van Wilgen et al. 2012a). The employment of large number of people still persists even though wages are set below market standards (Buch and Dixon 2009) and employment is only temporary (Kepe et al. 2004). The programme also provides training on effective alien clearing methods with additional social upliftment skill related developments through HIV/AIDS awareness as well as health and nutritional schemes, childcare and financial planning (Buch and Dixon 2009). The WfW programme has been considered an effective instrument for social and economic development (Binns et al. 2001) and has been commended for the substantial employment and poverty relief benefits that it provides (Hobbs 2004, Magadlela and Mdzeke 2004). The programme also relies on and incorporates IAP management through biological control* with the aim of reducing the invasiveness of invasive species (Moran et al. 2005, Impson et al. 2011, Klein 2011, Moran et al. 2011) without adversely affecting the commercial wood market (Moran and Hoffman 2012).

The WfW programme has also been critiqued by several authors. While Binns and others (2001) highlighted broad research concerns i.e. environmental and socio-economic impacts not being well enough investigated, Magadlela and Mdzeke (2004) were particularly concerned with detailed research relating to monitoring the effects of the programme on households and how tangible its HIV/AIDS schemes are. The sustainability of the programme has also been of great concern. Buch and Dixon (2009) pointed out that although the WfW programme has encouraged positive, solid social development, it was neither sustainable nor substantial. Additionally, Hough and Prozesky (2012) argued that low-income

* The use of natural enemies (predators, competitors, parasites, parasitoids, pathogens, antagonists and phytophages) for the management and control of pest organisms (invertebrates that feed on plants, plant pathogens, disease vectors as well as weeds) (Emerton and Howard 2008).

communities employed by WfW become dependent on financial gain generated through the programme as well as social structures formed within it. Methods to maximize people's chances to remain in employment after being employed by the programme have also been emphasized (Magadlela and Mdzeke 2004, Hough and Prozesky 2012). According to Kepe and others (2004), grave controversies arise from WfW's interrelated poverty relief and biodiversity conservation initiative. They raised the concern of IAPs being an essential source as either fuelwood or food to underprivileged communities and that the benefits obtained from these alien clearing programmes (remuneration, training, etc.) will at no time outcompete the benefits that these communities obtain from these plants (Kepe et al. 2004). An additional momentous issue is that WfW is widely perceived as a job creation scheme and that the programme's main objectives (i.e. alien clearing in order to enhance biodiversity and water availability) are not being regarded as important (Van Wilgen et al. 2012a). Concerns have been raised with regard to job losses if the focus of the program is shifted to promote its effectiveness in order to enhance natural "resources and ecosystem services that are vital for development and well-being" (Van Wilgen et al. 2012a:35). Additionally, effective biological control is an added concern with regard to labour-intensive job losses (Van Wilgen et al. 2012a).

2.4.3 The LandCare programme

The South African Government launched the nationwide LandCare programme in 1997 (Ntlokwana 2011). LandCare's Implementation Framework was released two years after its initial launch and captures the objectives envisioned for this programme by the government (see LandCare SA 1999). The programme was initiated to address the impacts of deterioration in soil quality due to mismanagement as well as a lack in monitoring and implementation of good practice (Paige 2012). In order to prevent further losses, sustainability of the land as a future resource is thus essential (Paige 2012). LandCare was also established to assist legislative bodies in ensuring sustainable development and resource management through the implementation of management actions (LandCare SA 1999). The foundation of the programme is strong community-based initiatives and incorporates both private sector and public participation (LandCare SA 1999). The programme is also aimed at dealing with poverty in rural areas through sustainable job creation (LandCare SA 1999). LandCare South Africa is spearheaded by the Department of Agriculture at the provincial level. It also has strong ties with WfW, which is now held by the Department of

Environmental Affairs, via the LandCare secretariat which “supports the Interprovincial LandCare Working Group in carrying out its responsibilities and functions” (LandCare SA 1999).

Similar to the WfW programme, LandCare has been critiqued regarding its poverty relief objective. Kepe and others (2004) have questioned the connection between LandCare’s integrated land management objectives and poverty relief, pointing how difficult these outcomes are to measure.

2.4.4 Integrated invasive alien plant management on private land

Working for Water’s involvement in alien clearing on privately owned land is presented in a document titled: “Working for Water Programme Circular: Approach to work on private land” and was released during July 2008 (WFWP 2008). This document states that land-owners are responsible and can be held accountable for the control and management of IAPs on their land through CARA* and NEMBA† (WFWP 2008). These acts make landowners liable for clearing invasive alien plants (IAPs) from their land. To date these acts have not been strictly enforced. This document also states that WfW provides aid to land-owners regarding alien clearing (WFWP 2008). Land-owners are also assisted with herbicide and whenever WfW are unable to aid land-owners the responsibility of alien clearing and management still remains with the latter (WFWP 2008).

Apart from the alien clearing and management supported by WfW on state owned land, a project linking the sustainable removal of invasive plants on privately-owned land with the employment of low-income groups is managed by LandCare under the auspices of DAFF (Germishuys, pers. comm.‡). A land-owner in need of labour for the initial removal of IAPs can apply for assistance and DAFF will compensate for 100% of the labour costs and safety equipment required (Germishuys, pers. comm.). Transport, machinery and additional costs must however be covered by the land-owner (Germishuys, pers. comm.). Much emphasis has been placed on monetary incentives, motivational tools as well as a more firm infringement of policies in order to encourage IAP clearing on private land (Urgenson et al. 2013, Van Wilgen et al. 2012b). While WfW depends on private land owners to clear on their land (Van

* Conservation of Agricultural Resources Act No. 43 of 1983

† National Environment Management Biodiversity Act No. 10 of 2004

‡ LandCare District Manager; Overberg District Municipality

Wilgen et al. 2012b) the reality is that as a result of the high costs concerned, landowners are unable to act in accordance with CARA and WfW's request except if infestation levels are exceptionally low (Turpie 2004, Urgenson et al. 2013).

2.4.5 Conflict of interest in the management of invasive alien plants

A lack in the generation and implementation of systems for the prevention and management of invasive alien plants (IAPs) is a worldwide concern (Cock 2003). This is mainly driven by the economic and developmental benefits that societies gain from these plants (Cock 2003). Conflicts of interest arise when these essential alien species spread beyond the areas where they are cultivated (Wise et al. 2012). Examples include *Pinus* and *Acacia spp.* for the forestry and firewood industries respectively (Higgins et al. 1997). The benefits that many invasive species hold result in scenarios whereby regulations are complicated, both on a political and social level (Baskin 2002, Wise et al. 2012).

Some countries invest substantially in exotic plants for a variety of reasons; hence reluctance to initiate management actions against those species that have become invasive is inevitable (Cock 2003). For IAP control to be effective, management actions must aim to achieve both socio-economic and ecological sustainability (Shine et al. 2000). Conflicts regarding IAPs and their management must be handled in a sensitive approach, taking into account the grievances and concerns of all relevant stakeholders if significant progress is to be made (Shine et al. 2000).

2.5 Concluding comments

The key issues emanating from this literature review are as follows:

- i. Goods and services provided by the ecosystem are regarded as an economic entity thus essential for regional, national and even international development. Invasive species' impact on biodiversity, ecosystem goods and services are undisputed and detrimental for the economic development of a country.
- ii. We need to expand our current understanding of value as it encompasses much more than just economic value.

- iii. Although it has been displayed on various occasions that IAPs hold detrimental impacts for human livelihood and well-being, they are frequently integrated into people's lives, either as a wild resource or maintained plantations. Yet, limited research encapsulates both positive (benefits and uses) and negative (costs) impacts of IAPs during valuation studies.
- iv. Even though substantial amounts of money have been spent on alien clearing and research, limited knowledge exists regarding WfW's social development goals as well as the link between private land-owners and the WfW programme. Similar to WfW, much emphasise has been put on demonstrating the effectiveness of the South African nationwide LandCare programme.
- v. Holistic valuation of IAPs and input from all stakeholders is imperative for the success of alien clearing programmes.

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Chapter 3:

Values and impacts of invasive alien plants: a marginalized community's perspective

Abstract

Negative impacts of invasive alien plants (IAPs) on biodiversity and ecosystem goods and services are frequently demonstrated in the literature. The Working for Water programme (WfW) was launched in South Africa to curb these impacts through alien clearing and management. Low-income communities are employed by this programme at minimum daily wages and various social development goals were set by the programme; much debate has centred on the programme's social development outcomes. Additionally, IAP use by local people and the impact thereof on livelihoods are not well understood and are poorly incorporated into alien clearing programmes. It is therefore pertinent to the future success of clearing programmes to understand how IAPs influence livelihoods. This chapter evaluates the perceived positive and negative value and impacts of IAPs on the livelihoods of local communities in and around Elim on the Agulhas Plain on the southern Cape coast of South Africa. A qualitative research design based on a grounded theory approach to data analysis was followed. Twelve (N = 12) basic qualitative interviews were conducted with rural land-users, specifically individuals from a marginalized community who live in a rural towns. Firewood from IAPs is used more frequently in economically deprived households. Despite Elim being fully electrified, IAPs still play a pivotal role as an energy source in this economically marginalized community. Certain IAPs are highly favoured as firewood due to inherent qualities i.e. high combustion temperature and long-lasting coals. Clearing programmes are therefore advised to consider the benefits and uses obtained from IAPs by local people in order to prevent them from being adversely impacted from such programmes. Results indicated that not only was WfW a means of poverty alleviation through the creation of jobs, but proved invaluable with regard to additional social development aspects (e.g. feelings of responsibility and awareness) gained by the marginalized community.

Keywords: Invasive alien plants, consumptive direct use value, fuelwood, Working for Water, LandCare, social development, rural livelihood

3.1 Introduction

Landscape functioning and the importance of ecosystem goods and services have become critical realities in the drafting of land resource management policies (Grimble and Wellard 1997, Hein et al. 2006, de Groot et al. 2010). These decision making processes thus require an understanding of the value of biodiversity and ecosystem goods and services (Turpie et al. 2003, Hein et al. 2006, de Groot et al. 2010). Decision makers therefore have to manage and consider specific demands for ecosystem goods and services from a wide range of stakeholders (Hein et al. 2006, de Groot et al. 2010). Ecosystem functioning is accordingly evaluated to distinguish between quantifiable and non-quantifiable factors, or the monetary and non-monetary values that goods and services hold (Winpenny 1991, Grimble and Wellard 1997). The outcomes and trade-offs that resonate from valuation procedures can therefore play a pivotal role in decision making processes (Winpenny 1991, Grimble and Wellard 1997, Hein et al. 2006, de Groot et al. 2010). Frameworks, such as the total economic value (TEV) framework, have been designed to assist valuation procedures of ecosystem goods and services which are vital for human livelihoods and well-being (MEA 2003). According to the TEV framework, ecosystems provide tangible goods (consumptive and non-consumptive direct use) as well as intangible services (indirect use and option value) (MEA 2003). Non-use values such as existence value (i.e. intrinsic, cultural, etc.) as well as the economic value that ecosystems goods pose (e.g. wood and wild fruit sold for economic gain) are also framed within the TEV framework (MEA 2003).

Invasive alien plants (IAPs) are known for causing detrimental threats to biodiversity and ecosystem goods and services and this can in turn undermine human livelihood and well-being (Richardson 1998, Le Maitre et al. 1996, Le Maitre et al. 2002, Richardson and Van Wilgen 2004, Henderson 2007, Pejchar and Mooney 2009). Valuations of biodiversity and services rendered by ecosystems have illustrated IAP impacts are associated with significant costs (Mack et al. 2000, Van Wilgen et al. 2001, Turpie et al. 2003, Pejchar and Mooney 2009). However, IAPs may also provide some value to people and additionally hold economic value (Kauffman 2004, De Neergaard et al. 2005, Shackleton et al. 2007, Kull et al. 2011, Shackleton et al. 2011). The impacts of IAPs are usually assessed on a national and regional scale and valuation processes are mostly directed towards the negative impacts (costs) associated with them (Shackleton et al. 2007). Impact assessments are therefore mostly focussed on the formal economy (see examples in Pejchar and Mooney 2009) and

rarely include IAP valuation on local livelihoods (McGarry et al. 2005), especially those associated with the informal economy.

The positive and negative impacts and value of IAPs vary spatially and temporally and are likely to be complex outcomes of interactions between geography (i.e. ecology) and social-economic context (McGarry et al. 2005, Kull et al. 2011). One needs to unpack these interactions in order to understand the drivers behind the impacts of IAPs on local livelihoods, as successful management actions often rely on land-user participation and an understanding of the social dimension of the problem (Shackleton and Gambiza 2008). If contemporary use and perceptions of IAPs are overwhelmingly positive, this can shape the outcome of a clearing programme such as the South African Working for Water (WfW) programme (Shackleton and Gambiza 2008). Kull and others (2011), in a qualitative comparison of case studies examining the use and perceptions of introduced Australian Acacias, found that economic conditions shaped Acacia use. Poorer communities tended to rely more on the resources derived from these IAPs, whilst middle to high income regions focused more concern over impacts on ecosystem services (Kull et al. 2011). Despite studies such as De Neergaard and others (2005), Shackleton and others (2007, 2011) and Kull and others (2011), there is relatively little research on the role that IAPs play in local livelihoods. In addition, no framework fully incorporates IAP valuation aspects such as that set out for ecosystem valuation by the TEV framework (*cf.* MEA 2003:132 and Emerton and Howard 2008:44; see also page 28 - 33 of Chapter 2).

Hence, a socio-economic case-study was conducted on the livelihood impacts of IAPs as perceived by local communities in and around Elim on the Agulhas Plain on the southern Cape coast of South Africa. The study group comprised individuals from an economically marginalized community whose income is either directly or indirectly dependant and/or affected by IAPs. This chapter addresses the benefits and costs of IAPs as perceived by marginalized community members and used a qualitative research design based on a grounded theory approach to data analysis. The aims were to address the following key questions:

- i. What are the marginalized community's attitudes towards and perceptions of IAPs?
- ii. How important are IAPs for individuals' well-being and livelihoods?
 - Are the IAPs used for sustenance, or any other domestic requirements?

- Are IAPs sold to provide an income?
- Does the marginalized community perceive IAPs as having a positive or negative impact on spirituality, culture and/or aesthetics?
- iii. What is the significance of the natural environment to the community?
- iv. How do IAPs in the area affect the supply of (other) ecosystem goods and services which are important to people's livelihoods?
- v. What is the impact of IAP distribution on land-use practices?
- vi. What are people from the marginalized community's attitudes towards IAP management?
- vii. What are the impacts of IAP clearing programmes on livelihoods?

Results report on a demographic profile to give background on the interviewees but still keeping within the ethical guidelines as stated by Stellenbosch University's Ethics Subcommittee for the Human and Social Sciences (2012).

3.2 Research design and methodology

3.2.1 Study area

A Moravian mission station, Elim, on the Agulhas Plain and its surrounding farms was selected as the focus for this study. This area is home to the endemic Elim Ferricrete Fynbos (Mucina and Rutherford 2006) which comprises asteraceous fynbos, acid sand proteoid fynbos, renosterveld and wetlands (see Figure 3.1, page 59). Rainfall on the Agulhas Plain has been recorded as high as 3 000 mm per annum. The central (were the study area is located) and north-eastern areas however, only receives a mean annual rainfall of 250 mm. As a result of extensive agricultural being practised in the region, intensive irrigation can be found in the Breede River valley that Elim is associated with. (For a detailed description of the study area please refer back to Chapter 1, page 6).

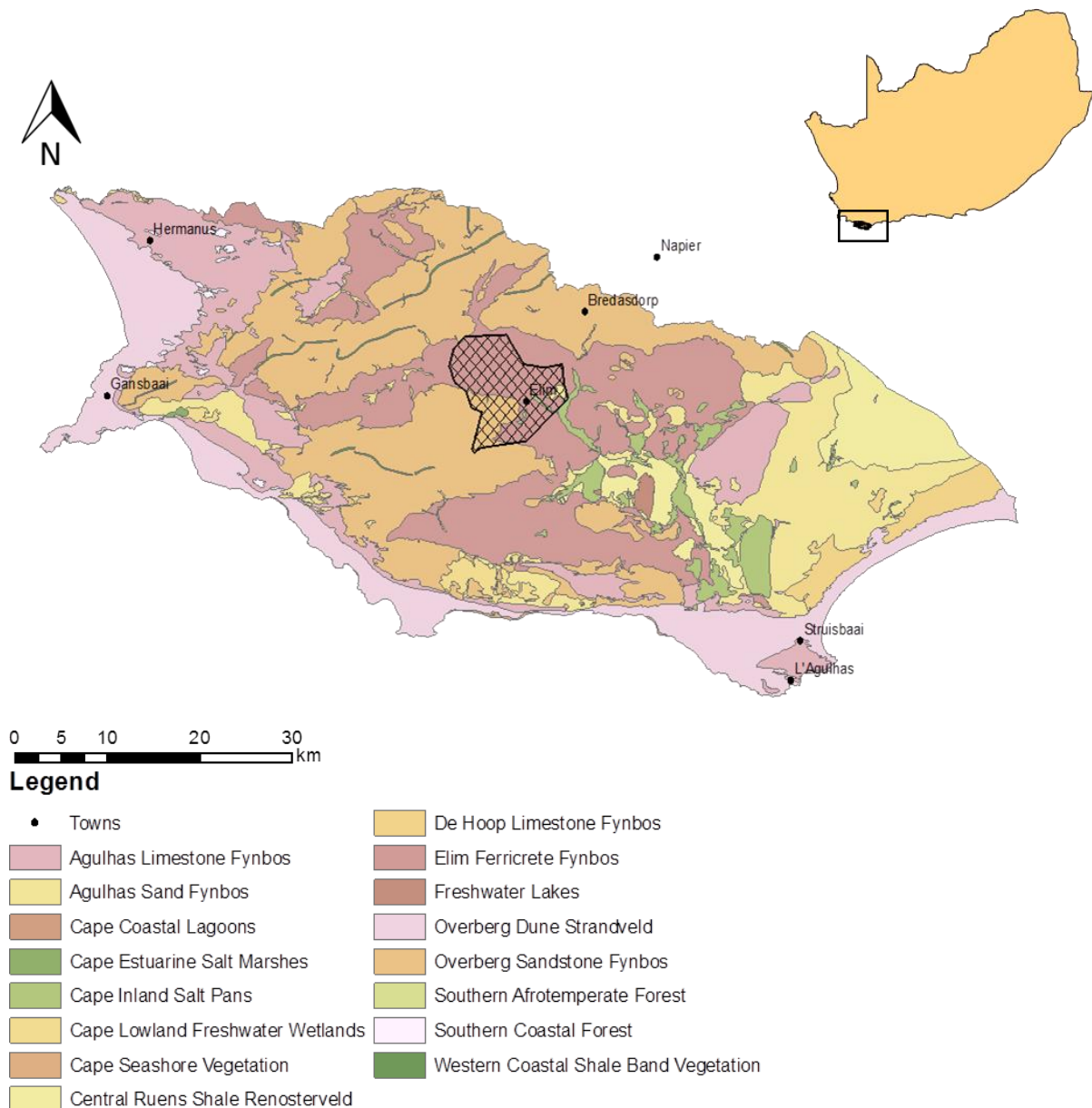


Figure 3.1: Map of the Agulhas Plain, indicating the extent of the Moravian Church ground (hatching). Interviews with farmers were conducted to the north of Elim. Exact location of interview sites is not given to ensure anonymity of interviewees. (Source: Esther Wessels)

3.2.2 Sample design and Sampling method

To address the key questions, it was essential that a broad sample group be interviewed that included individuals whose livelihoods are either directly or indirectly impacted by IAPs and the management thereof. The sample group included individuals from the marginalized community, Elim, with specific focus on individuals generating an income which is either directly or indirectly affected by, or dependant on IAPs. This group comprised wood

merchants and flower pickers as well as individuals that have previously worked on alien clearing programmes such as the WfW programme.

Snowball sampling as a non-probability sampling approach was used to allocate interviewees in the study area (Babbie and Mouton 2001). This approach was used in combination with a community member from Elim who aided with the selection of potential interviewees. Babbie and Mouton (2001) suggested that, for a master's degree in South Africa, between five and 25 respondents is sufficient for a study in the interpretative paradigm (also exploratory research/grounded theory approach to qualitative research^{*}). A total of 12 interviewees were thus selected as representatives of the marginalized community. Two of these interviews were conducted during the pilot stage of the research project of which both were incorporated into the sample profile for data analysis and interpretation as no significant changes were made to the sample protocol after the pilot study.

3.2.3 Data collection

Standard qualitative, face-to-face interviews were performed with interviewees to gather data for this research (Babbie and Mouton 2001). Interviewees were allowed by the researcher to invite an individual with whom they felt comfortable to sit in on the interview. When the individual's participation was more than 50% of the total interview, their insights were incorporated into the data analysis process and these interviews were then treated as one interview/interviewee. The qualitative interviews were conducted using a predetermined interview schedule (see Appendix B, page 141). In keeping within the custom of qualitative interviews, flexibility of the questions was allowed (Babbie and Mouton 2001). Where appropriate, additional questions were asked to elaborate on a topic brought up by an interviewee whether or not the topic was listed within the focus of the interview schedule (Rubin and Rubin 2005). Financial details were not asked due to the sensitivity of this topic (*cf.* Winter et al. 2007). In addition, the pilot interview session revealed that it is difficult to quantify the economic impact of IAPs as interviewees did not give exact numbers or exclusive values but qualitative answers were given instead. Therefore no exact monetary values could be obtained from interviewees. All interviews were recorded digitally after

^{*}Instead of beginning with a hypothesis, grounded theory method starts with data collection followed by key points extracted from it by means of codes. The codes are then grouped into categories to form a theory (Babbie and Mouton 2001; Babbie 2010). Grounded theory method is thus mainly in the social sciences, where theories are discovered and systematically constructed through the analysis of data (Babbie and Mouton 2001).

consent was obtained. This ensured that all the necessary data were captured for further data analysis and interpretation (Babbie 2010).

The information gathered in this study is a result of the interviewees' personal experiences and knowledge. Results presented in this study are thus the interviewees' subjective perceptions and may not be strictly factual (Botha et al. 2008, Snyman 2010), however perceptions can bring much insight in understanding the various impacts that IAPs have on rural land-users on the Agulhas Plain.

3.2.4 Ethical consideration

Written consent to conduct interviews was obtained from the Elim Overseer's Council and from Stellenbosch University's Ethics Subcommittee for the Human and Social Sciences (2012) (ethics approval reference number 573/2011). Following Stellenbosch University's guidelines, participants were informed of the nature of the study and were given the option to participate in the study, where after their consent was obtained. Each interviewee was assured that there would be no negative consequences as a result of them partaking in the study and that all information was to be treated in complete confidentiality. No incentives were provided to interviewees taking part in the study. Participation was thus as a result of personal choice and not due to any sort of intimidation or encouragement.

3.2.5 Data capturing and Data analysis

In-depth recorded interviews were transcribed verbatim. To ensure accuracy of data analysis and to prevent meaning and interpretation from being lost through translation, transcribed interviews were analysed in the language that the interview was conducted in. Data entry and analysis was facilitated through the use of MAX Qualitative Data Analysis 10 (MAXQDA) (2012), a Computer Assisted Qualitative Data Analysis Software (CAQDAS) package and Microsoft Office Excel 10 (2010). MAXQDA 10 was specifically designed for the analysis of qualitative data and is recognised as one of the leading CAQDAS packages (Schönfelder 2011). Also, through rigorous scrutinizing of available CAQDAS programs, MAXQDA 10 proved the most efficient and user friendly to the researcher who had no prior experience in CAQDAS packages.

Classical coding* was used for thematic analysis of data (Babbie and Mouton 2001). A code mainly consists of a short phrase that summarises the theme related to a section of the transcriptions (Babbie and Mouton 2001) and these were adapted from themes which frequently emerged from the interviews (Rubin and Rubin 2005). A detailed code memo with clear and consistent definitions was constructed to aid with the coding process (Rubin and Rubin 2005). Some of the descriptions were adapted from McGarry and others (2005) as well as Emerton and Howard (2008). For a detailed outline of the code memo see Appendix C (page 143). The 12 transcribed interviews were loaded into MAXQDA 10 (2012) and the coding process was engaged by reading each sentence, rereading it a few times and then assigning an appropriate code to a specified section in the text. More than one code was allocated to the same quote when the same part contained multiple code categories.

Plants referred to by the interviewees were identified by their common name during the interviews and later taxonomically classified.

In reporting the results, a method used by Botha and others (2008) was adapted. A superscript, which consisted of two numbers, was assigned to each theme and sub-theme. The first number is an indication of the number of interviewees in a group that mentioned that specific theme and the second is an indication of the number of times the theme was mentioned throughout the group i.e. the frequency of the theme. Themes that were frequently identified gave an indication of the popularity of that theme as well as how widely it was recognised. Infrequently mentioned themes could be an indication of a distinctive experience expressed by interviewee/interviewees or that interviewees had little knowledge and experience regarding that specific theme. Thus, codes should not be regarded as ranking according to popularity. This same method was applied by Snyman (2010) who elucidated pastoralists' perceptions to the changes in the vegetation structure and composition when livestock was excluded from an area in Namaqualand.

Some relevant quotations have been selected to illustrate key points in the discussion. These have been translated in English. The legends for the transcriptions are as follows:

- i. ...

* Segments/sections are selected in the text and coded with an existing code from the code list. New codes are developed when the existing codes does not describe the section in question. The code list is determined by the researcher (Babbie and Mouton 2001).

If found at the beginning of a quotation, this indicates that the quotation started in the middle of a sentence. If found in the middle or at the end of a quotation, it is an indication that the content following was not relevant and was therefore excluded from the quotation.

ii. {}

The empty brackets are an indication that the transcriber was unable to hear what the interviewee was saying.

iii. { words }

Words within the brackets describe sounds or actions carried out by the interviewee, or words that the transcriber was unsure of.

3.3 Results

A total of twelve interviews were conducted with interviewees from the marginalized community. This sample group included individuals that worked on alien clearing programmes to supplement the household's monthly income, wood merchants, an alien clearing contractor and flower pickers.

All of the interviews (N = 12) were conducted in Afrikaans as these individuals were all native Afrikaans-speakers. Of the interviews conducted with the marginalized community's members, eight took place at the interviewee's home and the remaining four at the interviewee's place of work. Permission was obtained from the interviewee's employer to conduct these interviews.

A total of six hours of interviewing was recorded with the average interview length being 30 minutes. Four of these interviews lasted longer than 35 minutes, while the rest ranged between 19 minutes and 30 minutes long. The duration of these interviews was mainly determined by individual's willingness to share information. Most of the interviewees in this group, except one, did not display any hesitation towards answering the questions.

Four interviews conducted with the marginalized community were with flower pickers. Two were with full time flower pickers and two with individuals employed on a farm with flower

picking and alien clearing being amongst their duties. Two ex-flower pickers who both have extensive experience in the flower picking industry (>17 years) were also interviewed. The current instability of the flower industry resulted in these individuals seeking other sources of income (personal communication with flower pickers). Four individuals that have previously worked on alien clearing projects in Elim were also interviewed. Of them, two are retired but still actively involved in community projects, one is self-employed and the other is a fully employed general worker in Elim. The remaining two interviews were conducted with wood merchants. Despite the assistance from a community member who assisted with the allocation of interviewees, only two wood merchants were located over a period of four weeks. One of these invited a family member to sit in on the interview as the latter was also actively involved in wood trade. This increased the total interviewees for this section to three. Hereafter only the demographic details of the primary interviewee will be addressed.

Four individuals from the marginalized community had completed secondary education (Grade 12), while the remainder had a lower level of secondary education (N = 6), one individual had a primary level of education and a single individual had no form of formal education.

In total, 119 unique codes were created for the transcripts (see Table 3.1, page 65). Codes were grouped into seven distinct categories addressing the beneficial and negative perceived impacts and values of IAPs. These categories are in accordance with the categories found within the Total Economic Value as well as the Direct and Indirect Economic Impacts frameworks (see Chapter 2, page 28 - page 33). Please note that the key categories found within these respective frameworks were only used to identify the key categories in the table below; frameworks mentioned above were not used to analyse the data.

The categories are as follows: direct use value divided into two categories i.e. (i) direct non-marketed consumptive use of IAPs, (ii) direct marketed consumptive use of IAPs, and also (iii) non-use value associated with IAPs, (iv) indirect economic benefits associated with IAPs, (v) costs associated with the direct non-marketed consumptive use of IAPs and (vi) costs associated with the direct marketed consumptive use of IAPs, as well as (vii) opportunity costs (can be both direct and indirect) associated with IAPs. For a clear definition on these categories please refer to the Code Memo, Appendix C (page 143).

Table 3.1: Benefits and costs associated with IAPs as perceived by the marginalized community. Codes were grouped into four benefit and three cost categories. The total number of unique codes generated under each category is displayed in the body of the table.

Benefits		Costs	
Direct non-marketed consumptive use	24	Costs associated with direct non-marketed consumptive use	15
Direct marketed consumptive use	15	Costs associated with direct marketed consumptive use	13
Non-use value	2	Opportunity costs	40
Indirect economic benefits	10		
Total	51		68

3.3.1 Plant profiling

Ten woody invasive alien plants were mentioned by the community members from Elim and seven could be identified up to species level which includes five *Acacia spp.*, one *Eucalyptus sp.* and one *Leptospermum sp.* The rest were grouped in taxa due to insufficient information. Interviewees also mainly referred to these plants through their common names such as Eucalyptus, Hakea and Pine.

Table 3.2: Ten IAPs were identified by the interviewees. Common names often cited in the literature are also listed. Folk names which are not commonly cited in the literature are also listed for three of the identified IAPs.

Status*	Scientific name	Common name [†]	Folk name [‡]
T, DI (Category 2)	<i>Acacia cyclops</i>	Afr. Rooikrans	Afr. Hoenderhout
T, DW [§]	<i>Acacia dealbata</i>	Silver Wattle	
T, DW	<i>Acacia longifolia</i>	Water/River Port Jackson, Long-leaved Wattle	Afr. Waaisand, Wysand
T, DI (Category 2)	<i>Acacia mearnsii</i>	Black Wattle	
T, DI (Category 2)	<i>Acacia saligna</i>	Port Jackson	Afr. Rooibas
T, DW ^{**}	<i>Eucalyptus lehmannii</i>	Spidergum	
T, DW	<i>Leptospermum laevigatum</i>	Australian Myrtle	
Insufficient information	<i>Pinus spp.</i>	Pine, Afr. Dennebome	
Insufficient information	<i>Eucalyptus spp.</i>	Eucalyptus, Gumtree, Afr. Bloekom,	
Insufficient information	<i>Hakea spp.</i>	Hakea	

Three folk names, not commonly cited in the literature, were articulated by the interviewees (see Table 3.2).

One interviewee from the marginalized community who has previously worked on alien clearing operations described *Leptospermum laevigatum* as being a pest when it came to removal of the plant (“...*daai Myrtle boom, hy’s nou ’n pes gewees!*”; Eng. ...that Myrtle tree, it was a pest!).

* Invader status according to Henderson (2001); T = Transformer, DI = Declared invader, DW = Declared weed

[†] Names normally cited in the literature.

[‡] Names distinct to a specific area, group, etc. and are not normally cited in the literature.

[§] Status only for the Western Cape, differ for the rest of the country (Henderson 2001).

^{**} Status only for the Western Cape, differ for the rest of the country (Henderson 2001).

3.3.2 Benefits derived from invasive alien plants

Aside from the detrimental impacts of IAPs, interviewees highlighted positive aspects of these plants. This section reports on the value derived from invasive alien plants by the interviewees in the study area.

3.3.2.1 *The direct non-marketed consumptive use of invasive alien plants*

i. Fuelwood

Invasive alien plants are a source of energy for the economically marginalized community who all make use of wood as a source of energy^{12,70}. Woody invasives mentioned by more than half (N > 6) of the interviewees as their wood sources included *L. laevigatum*^{9,18}, *A. cyclops*^{9,15}, *E. lehmannii*^{6,13} and *Eucalyptus spp.*^{6,9}. *Acacia mearnsii*^{4,4}, *A. saligna*^{3,5}, *Pinus spp.*^{4,7} and *A. longifolia*^{1,1} were mentioned to a lesser extent.

Acacia saligna was not considered an efficient energy source by some of the interviewees^{3,5}. The wood burns out quickly and produces ash instead of long lasting, good quality coals. Interviewees stated that it cannot be used for activities such as food preparation, boiling of water, etc. but are mainly used to create a “staan vuur”^{*,3,3} (Eng. fire). In addition, *A. longifolia*^{2,2} was also mentioned as a poor coal producer. Marginalized community members also indicated that Pine cones^{2,4} and Pine wood^{1,1} are mainly used to start fires and not used as a primary heat source since Pine wood does not produce long lasting coals, burning out quickly and turning to ash^{3,5}. One interviewee indicated that she can recall that it was, however, used by previous generations as a source of firewood. One of the interviewees indicated that they would mix low quality wood (such as *A. saligna*) with wood that produces good quality coals (such as *L. laevigatum*) as the former ignites swiftly but also burns out quickly and does not produce a coal.

One of the marginalized community members mentioned the use of dry seed capsules of *E. lehmannii* as a source of fuel^{1,3}. The coals produced by the seed capsules were noted as sufficient for a long lasting fire and no additional wood was deemed necessary. Additionally, they also found the wood from *E. lehmannii* to be poisonous^{2,4}. It was indicated by an

* Fire normally made to provide heat for protection against cold and where socialization takes place i.e. sharing of knowledge and skills amongst the individuals present in order to preserve social and cultural continuity (de la Fontaine, pers. comm.)

interviewee that the wood should be burned out before it is used for purposes such as preparing food to ensure that all the poisonous gasses have escaped from the wood.

Wood is also preferred to electricity as an energy source as it is more affordable than electricity, paraffin or gas and freely accessible yet restricted to Elim grounds. When electricity is available it is used in a prudent manner.

- *Water, {} putting on the kettle, yes, or sometimes, when the fire is burning, you put on a pot of water for heat, to heat the water for washing or so. Then you save some electricity.*

Another example includes the following:

- *To save too. You always think about the electricity, you can't use electricity alone. Together with wood, you light a fire, you can do that too. You can prepare food on the fire.*

ii. Construction material

Apart from firewood, woody IAPs were used as construction materials^{5,5}. This includes the making of wooden spars (droppers) which are used to erect fence lines by farm labourers or individuals from low income communities^{3,3}. Wood indicated as a source for this purpose included *L. laevigatum*^{1,1}, *Eucalyptus spp.*^{1,1} and *A. saligna*^{1,1}.

One interviewee recalled the use of Pine trees for construction purposes^{1,3}. Pine was used to construct trusses and beams (from nearby invasions) for houses in Elim in the past. Presently, Pine must be chemically treated when used for construction purposes. The same individual indicated that the reason for the abundance of Pine in Elim can be ascribed to the fact that it has no significant direct use value.

3.3.2.2 *The direct marketed consumptive use of invasive alien plants*

Interviewees indicated knowledge of the charcoal manufacturing plant which used to operate in Elim but had to cease due to managerial and financial complications. They emphasized that it could hold lucrative opportunities for the community and the area once it is revived^{3,6}. Interviewees were, however, unclear as to why the plant had ceased operation.

Flower pickers mentioned that they have worked with dried and chemically treated wooden fruit capsules of *H. gibbosa* for the dried flower industry^{2,2}. I also observed flower pickers gathering dried out seed capsules from *E. lehmannii* trees as well as clumps of seed capsules from *Eucalyptus diversicolor* trees for the flower industry.

As a result of the wavering flower industry certain individuals have been forced to make use of other sources of income such as selling wood^{2,2}. A small number of wood merchants were interviewed (N = 3). This indicates that there are very few wood merchants operating in Elim and the surrounding areas. The latter was confirmed by one of the interviewees (“*Hier is nie eintlik meer baie wat hout maak nie*”; Eng. There aren’t many left who cut wood). Wood sold by the wood merchants mainly included *Eucalyptus spp.*, *A. mearnsii*, *A. cyclops* and *L. laevigatum*. *Acacia cyclops* and *L. laevigatum* were sold at a higher price (see Table 3.3) than other types of wood due to its accessibility and good quality^{2,3}. One merchant also indicated that there are very limited existing stands of *A. cyclops*, and linked this dramatic decline to high volume use and pressure.

Table 3.3: Indication of the wood sold in Elim and surrounding areas as well as the price per selling unit (values as recorded October 2011; R 7.8 = ca. US\$ 1 in October 2011).

Interview	Number of interviewees	Source of income	Type of wood	Use of wood	R/1000 pieces
Interview 15	1	Primary	<i>Eucalyptus spp.</i>	Wood used in the fireplace	R 450.00
			<i>A. mearnsii</i>	Wood used in the fireplace	R 450.00
			<i>A. cyclops</i>	Wood used for barbeque	R 550.00
			<i>L. laevigatum</i>	Wood used for barbeque; Wood used to make droppers	R 550.00
Interview 16	2	Secondary	<i>A. cyclops</i>	Wood used for barbeque	R 600.00

The wood merchants interviewed did not create many employment opportunities beyond their own employment. The three interviewees worked for themselves and one provides a work opportunity for two community members (see Table 3.4, page 70).

Wood was not their only source of income. Interviewee 15 indicated that wood is his primary income but supplements this with flower picking at times when the wood market is slow. For the two interviewees from interview 16, selling wood is a secondary source of income whilst they indicated that they supplement their income with flower picking. Individuals also expressed appreciation towards opportunities for financial income which arise from excess wood collected and sold after alien clearing has been done^{4,6}.

Table 3.4: Indication of the number of wood merchants interviewed in the area, their mode of transport, wood source, their market as well as the number of people employed in the group.

Interview	Number of inter-viewees	Transport	Source	Market	Employed
Interview 15	1	Light delivery truck (also bakkie)	Elim and surrounding farms	Surrounding larger towns (e.g. Stanford and Napier)	Individual self & 2 employees
Interview 16	2	Bakkie	Overstrand municipal area	Overstrand municipal area	Individuals self

Their market is concentrated outside Elim and its neighbouring farming communities (see Table 3.4). Interviewee 15 indicated that it is predominantly the more prosperous groups that would buy wood for use within the fireplace and for braai/barbeque.

Appreciation was expressed towards wood “refuse” after alien clearing was done; wood was collected by interviewees who claimed that they used the wood for household purposes as firewood^{2,2} and sold it for financial income^{2,2}.

3.3.2.3 *The non-use value of invasive alien plants*

A single individual from the marginalized community articulated cultural value towards IAPs, specifically wood used to make fires (“staan vuur”) for individuals, whether friends, family or both, to gather around and share stories and daily local information^{1,4}. Interviewees that have worked on alien clearing programmes, stated that their inherent value for the natural environment made them feel the need to work on these alien clearing project^{2,2}.

3.3.2.4 Indirect economic benefits associated with invasive alien plants

The marginalized community members^{6,12} expressed their support and approval towards alien clearing programmes as it was a means of job creation for impoverished communities. Four (N = 4) individuals who have previously worked on alien clearing projects derived indirect benefits from the latter to various degrees. Interviewees felt that these projects enhanced their union with other community members who were also co-workers and that these projects were in a sense a socially enriching experience^{4,23}.

- *...it was team-building... ...Elim is a small town, our lives are different... ...but there, we actually learned about one another... ...got to know one another.*

Another example was the following:

- *...it was a very good thing... ...getting to know one another... ...because even if you stay in a town and I know your name, I may not know you. You get closer to the person. You see a part of that person that you never knew. You know how he responds to pressure, you know how he responds to misunderstanding... ...and if {you}... ...sit and chat... ...you start to catch on to his thinking... ...his life's philosophy and that sort of stuff.*

These individuals expressed passion for the work they did and added that it gave them a feeling of pride^{3,7}. They valued these clearing projects which were perceived as educational^{3,10} and training equipped them with special skills that they incorporated into their daily lives^{2,10}. Working on these projects increased their feelings of responsibility and awareness as they had to take great precaution in safety and had to strictly adhere to working protocol^{3,12}. One of the interviewees, an ex-contractor for one of the alien clearing programmes, added that his ability to manage conflict was improved and he could, in turn, deliver adequate resolutions for crisis scenarios^{1,2}. Interviewees valued the passion and concern that project supervisors had for their general working group^{2,4}. Individuals became conscious of innate capabilities which were only drawn out and tested by being part of these alien clearing projects^{2,5}.

- *...you could actually see, hey, maybe you were surprised about what's inside you, what you can do... ...I can also do that... ...I'm not going to sit back, I'm going to go for it...*

These projects were perceived as a source of financial upliftment and it improved individuals' life and living conditions and ensured life preservation^{2,8}.

3.3.3 Costs associated with invasive alien plants

3.3.3.1 *Costs associated with the direct non-marketed consumptive use of invasive alien plants*

Interviewees from the marginalized community stated that they are restricted to small volumes of wood collected for household consumption^{10,14}, since transport is a limitation^{7,20} and access to tools such as handsaws to make wood^{2,3} is also limited. Chopping wood is time consuming^{8,12}, and respondents obtain help from others^{3,8}, either a friends or groups of individuals that go out to cut wood. In eleven of the cases it was the responsibility of the head of the household to obtain wood and in one case a pensioner said that her sons provide wood as she is unable and unfit as it is a physically strenuous job. One interviewee gives wood to older members who are unable to cut wood for themselves.

Individuals indicated that they borrowed machinery such as chainsaws from others to cut wood^{3,6}. This allows respondents to make large volumes at a time^{3,5}. The owner of the chainsaw is however rewarded for the use of it. As one interviewee stated, this is not necessarily in monetary values (*“Een was die ander een se rug. ...dan help ek weer een of ander tyd vir hom uit.”*; Eng. You scratch my back and I'll scratch yours... ..then I help him again at some stage.).

Production of wood increases at certain times of the year^{3,5} such as Moravian festive events, Christian holidays such as Easter and Christmas as well as in winter. The high demand and collection decreases the availability of certain wood species^{2,2} such as *A. cyclops* and increases the availability of wood considered “bad quality”^{4,14}. One individual expressed concern regarding the future availability of wood due to increased pressure on favourable wood types^{1,5}.

One interviewee directly stated that wood is an essential source that one cannot live without due to high electricity costs.

3.3.3.2 *Costs associated with the direct marketed consumptive use of invasive alien plants*

Interviewees who exploit IAPs for economic purposes suffered excessive transport costs^{2,11} which included transport to the source and then to the market area where the wood is sold. Machinery costs are high as chainsaw blades have to be regularly replaced^{2,5}. The process of making wood, from cutting a tree to cleaving it into usable pieces, was mentioned as a time consuming process^{2,13}. Pressure on certain wood types such as *A. cyclops* has resulted in perceived scarcity^{1,1}. Wood merchants thus have to resort to cutting wood on private property and in doing so, have to compensate the landowner for it^{1,3}.

Individuals from the marginalized community seldom to never obtain wood from wood merchants as they perceived them to be too expensive^{2,4} and when they do buy from merchants they generally buy low quality wood at reduced prices^{1,2}. Wood is seldom bought from individuals in the local town^{1,1}, as the more affluent groups in the larger towns are the buyers^{1,1} who buy on large scale. The income for a wood merchant is often uncertain and mostly dependant on orders^{1,3} or if an opportunity from an alien clearing project provides excess wood that can be sold^{1,1}. Business for wood merchants is mainly optimal in winter at a time when extreme weather conditions are common^{1,2}. These above-mentioned factors all contribute to an inconsistent income for wood merchants^{1,1}.

3.3.3.3 *Opportunity costs*

i. Ecological costs

A single inhabitant of the marginalized community^{1,2} argued that IAPs had a considerably high water intake and accordingly decreased the availability of water.

The interviewees expressed their concern with regard to IAPs crowding out fynbos^{5,9} that resulted in its limited growth and re-establishment^{4,5}. A single flower picker noticed that certain specialized indigenous species' numbers decreased as a result of IAPs crowding out fynbos^{1,1}.

Clearing was perceived as essential and effective as a single individual^{1,1} valued the increase in water availability through this endeavour. Alien clearing projects were valued as it helped with IAP management and in turn the restoration of fynbos^{3,4}.

ii. Cost to (other) livelihood strategies*

This sub-section reports on the impacts of IAPs as perceived by the interviewees as having a negative impact on their livelihoods or livelihood strategies. Cases where individuals directly indicated that their livelihoods were threatened as a result of IAP impact are addressed.

Flower pickers in the area were reliant on the fynbos for livelihood^{1,2} and a lack of management decreased their livelihood potential^{1,1}. This is as a result of fynbos dying off^{4,8} as IAPs crowded out fynbos^{3,5} and it increased due to a lack in management^{3,5}. This contributed to flower pickers' movement and flower picking time being hampered^{2,6} as they have to spend more time in finding their way through invasives than they do picking flowers. A lack of management or veld rehabilitation caused for veld conditions to deteriorate which contributed to low flower quality and consequently bad business^{3,9}, buyers became unhappy and reluctant^{1,5} and evidently less work were available for flower pickers^{2,5}.

iii. Alien clearing programmes

Individuals from the marginalized community that have worked on IAP clearing programmes expressed dissatisfaction regarding the limited reimbursement obtained^{2,4}. It was added that working on these programmes was mentally^{2,5} and physically challenging and strenuous^{4,18}. Women reported that they still had to fulfil their role as mother and caretaker even after experiencing these challenges at work as stated by one of the interviewees:

➤ *...but now, the thing is, when you get back home in the evenings, all the work lies there waiting for you.*

Individuals working on these programmes incurred physical injury^{2,4} and a single interviewee was worried about the possibility of future physical harm as a result of insufficient protection^{1,5}. Certain alien plants, such as *Hakea spp.* with its long, spiny foliage, complicated the clearing processes caused by its physical attributes. As a result, less clearing is done as more time is spend on these plants, which meant that less work was completed and less income was generated^{5,14}. It was stressed that individuals working on alien clearing projects should be adequately trained^{5,19} as areas such as riparian zones and waterways were difficult to clear^{2,3} and that people were exposed to dangers such as snakes, spiders, etc.^{1,1}.

* Livelihood strategies refers to the variety and combination of decisions that people make and activities they carry out in order to accomplish livelihood goals (Scoones 1998, Babulo et al. 2008).

Inadequate training led to work not thoroughly completed^{1,2}. It was suggested that more adequate tools were provided to do alien clearing^{1,6}. Disappointment towards management^{1,3} was expressed; miscommunication^{2,5} and differences with regard to working protocol^{1,3} caused for disagreement between management and employees. It was perceived by a single interviewee that management, with their theoretical knowledge, undermined the practical knowledge of the individuals working on alien clearing projects^{1,4}. It was stated that alien clearing projects provided temporary employment^{1,1} and that reimbursements from took long to be paid out^{1,1}. Interviewees emphasized that regular management through alien clearing programmes were crucial^{6,21} as invasives constantly re-established^{2,3}. The importance of veld rehabilitation^{3,14} were raised by flower pickers. Marginalized community members expressed concern regarding the ceasing of IAP clearing and management as soon as funding ended^{2,4}. A lack of management was perceived by these individuals to contribute towards increased fire risk^{2,2} as fuel loads were increased. Further concern was raised by a flower picker who perceived increased fire as contributing to the prolific growth of IAPs^{1,2}.

- *...it (Australian myrtle) also sheds sticks and branches, so if you move, you can't move. For example after a veld fire or if you don't rehabilitate your field, it simply multiplies, almost like the black wattle does after a veld fire. It just shoots up.*

Interviewees from the marginalized community regarded IAP clearing as being costly^{4,8} and that financial resources were essential for these clearing programmes^{1,2}. Yet, interviewees^{2,2} were grateful for governmental funding initiatives towards alien clearing.



Image 3.1: *Eucalyptus diversicolor* F.Muell. (Henderson 2001) used in the dried flower industry (Credit: Rhoda Malgas).



Image 3.2: Droppers being used in the erection of fences (Credit: Carlo Cloete).



Image 3.4: Capsules of *Hakea gibossa* (Sm.) Cav. (Henderson 2001) used in the dried flower industry (Credit: Rhoda Malgas).



Image 3.3: Piles of wood collected for firewood are stacked for later use.

3.4 Discussion

3.4.1 Linking local knowledge with scientific knowledge: plants perceived as invasive and people's associated attitudes

Knowledge and perceptions of IAPs are shaped through exposure and how livelihoods and well-being are influenced by these plants (Drew 2005, Kull et al. 2011). Ten species of invasive plants were mentioned by the marginalized community at Elim; the links specifically focused towards the direct uses of these plants, i.e. for firewood and as a source of income from selling wood. Invasive alien plants described by the interviewees also included invaders that individuals were exposed to via alien clearing programs and ecological knowledge passed down and exchanged with predecessors and peers.

Folk names, distinct to the area, were articulated for three of the IAPs i.e. *A. cyclops*, *A. longifolia* and *A. saligna*. It is noteworthy that these three species were amongst the plants first introduced to South Africa (i.e. *A. cyclops* (1850), *A. longifolia* (1850) and *A. saligna* (1833)) for dune stabilization in the Western Cape province and have subsequently become invasive (Avis 1989). No record illustrating these species' estimated time of establishment in the vicinity of Elim could be found. Yet, if they were amongst the first to be introduced one could assume that they were the first to become established in this region. If so, it could be that prolonged exposure has resulted in this community to becoming so accustomed to these species that they have assigned folk names to them (Shackleton et al. 2007).

The significant intrinsic value that the community of Elim have towards fynbos was captured by Killian (1996) in a documented titled "Flora of Elim: remarkable natural heritage and useful economic resource" (translated). This study emphasized those perceptions of the inherent value for nature by individuals and was linked to their increased awareness of the effects of IAPs. However, regardless of the known negative impacts associated with these plants, they are culturally still valued in rural communities (Siges et al. 2005, Shackleton et al. 2007, Shackleton et al. 2011).

3.4.2 Impacts and value of invasive alien plants

3.4.2.1 Impacts of invasive alien plant use on livelihood strategies

Interviewees mentioned IAPs primarily in relation to their various livelihood strategies. Invasive plant use by the marginalized community was concentrated towards their uses as firewood for a diversity of domestic functions which included preparation of food, heating of water and heat provisioning during cold, winter months. One can reason that this might be a display of this community's dependence on firewood. A variety of species were used as fuelwood knowledge regarding their use were widespread and detailed, linked to the intrinsic qualities of these plants for this specific purpose. Arguably, this type of knowledge is acquired by such local communities through trial and error over centuries and passed down from one generation to another (Drew 2005).

Despite being known for its superb qualities as firewood, *A. cyclops* was not as extensively used as expected (Killian 1996, Turpie et al. 2003). One of the wood merchants stated that he found it more challenging to source adequate supplies as a result of high pressure on this favoured wood type. Alternative possibilities might be that *A. cyclops* populations are in decline because of effective biological or mechanical control (Impson et al. 2011, Moran and Hoffman 2012) or that it simply does not grow well in the Elim area (Killian 1996, Turpie et al. 2003). In addition to *A. cyclops*, *A. mearnsii* was indicated by a few individuals as a source of firewood even though it was sourced for the firewood trade. One would expect that a competitive wood species in the firewood trade would be equally appreciated by individuals that rely on freely available wood resources. However, it was not the case. Similarly, the local decline in *A. mearnsii* can be ascribed to high pressure on this wood species, combined with the success of alien clearing as well as that of biological control agents (Impson et al. 2011, Moran and Hoffmann 2012).

Invasive alien plants used for construction purposes include *L. laevigatum*, *A. saligna* and *Eucalyptus spp.* Amongst the first non-indigenous plants introduced for dune stabilization along the coast of South Africa were *A. saligna*, *L. laevigatum* and *E. diversifolia*, in that specific order (Avis 1989). Of the seven *Eucalyptus spp.* reported as introduced to South Africa, all introductions are timber related as well as that of *A. saligna* (Nyoka 2003). As *L. laevigatum* was not initially introduced for timber related matters, one can assume that this

use evolved over time. Invasives are still widely used in the timber industry in South Africa and are a valuable source to impoverished households as building material (Kull et al. 2011).

Interviewees from the marginalized community made use of opportunities to generate income from wood. This includes people selling IAPs collected after clearing projects to supplement household funds as well as wood merchants who make a business out of selling wood for a more steady income. The small-scale direct sales of wood contribute to some households' welfare. This is a display and affirmation of the level of poverty in Elim.

Wood merchants that were allocated for interviewing were low in number as there was a difficulty in locating them. This could be a result of a limited number of wood merchants operating in the area due to a restricted market, insufficient income produced by this industry as well as difficulties and limitations suffered that have the ability to hamper their operations.

Two of the most significant impeding factors mentioned by the interviewed wood merchants include transport costs, high machinery costs and the lack of efficient machinery and tools to cut and prepare fuelwood. Additionally, these merchants are restricted to the volumes of wood they collect at a time as their only mode of transport is a 'bakkie' (light delivery truck), the maximum load of which usually does not exceed 1 ton. Killian (1996) stated that there are no significant marketing prospects for fuelwood outside of Elim as a result of increased electrification. The wood merchants' dilemmas are clearly summed up by Marker and others (2002:7) who defined poverty and the individuals that suffer under it. Ultimately one can deduce that when these merchants are better equipped and adequately resourced with transport, mechanical equipment, and entrepreneurial skills they will possess over the abilities to expand their current market to include businesses such as lumber or timber companies, pizza restaurants, charcoal producing factories, etc. located in larger towns and business areas.

3.4.2.2 *Social development through alien clearing programmes*

Fynbos wildflower farming, which is based on the area's biodiversity, is an important source of income for the Agulhas Plain, yet IAPs have been deemed one of its biggest threats and contribute to increased fire risks (Heydenrych et al. 1999, Privett et al. 2002). Although fire is critical for the survival of fynbos plant communities (Cowling 1987, Van Wilgen and Richardson 1985), increasing fire cycles caused by high biomass and leaf litter fall by IAPs

can be detrimental for fynbos (Midgley 1989, Holmes and Cowling 1997). Alien clearing and management is thus fundamental for individuals' livelihoods, especially that of flower pickers who highlighted the importance of IAP management and constant follow-ups. Although wildflower farming is extensively practised in the region (Heydenrych 1999, Privett et al. 2002), it cannot diminish unemployment to a substantial degree (Conradie 2010). A combination of livelihood strategies is thus carried out by marginalized communities to reduce poverty. Part-time IAP clearing through extended public works programmes are amongst these.

Apart from Buch and Dixon (2009), this research has identified a suite of social development outcomes generally overlooked by previous research. Results indicate that alien clearing programmes have played an important role in enhancing community relationship amongst its employees (i.e. interviewees regarded it as a tool that enhanced union amongst community members who worked on these projects). This social development benefit was substantially highlighted as opposed to WfW's conventional social developmental aims (i.e. job creation, poverty alleviation and skills training) (*cf.* Buch and Dixon 2009). Other knock-on social developmental benefits were also articulated by the interviewees that included safety awareness, conflict management, surfacing of innate capabilities, instilment of pride amongst the interviewees as well as feelings of responsibility and enhanced work ethic (*cf.* Buch and Dixon 2009:137). These outcomes were developed and promoted through the holistic programme experience and not by means of any specific intervention (Buch and Dixon 2009). Buch and Dixon (2009:136) stated that even though these knock-on benefits are "less concrete than the key objectives of the programme, they present an area of unidentified potential for WfW".

Attention was also given to issues that can limit the success of alien clearing programmes' social development effects, specifically that of WfW. Interviewees articulated that work is not thoroughly completed due to a lack in training and emphasize was directed towards WfW investing more in adequate training procedures (*cf.* Buch and Dixon 2009). Wages provided by WfW were considered too low (workers are currently paid a minimum of R43 (~US\$6) a day, Buch and Dixon 2009) but the impression created by the interviewees was that the latter was of less concern than the unsustainability of the jobs created by WfW. An additional complaint was that wages took too long to be paid out (*cf.* Binns et al. 2001). Though Hough and Prozesky (2012) argued that individuals employed by WfW had a tendency to become

reliant on the programme, none of the interviewees from this study displayed this nature (see page 64). Women regarded the work as strenuous yet benefits outweighed costs, so this was not perceived as a major problem. Women play an important role as the household caretaker within rural societies (Little 1987, Little and Austin 1996). By working on programmes such as these, women help to maintain and even enhance the family's economic condition, but she must still fulfil her role as mother and wife. As WfW's focus is appointing female employees in order to reduce gender inequalities (Buch and Dixon 2009), aspects such as the provisioning of crèche facilities must strongly be focused on (Binns et al. 2001, McQueen et al. 2001). An ex-contractor expressed differences regarding miscommunication that existed pertaining to working protocol between upper management and labour workforce (*cf.* Buch and Dixon 2009). No evidence was found illustrating WfW consulting employees on issues such as grievances and objects relating to the programme (*cf.* Buch and Dixon 2009). This insinuates that WfW follows a top-down approach where little room for empowerment is given to those that the programme have actually set out to empower (Buch and Dixon 2009).

3.5 Conclusion

The economically marginalized community is dependent on woody invasives for the supply of provisioning services as well as for economic gain. The use of alternative energy sources (i.e. wood as opposed to electricity) is a common occurrence within households bearing the brunt of poverty and financial deprivation. Wood as an alternative energy source is highly accessible and more affordable than formal sources of energy (electricity, gas, paraffin). The marginalized community's knowledge concerning IAPs was detailed regarding different wood types that can be used as fuelwood and for construction purposes through their intrinsic qualities (i.e. combustion temperature, longevity of coals, durability of wood). Invasive alien plant clearing programmes should take into account the uses and benefits which local communities obtain from IAPs and thus take care not to adversely impact poor communities dependant on them. Aside from the social development aims part of WfW's mandate, knock-on social developmental benefits were also obtained. Livelihoods are dependent on ecosystem services and processes and a lack in IAP management (by government and private land-owners) undermines marginalized community's livelihoods.

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Chapter 4:

Value and impacts of invasive alien plants as perceived by farmers on the Agulhas Plain

Abstract

Invasive alien plants (IAPs) are known to have detrimental impacts on biodiversity, ecosystem processes and services and ultimately human health, well-being and livelihood. The Working for Water programme was launched in South Africa to curb these impacts through alien clearing and management. The programme relies heavily on clearing by private landowners in order to inhibit the spread of IAPs. A socio-economic case study was conducted with rural land-users on the value and impacts of IAPs as well as that of IAP management. The sample group included farmers (N = 12) and data collection was done through basic, qualitative interviews in the Elim and the surrounding farming communities on the southern Cape coast of South Africa. Transcribed interviews were analysed following a grounded theory approach to data analysis. Very few farmers expressed considerable positive valuation for IAPs. Those that did, value IAPs as a source of fodder, for the production of mulch, fence poles, furniture and for fire wood. A link was found between the types of agricultural enterprises, level of infestation experienced and the degree of antagonistic attitudes towards IAPs i.e. land under more intense management had fewer IAPs and this contributed to farmers displaying less antagonistic attitudes towards IAPs. Farmers conveyed that IAP clearing was a protracted process and that it demanded excessive financial input. Clearing was perceived as variable, and more support is needed from government.

Keywords: Invasive alien plants, Working for Water, LandCare, social development, rural livelihood, alien clearing on private land, fuelwood, fodder, shade for livestock, construction material

4.1 Introduction

Cross-continental anthropogenic introductions of exotic plants were widespread during the colonial era in the 1800's, driven by purposes that included "establishing productive lands, rehabilitating poor soils" and producing landscapes indicative of colonists' economic well-being (Carruthers et al. 2011:812). These introduced plant species, many of which have become invasive, now hold detrimental consequences for biodiversity and ecosystem goods and services worldwide (Van Wilgen and Van Wyk 1999, Van Wilgen et al. 2001, Le Maitre et al. 2011). Invasive alien plants (IAPs) have the capacity to survive, reproduce and spread unaided across ecosystems, generally to the disadvantage of other organisms (Van Wilgen and Van Wyk 1999, Van Wilgen et al. 2001, Le Maitre et al. 2011). A vast number of alien plants have been introduced to South Africa (Van Wilgen and Van Wyk 1999) and the fynbos biome is reported as the most widely invaded (Henderson 2007). With its Mediterranean type climate, the fynbos biome has a significantly high level of biodiversity and endemism (Mucina and Rutherford 2006). It comprises of two main vegetation types i.e. fynbos and renosterveld, the latter being a focus of agricultural activities in the Western Cape Province (Mucina and Rutherford 2006). The biome and the region boasts successful wine, flower and fruit industries as well as wheat and other agricultural crop produce (Mucina and Rutherford 2006); these support a significant number of livelihoods in the region (Turpie et al. 2003).

Invasive alien plants are however one of the major threats to biodiversity, ecosystem goods and services and consequently livelihoods in this region (Heydenrych 1999, Heydenrych et al. 1999, Privett et al. 2002).

The Working for Water (WfW) programme was launched in 1995 by the South African government in response to the impacts caused by IAPs (Van Wilgen et al. 2012). The main objective of the WfW programme is to manage the spread of IAPs to minimise loss of ecosystem services as well as poverty alleviation through skills training and employing individuals from marginalised, low-income communities (Van Wilgen et al. 1998, Binns et al. 2001, WFWP 2003 and 2004, Hobbs 2004, Kepe et al. 2004, Buch and Dixon 2009). Support is required from private landowners in order to prevent the spill over of IAPs to areas that have already been cleared (Woodworth 2006, Van Wilgen et al. 2012, Urgenson et al. 2013). In addition, a project linking the sustainable removal of invasive plants on privately-owned land with the employment of low-income groups is managed by the nationwide

LandCare programme under the auspices of the provincial Departments of Agriculture (Ntlokwana 2011). Incentives have been put in place regarding IAP clearance on private land, yet it has been emphasized that monetary encouragements, motivational tools as well as stricter enforcement of regulations are necessities to achieve positive results (Urgenson et al. 2013, Van Wilgen et al. 2012).

Assessing and understanding the impacts of IAPs on land production has been regarded as important for IAP clearing and management programmes since this creates a framework for areas of interest i.e. priority areas (Forsyth et al. 2012). Previous valuation studies have normally focused on the threats of impacts brought about by IAPs (Ruesink et al. 1995, Rouget et al. 2004, Hauser and McCarthy, 2009). Valuation frameworks have however been advised to incorporate both positive and negative impacts of IAPs in order to give decision-makers an holistic view of the impacts of these plants (Emerton and Howard 2008). Sufficient resources to manage IAPs are not always readily available (Woodworth 2006), thus evaluation of affected stakeholder perception is regarded as a means to guide alien clearing processes and disperse resources in a prudent and well-structured manner (De Lange et al. 2012).

A socio-economic case-study was therefore conducted on the perceived value and impacts (both positive and negative) that IAPs have on land production as well as the impacts of IAP management on livelihoods. The sample group comprised of active (commercial and subsistence) farmers, including both landowners and land managers in and around Elim on the Agulhas Plain on the southern Cape coast of South Africa. In this study, a landowner refers to an individual who is the legal owner of an erf or part thereof. A land manager refers to an individual who is currently in a lease agreement with the landowner to farm on the land or a part thereof. Hereafter landowners and managers are communally referred to as farmers.

Using a qualitative research design based on a grounded theory approach to data analysis. This chapter addresses the values and impacts of IAPs and their management on the livelihoods of a farming community on the Agulhas Plain. Themes that resonated from this research are centred on the IAP valuation framework provided by Emerton and Howard (2008:44) and the Total Economic Value (TEV) framework (refer back to Chapter 2, page 29).

The aims were to address the following key questions:

- i. What are farmers' attitudes towards and perceptions of IAPs?
- ii. How important are IAPs for farmers' well-being and livelihoods?
 - Are the IAPs used for sustenance, or any other domestic requirements?
 - Are IAPs sold to provide an income?
 - Do farmers perceive IAPs as having a positive or negative impact on spirituality, culture and/or aesthetics?
- iii. What is the significance of the natural environment to the farmers?
- iv. How do IAPs in the area affect the supply of (other) ecosystem goods and services which are important to farmers' livelihoods?
- v. What is the impact of IAP distribution on land-use practices?
- vi. What are farmers' attitudes towards IAP management?
- vii. What are the impacts of IAP clearing programmes on livelihoods?

Results report on a demographic profile to give background on the interviewees but still keeping within the ethical guidelines as stated by Stellenbosch University's Ethics Subcommittee for the Human and Social Sciences (2012) (ethics approval reference number 573/2011).

4.2 Research design and methodology

4.2.1 Study area

As the study area has already been discussed in previous chapters it will not be elaborated on here. For a detailed exhaustive outline on the study area, please refer back to Chapter 1 (page 6) as well as Chapter 3 (page 58).

4.2.2 Sample design and Sampling method

To address the key questions, it was essential that a broad sample group be interviewed. To locate farmers from various ethnic backgrounds, languages, age differences and farming practices, snowball sampling as a non-probability sampling method (Babbie and Mouton 2001), was used. Once a participant was interviewed, the individual was asked for references that fits the criteria of the study. The snowball sampling as a non-probability sampling

approach (Babbie and Mouton 2001) was used in conjunction with a community member from Elim who aided with the selection of potential interviewees. A total of 12 interviewees were selected as representatives of the farming community around Elim. Two of these interviews were conducted during the pilot stage of the research project of which both were incorporated into the sample profile for data analysis and interpretation. Refer to Chapter 3 (page 59) for a detailed outline on sample design and sampling methodology.

4.2.3 Data collection

Data collection was done by means of standard qualitative, face-to-face interviews that were conducted using a predetermined interview schedule (see Appendix B, page 141) (Babbie and Mouton 2001). The researcher allowed the interviewees to invite an individual whom they felt comfortable with to sit in on the interviews. The invitee's insights were incorporated into the data analysis when their participation was more than 50% of the total interview. This was then handled as one interview. The researcher refrained from asking exact financial details (*cf.* Winter et al. 2007). Flexibility of the questions was allowed (Babbie and Mouton 2001) and additional questions were asked to elaborate on a topic brought up by an interviewee irrespective of whether the topic was listed within the focus of the interview schedule (Rubin and Rubin 2005). To ensure that all the necessary data were captured for further data analysis and interpretation, interviews were digitally recorded after consent was obtained (Babbie 2010). Refer to Chapter 3 (page 60) for a detailed outline on data collection.

4.2.4 Data capturing and Data analysis

The recorded interviews were transcribed verbatim in the language it was recorded in. This was to ensure accuracy of data analysis and to prevent meaning and interpretation from being lost through translation. Data analysis was facilitated by a Computer Assisted Qualitative Data Analysis Software (CAQDAS) package i.e. MAX Qualitative Data Analysis 10 (MAXQDA) (2012) and Microsoft Office Excel 10 (2010). This CAQDAS package was specifically designed for the analysis of qualitative data (Schönfelder 2011) and rigorous scrutinizing of available CAQDAS programs illustrated its user-friendliness. This was an advantage as the researcher had no prior experience in CAQDAS packages.

Classical coding* was used for thematic analysis of data. A comprehensive code memo was constructed to aid with the coding process (Rubin and Rubin 2005) with descriptions adapted from McGarry and others (2005) as well as Emerton and Howard (2008) (see Appendix C, page 143). In reporting the results, a method used by Botha and other (2008) was adapted. Some relevant quotations have been selected to illustrate key points in the discussion. Please refer to Chapter 3 (page 62 - 63) for a detailed outline of the legends used within these quotations.

4.3 Results

Twelve interviews were conducted with the farmers totalling to 14 individuals. This was because two male farmers invited their wives to sit in on the interviews as the latter were just as actively involved in the farming activities. Hereafter only the demographic details of the primary interviewee will be addressed.

The majority of the interviews (N = 11) were conducted in Afrikaans as these individuals were all native Afrikaans-speakers. A single interview, conducted with a farmer, was in English. Interviewing with the farmers took mostly place at the individuals' home with one interview conducted on a farm.

Five hours of interviewing were recorded with the farmers. Two of these were longer than 40 minutes while the remaining interviews lasted between 14 and 36 minutes. The duration of the interviews was determined by the amount of conversation encouraged by the interview schedule as well as the time that the farmer was willing to spend on the interview (*cf.* Winter et al. 2007). In cases where the individual's body language indicated resistance, certain questions were excluded to shorten the interview.

The majority of the interviewed farmers were male (N = 9). The number of years' experience of these farmers ranged from four to 70, with a median at 12.5 (total cumulative farming experience of 217 years). Five farmers had a farming experience of more than 15 years each. The majority of the farmers (N = 6) held tertiary qualifications, while five completed

* Segments/sections are selected in the text and coded with an existing code from the code list. New codes are developed when the existing codes does not describe the section in question. The code list is determined by the researcher (Babbie and Mouton 2001).

secondary schooling and a single farmer, who is now retired, had a primary level of education.

Three of the farmers owned farms larger than 700 hectares and focused primarily on mixed farming which included wild and cultivated flower farming, livestock farming and honey bush plantations. One farmer operated a dairy on his farm. The remaining nine farms ranged between 20 and 200 hectares with seven of them focusing on mixed farming which included wild flower farming, cultivated farming, rooibos, livestock and various fruit and vegetables being grown. Two of these farmers primarily focused on either wild or cultivated farming. Three out of the 12 farmers reported no to very limited occurrence of IAPs on their farms. IAPs that did occur on these farms were to such a degree that it was not viewed as a problem. These farmers described the occurrence of IAPs as young shoots which are immediately and regularly taken care of and cited the value of sparsely distributed trees as shade providers. All farms with limited to no occurrence of IAPs are cultivated intensively and none of them included mountainous habitats that are normally not suited for agricultural purposes. Invasive alien plants on these farms are however evident along the edges of rivers and on adjacent farms. Nine farmers reported dense stands of IAPs on their farms. On these farms, not all of the available land is cultivated and most of the farmers focus predominantly on wild flower farming. These farms were located in lowland areas and associated with riparian zones (N = 4) while a single farm included only mountainous areas and some encompassed both highland and riparian areas (N = 4). One farmer, who is located adjacent to a river system, commented that *Acacia longifolia* grew so thick in the valley that he was unable to walk through it.

- *Those trees grow in the ditch; they are (still) standing in the catchment area from where we get our water... Apart from my area where my pump station is, you could probably go up another 200 m, but from there, you can forget about going any higher, it's a nightmare. I have tried to walk up there, because I would have liked to see where the water actually comes from, {} but there are these massive trees right there next to the ditch. But otherwise, it is only in the mountain area that there are so many.*

In total, 118 unique codes were created for the transcripts (see Table 4.1, page 95). Codes were grouped into eight distinct categories addressing the beneficial and negative perceived impacts and values of IAPs. These categories are in accordance with the categories found within the Total Economic Value as well as the Direct and Indirect Economic Impacts

frameworks (see Chapter 2, page 28 - page 33). Please note that the key categories found within these respective frameworks were only used to identify the key categories in the table below; frameworks mentioned above were not used to analyse the data.

The categories are as follows: direct use value that were divided into two categories i.e. (i) direct non-marketed consumptive use of IAPs, (ii) direct marketed consumptive use of IAPs, and also (iii) non-use value associated with IAPs, (iv) indirect economic benefits associated with IAPs, (v) costs associated with the direct non-marketed consumptive use of IAPs and (vi) costs associated with the direct marketed consumptive use of IAPs, as well as (vii) opportunity costs (can be both direct and indirect) and (viii) management costs associated with IAPs. For a clear definition on these categories please refer to the Code Memo, Appendix C (page 143).

Table 4.1: Perceived benefits (four categories) and costs (four categories) of the direct and indirect economic impacts of IAPs on land production and IAP management. The total number of unique codes generated under each category for both land-user groups (farmers and marginalized community respectively) is displayed in the body of the table.

Benefits		Costs	
Direct non-marketed consumptive use	37	Costs associated with direct non-marketed consumptive use	1
Direct marketed consumptive use	8	Costs associated with direct marketed consumptive use	5
Non-use value	2	Opportunity costs	7
Indirect economic benefits	2	Management costs	56
Total	49		69

4.3.1 Plant profiling

Twelve woody invasive alien trees were mentioned by the farmers and eight could be identified up to species level. The remaining four were placed into taxonomic groups due to the limited information gathered to identify these up to species level (see Table 4.2, page 97).

Two known invasive weed species (*Pennisetum clandestinum*, *Cirsium vulgare* (Savi) Ten.) (Henderson 2001) and three indigenous problem plants i.e. one shrub (*Berkheya coriacea* Harv) (Mustart et al. 1997), one grass (*Aristida junciformis* Trin. & Rupr.) (Van Oudtshoorn 2012) and one weed species (*Tribulus terrestris* L.) (Kaufman and Kaufman 2007) were also identified, primarily by the livestock and cultivation farmers. The rest were grouped in taxa due to insufficient information. Interviewees also mainly referred to these plants through their common names such as Eucalyptus, Hakea and Pine.

Three folk names, not commonly cited in the literature, were articulated by the interviewees (see Table 4.2). Adjectives used during the interviews by farmers to describe IAPs include “*die ouwabond*” (Eng. the old rascal)^{1,1}, “*Dis n pyn*” (Eng. It’s a pain)^{1,1}, “*pestelik*” (Eng. pestering)^{1,1}, “*vyand*” (Eng. enemy)^{1,1}, “*kopseer*” (Eng. headache)^{2,3}, “*kalante*” (Eng. menaces)^{1,1}, “*plaag*” (Eng. plague)^{1,1} and “*probleem*” (Eng. problem)^{6,15}.

One farmer described the profuse growth and re-establishment of invasive seedlings after they had been stimulated to grow like hair on the back of a dog (“*hare op hond’s rug*”).

Invasive alien trees, such as *Acacia dealbata* and *Paraserianthes lophantha* that proved to be of no socio-economic value, were also mentioned.

- *Then, of course, there’s the Silver Wattle, which is a bit of a problem to us. It’s not incredibly invasive, but it’s also good for nothing.*

Table 4.2: Seventeen problem plants were identified by the interviewees. Twelve were IAPs, two were alien weeds and three were indigenous problem plants. Common names often cited in the literature are also listed. Folk names which are not commonly cited in the literature are also listed for three of the identified IAPs.

Status*	Scientific name	Common name	Folk name
T, DI (Category 2)	<i>Acacia cyclops</i>	Afr. Rooikrans	Afr. Hoenderhout
T, DW [†]	<i>Acacia dealbata</i>	Silver Wattle	
T, DW	<i>Acacia longifolia</i>	Water/River Port Jackson, Long-leaved Wattle	Afr. Waaisand, Wysand
T, DI (Category 2)	<i>Acacia mearnsii</i>	Black Wattle	
T, DI (Category 2)	<i>Acacia saligna</i>	Port Jackson	Afr. Rooibas
T, DW [‡]	<i>Eucalyptus lehmannii</i>	Spidergum	
T, DW	<i>Leptospermum laevigatum</i>	Australian Myrtle	
T, DW	<i>Paraserianthes lophantha</i>	Stink Bean	
Insufficient information	<i>Pinus spp.</i>	Pine, Afr. Dennebome	
Insufficient information	<i>Eucalyptus spp.</i>	Eucalyptus, Gumtree, Afr. Bloekom,	
Insufficient	<i>Hakea spp.</i>	Hakea	

* Invader status according to Henderson (2001); T = Transformer, DI = Declared invader, DW = Declared weed, PT = Potential transformer, PDW = Proposed declared weed, RAS = Ruderal, agrestal and special effect weed.

[†] Status only for the Western Cape, differ for the rest of the country (Henderson 2001).

[‡] Status only for the Western Cape, differ for the rest of the country (Henderson 2001).

information		
Insufficient information	<i>Poplar spp.</i>	Poplar
PT, PDW	<i>Pennisetum clandestinum</i>	Kikuyu grass, Afr. Kikoejoegras
RAS, DW	<i>Cirsium vulgare</i>	Afr. Skotse distel
Indigenous grass	<i>Aristida junciformis</i>	Ngongoni grass, Afr. Steekgras
Indigenous shrub	<i>Berkheya coriacea</i>	Afr. Disseldoring
Indigenous weed	<i>Tribulus terrestris</i>	Afr. Duwweljedorings

4.3.2 Benefits associated with invasive alien plants

4.3.2.1 The direct non-marketed consumptive use of invasive alien plants

i. Fuelwood

Invasive alien plants are a source of energy for farmers^{6,14}. In addition, farmers also acknowledged that farm labourers and low income communities derive their energy from firewood^{3,4}. Invasiveness and the ability to grow fast, qualities normally associated with IAPs (Van Wilgen and Van Wyk 1999, Van Wilgen et al. 2001), were described by one of the interviewees as unique characteristics allowing IAPs to be an excellent sustainable wood source^{1,4}. Invasive alien plants that were found to be a source of fuel wood included *Leptospermum laevigatum*^{5,5}, *Eucalyptus spp.*^{3,5}, *Acacia longifolia*^{2,2}, *Acacia saligna*^{2,2}, *Eucalyptus lehmannii*^{2,2}, *Acacia cyclops*^{1,1}, *Pinus spp.*^{1,1} and *Acacia mearnsii*^{1,1}.

Farmers that make use of *L. laevigatum* as a fuel source added that it is an excellent source of energy that produced good quality coals^{2,2}. In contrast, *A. saligna* was not considered an efficient energy source by a single individual^{1,1}. The wood burns out quickly and produces ash instead of long lasting, good quality coals.

One interviewee, who was partial to *Eucalyptus spp.* as a source of firewood, stated that he did make use of other invasives for this purpose, preferring to use Eucalyptus over the other IAPs. He associated a sentimental value attached to Eucalyptus, sharing that his father told him that the area used to be without trees and that successive generations of his family planted Eucalyptus as a source of fuel wood. Some invasive alien plants that were found to have beneficial use as firewood (for either direct use as firewood or selling of these wood as firewood), were not perceived by interviewees to be IAPs^{2,2}. IAPs which mainly fell under this criterion included *Eucalyptus spp.*

- *...the Eucalyptus is also an invasive, but I won't consider it an invasive because I cut it for wood that I use, and you can also sell that wood.*

Another interesting example was the following:

- *Farmer 5: ...do you consider Eucalyptus and Spidergum also as invasives?*

Researcher: Yes.

Farmer 5: But it's not really invasive for us because we keep it under control. It is the wood that we use, which we cut.

ii. Construction material

One farmer indicated that *L. laevigatum* is specifically adapted for this purpose as it is a hard wood and does not require any chemical treatment to sustain its longevity. The latter is however not the case for Pine, as it needs specific chemical treatment to prolong its useful lifespan. One farmer indicated that he has recently started a self-initiated project where he collects wood from *A. saligna* trees on his property for furniture manufacture. He was unable to comment on the progress of this project as it was still in its early phases and he was still busy waiting for the wood to dry out.

iii. Fodder and shade for livestock

Invasive alien plants (including an invasive weed) were used mainly by farmers as fodder^{4,8} and shade for livestock^{1,2}. Species used as feed for livestock included *A. saligna*^{2,3}, *A. longifolia*^{2,2}, *Acacia mearnsii*^{1,1} as well as *Pinus spp.*^{1,1}, a less conspicuous source of fodder, were also mentioned by a single farmer.

- *Our sheep feed on Pine, they feed on it until there's nothing left. They feed on Port Jackson, they feed on Black Wattle. ...they love longifolia.*

One interviewee shared that IAPs, especially *A. saligna* and *A. longifolia* proved invaluable as a source of fodder for livestock during a drought period which was experienced in the area several years back.

- *...many years ago, I cannot remember how long, during the drought, I sawed it off and then the livestock would feed on the leaves. It's actually {great} nutrition for livestock, if there is not food.*

A grass species i.e. *Pennisetum clandestinum* (Kikuyu), not native to South Africa, was mentioned by farmers as a being a primary source of fodder to their livestock^{2,2}. The farmers, who mentioned using Kikuyu as fodder, spoke highly of its unique qualities as a source of fodder to livestock and indicated that they have or have tried to establish Kikuyu pastures. One farmer mentioned that *P. lophantha* could not be utilized as fodder as it emits an odour which causes for livestock not to feed on it. This is where the common name (Stink Bean) of this plant originates from as it gives off a “nauseating” smell when seedpods are broken (Stirton 1978) and has been documented as being poisonous (Henderson 2001). *Leptospermum laevigatum* was also added as being of no value regarding feed for livestock^{1,1}. The farmer added that due to this, this tree remains a problem for them (Afr. “*bly 'n probleem vir ons*”).

iv. Additional uses

One farmer with recently established fruit orchards (granadilla) mentioned that the success of the orchards is highly dependent on the impacts of the baboons that reside in the mountains located near his farm. The Pine forest (jungle invasions) which is also located there, acts as a buffer to mitigate the impact of the baboons on this specific farming activity.

It was also indicated that mulching was made from IAPs and used as green manure^{1,1}. The individual added that it is an efficient process as the mulch is very useful and that the process is a benefit associated with alien clearing and management.

It was observed in the field that various farmers used IAPs to a great extent, especially *Eucalyptus spp.*, as wind breaks and shading around water points used for livestock (Image

4.2, page 103). This was, however, not mentioned by any of the farmers that interviewed in the study area.

4.3.2.2 *The direct marketed consumptive use of invasive alien plants*

When asked about the economic value of IAPs, farmers indicated that they have received financial incentive from a private sawmill company (see Image 4.4, page 103) in the vicinity which buys usable, large Pine trees from them (which have invaded their property), felling them on their land and transporting them to the nearby processing plant^{3,5}. One interviewee indicated that he knows of another farmer that has received financial incentive from this company for selling his Pine trees to them^{1,1} and a few indicated that they are well aware of the private sawmill company but have not been approached in the past^{3,4}. Interviewees spoke of this with much enthusiasm as indicated by one of the farmers:

- *Pine is an asset, because you get money for it. We use to cut it off and let it lay there in the hope that it would rot away. Or we would burn it. Now you don't do it anymore. Pine is really worth money. I don't regarded Pine as a problem.*

Wood is sold for the purpose of creating building material (i.e. making planks or poles from it) by either the farmer^{1,2} or by underprivileged individuals collecting excess wood from the farmers' property after clearing has been done^{2,2}. Wood is also sold by farmers as firewood^{2,2}.

A few farmers were also well aware of the production of charcoal from invasive alien plants^{3,4} and highlighted their concerns of the charcoal production plant which was established in the area but had to cease due to managerial and financial complications (Cloete, pers. comm.*). Interviewees were, however, unclear as to why the plant had ceased operation.

It was also indicated that invasives, specifically the dried out seed capsules of *Hakea gibbosa*, were used for the dry flower industry^{2,2}. One farmer indicated that craft boxes are made from invasives to sell in their craft store^{1,1}. Invasive alien plants were also utilized as forage for bees. Interestingly, none of the interviewed farmers listed this as a use value of IAPs although several bee hives were apparent in the field on farmers' plots, strategically placed between *L. laevigatum* and Eucalyptus trees (see Image 4.1, page 103).

* Sustainable economic development officer, Elim.

4.3.2.3 *The non-use value of invasive alien plants*

Two farmers expressed non-use value for IAPs. The first reported that *Acacia mearnsii* was a visually pleasing tree. The second farmer perceived IAPs as having intrinsic value.

- *...there are trees on the farm, I reckon they're about 100 years old, maybe more, it doesn't make sense to me – to remove the tree just because it is earmarked as alien.*

These interviewees were both well-educated female farmers.

4.3.2.4 *Indirect economic benefits associated with invasive alien plant management*

Farmers^{5,8} expressed their support and approval towards alien clearing programmes as it was a means of job creation for impoverished communities in the area.

One farmer mentioned that the soil where IAPs grew is quite fertile because of the release of nitrogen in the soil.



Image 4.1: Bee hives placed strategically between flowering IAPs, mainly *L. laevigatum* (Gaertn.) F.Muell. (Henderson 2001).



Image 4.2: Pine trees used to provide shade for livestock and humans.



Image 4.4: Private sawmill company buy Pine trees from farmers and produce logs which are used for construction purposes.



Image 4.3: Invasive alien plants are a source of food to baboons and help to limit the detrimental impacts of baboons on farmers' crops.

4.3.3 Costs associated with invasive alien plants

4.3.3.1 *Costs associated with the direct non-marketed consumptive use of invasive alien plants*

One farmer indicated that mulch is made from IAPs for use as green manure, this farmer added however, that even though the process is efficient, mulching is a very cost ineffective process^{1,2}.

- *We also carried out an experiment. We chipped 2 ha on our farm, but the costs were very high. We had to spend too much for the 2 ha. So, we stopped chipping it ourselves. We used to clean it manually and then we fed it into the chipper. I mean, it looks very nice, it works and everything, but it is very, very expensive.*

None of the farmers who made use of IAPs as firewood claimed to have any difficulty in obtaining the wood. This might be as they get hold of wood that is located on their farms and no notable costs are involved in retrieving the wood.

4.3.3.2 *Costs associated with the direct marketed consumptive use of invasive alien plants*

The two farmers who indicated that they sell wood as firewood also expressed their concern regarding the cost associated with this venture. Buyers not willing to pay cost price for the wood^{1,3} and the problem of high transport costs^{1,2} was highlighted. Ultimately, the chopping and selling of wood is seen as a financially costly^{2,3} and physically strenuous^{1,1} venture.

One farmer added that even though the sawmill company holds financial benefits and that it aids with IAP management, this method might not be as successful in the long-term^{1,1} as he noticed that tree felling and soil disturbance promotes the growth of IAP seedlings.

- *Where the one Pine tree has been sawed down, there are now hundreds of little ones. So, if you were just to leave it, it would simply grow again, and much worse.*

4.3.3.3 Opportunity costs

i. Ecological costs

Farmers^{3,5} argued that IAPs had a considerably high water intake and accordingly decreased the availability of water.

➤ *I can prove to you that my streams flow throughout summer, as opposed to where invasives grow, where it is bone-dry. So it definitely does drink a lot of water!*

Farmers were concerned of the fact that invasives had the ability to alter stream flow as it clogged out waterways^{3,8}. No reference was made to any particular IAP. This could be due to the difficulty in determining the effect of one specific IAP as farmers had more than one species on their land.

Clearing was perceived as essential and effective as farmers^{2,2} valued the increase in water availability through this endeavour.

ii. Cost to (other) livelihood strategies*

This sub-section reports on the impacts of IAPs as perceived by the interviewees as having a negative impact on their livelihoods or livelihood strategies. Cases where individuals directly indicated that their livelihoods were threatened as a result of IAP impact are addressed. Results include plants that were perceived as invasive by farmers and not specifically targeted by clearing programs operated through Working for Water (WfW).

One farmer who specializes in the production of cash crops, expressed discontent regarding an indigenous grass species, i.e. *Aristida junciformis* that he was in a continual struggle with^{1,1}. Livestock farmers complained that they are frequently plagued^{2,9} by weeds and problem plants which included *Cirsium vulgare*, *Berkheya coriacea* and *Tribulus terrestris*. The latter two are however both indigenous species (a shrub and a weed species respectively) (Mustart et al. 1997, Kaufman and Kaufman 2007). These plants posed detrimental threats to livestock; they get caught in the wool of sheep and are notorious for causing deterioration in livestock health. If not continuously given attention to, these weeds and grasses have the

* Livelihood strategies refers to the variety and combination of decisions that people make and activities they carry out in order to accomplish livelihood goals (Scoones 1998, Babulo et al. 2008).

potential to reduce the productivity of arable lands and livestock farming (Zimmerman 1991). Concerns regarding decreased yield and productivity as a result of the prolific growth of IAPs were expressed by farmers^{3,7}. This was especially noted for farmers who specialized in (wild) fynbos farming as these systems were under low to no intense management. Farmers expressed distress towards dense stands of IAPs as well as highly invasive plants having the ability to reduce the potential for future production^{4,14}.

4.3.3.4 Management costs

This section reports on management costs and is divided in the following sub-sections: management methods, financial costs, governmental involvement, follow-up and time spent on management. This section mostly focuses on alien clearing done by farmers on privately-owned land as members of the marginalized community are normally not directly involved with this.

i. Management methods

All the farmers interviewed, except one, have used various approaches to clear and manage IAPs on their land. These farmers claimed varying degrees of success. Methods used to clear IAPs included manual removal by hand^{1,1}, chopping^{4,5}, burning^{3,4} with herbicide^{7,11} used to a great extent. Chopping was done using implements such as machetes^{1,1}, slashers (“bossiekappers”)^{1,1}, pruning scissors^{1,1} and hand saws^{3,3}. Manually operated machinery included brushcutters^{1,1} and chainsaws^{4,4}. In some instances the area was cleared with the intention to cultivate by using heavy machinery such as tractors^{2,3}, digger loaders^{1,1} and bulldozers^{7,10}. Manual removal was perceived as successful and effective^{2,2}, specifically for *Hakea spp.*^{2,2} and *Acacia saligna*^{1,1}. In contrast, manual removal was identified as an unsuccessful manner of IAP management^{2,2}. Ploughing was regarded as practical and effective^{4,6} especially in the removal of *Hakea spp.*^{1,1} and *Leptospermum laevigatum*^{1,1}. Farmers added that the problem with chopping was that too many stumps were left behind that hampered ploughing; stumps were detrimental for heavy machinery^{6,8}. Farmers indicated that clearing were done by farm labourers^{3,4} and incorporated within the farm duties. A single farmer specified that he made use of external work force^{1,1} as a means of job creation. The use of herbicides for IAP management were regarded as effective^{2,2}, particularly when used on *A. saligna* trees^{1,1}. Some farmers perceived herbicide as ineffective^{2,2}. This was noticed for *L. laevigatum* as high concentrations of herbicide were deemed necessary for it to be

effective^{1,1}. A young farmer also regarded herbicide as ineffective on small trees. He added that he applied it directly to smaller trees.

- *When it's taller than us we cut it and then we poison the stump. And if it's smaller than us we spray the whole thing with poison...*

Farmers indicated that they obtained herbicide through governmental funding but experienced problems with the latter recently^{2,4}. In most cases farmers share herbicide amongst each other^{3,4} and herbicide was perceived as very expensive^{1,2}. The re-establishment of indigenous (wild) fynbos was regarded as unsuccessful^{1,2} as invasives tend to constantly re-grow in areas which are not actively and persistently managed, such as in cultivated fields^{4,5}. Some farmers were in agreement with the neighbouring marginalized communities who cleared IAPs on their land in exchange for the wood; this helped getting rid of unwanted wood^{3,4}.

- *...I got in some people, if they wanted the pine trees, I said: 'Just come and cut them down and take the wood.' Because that meant I did not have to do it myself.*

It was established that no financial incentive was obtained from the neighbouring marginalized communities who cleared IAPs on their land in exchange for the wood (see above). One farmer added that it was not financially viable to obtain money from these communities regarding the above-mentioned and that the main aim was to clear the area from IAPs and not to collect money.

Burning was perceived as ineffective^{1,1} as it accommodated the rapid re-establishment of IAPs. One farmer noticed this after burning refuse biomass from *A. saligna* trees^{1,1}. Yet, he regarded this method as his only option:

- *Unfortunately, you don't have a choice. What do you do with the stuff? You just have to (burn it)... Once I've burnt a block or so, I can expect it to be grass-green in a month.*

Chopped wood was not removed from farms and it heightened the fire risk in the area^{1,2}. Individuals recalled the wildfire of 2006 that had serious damaging impacts on many farms in the vicinity.

Some farmers believed that the only way to effectively manage IAPs was to cultivate available land with either crops (including flowers)^{3,5} or pastures for grazing^{2,4}. One farmer alleged that the only effective way to bring IAPs under control was to establish pastures of *Pennisetum clandestinum* (Kikuyu grass) then allowing livestock to feed on IAP seedlings together with the Kikuyu grass whilst actively clearing that not eaten by the livestock. Farmers who utilized IAPs as a source of fodder for their livestock said that it aided with IAP management^{3,3}.

A single farmer was appreciative of the impact of biological control agents on IAPs. He said that it had definite impacts on these trees which were suffering physically^{1,3}. He perceived the biological control agents in the area as well established and that he noticed that their success is highly dependent on environmental conditions. He was unable to comment on specifics regarding the latter.

- *...the parasites that work against the aliens are well established, but still I cannot see any places where it had any substantial effects... ...it's not very successful. Some years a small number of seeds are formed but other times the plant constantly produces seeds. ...it has something to do with the weather or the annual {water} conditions.*

ii. Financial costs

Ten farmers who did alien clearing indicated that they have used their own financial as well as institutional sources. A single farmer specified that alien clearing had only been done through governmental funding. Farmers stated that IAP clearing and management demanded substantial amounts of money and energy^{11,37}. It was declared that a lack in management was due to farmers not having the resources to adhere to high operational costs^{4,7}.

- *Farmers don't have the money to clear. So, it's a big problem. If you look at the value of the land per hectare, it maybe costs five times more to clear the land than to buy it. So, what I'm saying is, if I had to get another farm looking like this, I would not even take it for free...*

A farmer who realised only after suffering high financial costs, that livestock could be used to aid with IAP management to cut on management costs, expressed his regret at not knowing this earlier^{1,1}. One farmers articulated discontent with high irrigation costs suffered^{1,2}. This

individual claimed that this must be due to low water availability as IAPs clogged water ways but that it could also be ascribed to the catchment area being a special management area (SMA). The interviewee was unclear about this but believed that if IAPs were removed, more water would be available at lower cost.

iii. Governmental involvement

Farmers expressed concern regarding temporary job creation^{5,12} through alien clearing initiatives and that wages from alien clearing programmes were too little^{1,2}. They were weary of the time-consuming logistics surrounding funding^{5,12} and were displeased that financial funding for alien clearing is too little and only temporary^{3,7}. Farmers stated that they were unclear and uncertain regarding the logistics of the funding process^{2,9}. Extreme dissatisfaction was exhibited by one farmer towards the LandCare funding project saying that the project was very ineffective^{1,12} and that they were left with more damage and financial costs as a result of it.

➤ *...it was no use, because the areas are now even more inaccessible than they used to be. So, all the seeds and the young trees are now growing even stronger than before. It was a complete waste of time. ...to Government, it means that they can say 'We employed people', and I get it, but to us, it was actually pretty stupid. I cannot put it any other way.*

Farmers stated that they add on to governmental funding with their own resources^{4,6} and farmers who cannot afford it are left with IAPs that re-establish when governmental funding stops^{2,3}.

➤ *It worked well, but, as I say, when the funding stops, no-one has the money to do the follow-ups, and then it was a complete waste. So, if there can be long-term planning and long-term funding. With anything that's sustainable, it's got to be sustainable, otherwise, it means absolutely nothing, don't even start.*

Farmers added that even though government was subsidising herbicide use for alien plant management, they have encountered various problems obtaining stock from government^{2,4}. They also felt that funding should be released during summer and not during winter; plants were perceived as physiologically more vulnerable during the summer and optimal working conditions were also present during this period^{4,12}. A single farmer was concerned that

government and governmental institutions' underlying concern was not with the farmer^{1,2}. Another farmer felt that racial discrimination were directed towards farmers when it came to support from the government^{1,2}.

From the interviews it was clear that most of the farmers realised that it was their responsibility to manage and combat the spread of invasive plants, but felt that more responsibility should lie with government and governmental institutions^{4,4}. Farmers stated that governmental institutions should consider putting more emphasis on the secondary use or consumption of IAPs^{5,18} and use the revenues returned from this system for long-term and sustainable alien clearing programmes^{2,5}. Farmers stated that they lack financial, mechanical and various other resources to attend to the issue at hand; instead, they spent their resources and time on areas already cleared^{2,3}. Yet, some farmers were grateful for governmental funding initiatives towards alien clearing^{3,4}.

iv. Time spent on management

All of the farmers that were involved in alien clearing and management claimed that they have spent considerable amounts of time on these processes. One farmer reported that he spent substantial amounts of time on alien clearing and management annually. On average it totalled six months per year ranging from April to October. He claimed that he was busy clearing one plot for the past three years with limited success. One of the farmers with limited IAPs on his farm mentioned that the initial clearing phase lasted more than 20 years and that follow-up is an on-going process. Two young farmers reported spending most of their time on alien clearing totalling to three and four years respectively. Both were on alert for emerging seedlings that were continuously removed.

From the interviews it was clear that these farmers committed substantial amounts of their time and resources to IAP management.

v. Follow-up

All the farmers (N = 11) who cleared added that they do follow-up control^{11,20}. Follow-up was done one year after initial clearing^{4,8} and on an ad-hoc basis i.e. immediate removal when seedlings are spotted^{6,10}. One farmer stated that it was crucial for follow-up to be done at least every second year after initial clearing.

Follow-up was done through manual removal^{4,6} which included implements such as pruning scissors^{1,1} and slashers^{3,3}. Farmers used herbicide^{1,1} and livestock to do follow-up^{1,3}. Fire breaks were used within cultivated flower fields^{1,1}.

Farmers agreed that follow-up was essential for IAP control^{5,6} and must be done to prevent seedlings from growing^{3,3}. One farmer stated that initial clearance was only started with when follow-up of previously cleared sections were completed. One farmer regarded follow-up as very successful^{1,1} while another perceived follow-up as unsuccessful^{1,1} as it does not control IAPs^{1,2} and only keeps the height of IAPs low^{1,1}.



Image 4.5: The spiny foliage of *Hakea spp.* impeded flower picking and alien clearing (Credit: Rhoda Malgas).



Image 4.6: Job creation through the Working for Water programme as a form of poverty alleviation (Credit: Carlo Cloete).



Image 4.8: Woody invasive plants removed through alien clearing was stacked and perceived as fire hazards.



Image 4.7: Invasive alien plants created fire risks that were detrimental to people's livelihoods (Credit: Carlo Cloete).

4.4 Discussion

4.4.1 Linking local knowledge with scientific knowledge: plants perceived as invasive and people's associated attitudes

Not all plants recognised as invasive in ecological terms were perceived as invasive by interviewees. Interviewees did not recognize IAPs that were of benefit or of use to them, with no opposing negative impact on their livelihoods, as invasive. This was the case with one farmer who kept *E. lehmannii* and other *Eucalyptus spp.* under control on his farm. Eucalyptus species in general, except *E. camaldulensis*, do not appear to be very invasive (Van Wilgen 2009); likewise Kikuyu grass that holds significant benefit as a forage plant was not considered invasive. Richardson and others (2000:93) state that “the notion of ‘invasion’ frequently evokes anthropocentric concepts (aggression, assault, attack, encroachment, incursion, infringement, intrusion, onslaught, raid, etc.)”. Farmers certainly used descriptive words with strong negative connotations (e.g. rascal, enemy, headache, plague, and problem) to express their feelings towards plants perceived as invasive (see page 96). Plants that hold uses and benefits to some individuals and can be controlled on a local scale, nevertheless still remain invasive, with detrimental impacts for the wider society and ecosystem goods and services. In order to educate and communicate the importance regarding the negative impacts of IAPs to the broader society, there is “a need for a universally acceptable, and objectively applicable term for the most damaging invasive plant taxa within given regions, or globally” (Richardson et al. 2000:102). (For the discussion on folk names, see page 77 of Chapter 3. As it relates to both land-user groups (i.e. marginalized community and farmers), the discussion will not be repeated here).

4.4.2 Value of invasive alien plants

The introduction of IAPs to South Africa is historically associated with aesthetic value, support of culture, or practical use, but widespread research since the 1930's has resulted in society's acknowledgement of the detrimental impacts of IAPs (Carruthers et al. 2011). The notion of ‘aesthetics and culture’ has now shifted from a focus on the positive value of introduced species to concern for impacts to indigenous plant species and communities such as fynbos and to ecosystem services such as water supply (*cf.* Carruthers et al. 2011; Chapter

3). This shift has been predominantly associated with the middle-class population (such as the farmers) with no mention of valuation as perceived by the low-income individuals (*cf.* Carruthers et al. 2011; Chapter 3). Single alien species have certainly become part of the culture and aesthetics rooted deep within the wider South African society (e.g. *Jacaranda mimosifolia* trees in Pretoria, Oak trees (genus *Quercus*) in Stellenbosch, and wood used for braai's). Even so, the detrimental impacts associated with IAPs have resulted in nationwide programmes aimed at the eradication and management thereof (Shackleton et al. 2007, Carruthers et al. 2011, Le Maitre et al. 2011), which is somewhat ironic given the driving forces behind their introduction (Carruthers et al. 2011). This can create conflict in a country like South Africa where IAPs are seen as both a weed and a resource (Kull et al. 2011, Carruthers et al. 2011, Wise et al. 2012).

Where IAPs were mentioned by farmers as having any direct use value, this included uses as fuelwood, the potential to make mulch, furniture and fence poles. Firewood preferences were not as clearly defined amongst the farmers. One can reason that this is since farmers are not as dependent on IAPs as a source of fuelwood. Farmers valued the income generated from IAPs from a private sawmill company logging wood on farmer's properties. Although the use of IAPs by farmers was not recorded to a significant extent, they did exhibit innovative uses for IAPs than just the general use as fuelwood.

Fynbos, with its low soil nitrogen levels and poor nutritional value, is not an adequate source of grazing for domestic livestock (Louw 1969, Le Roux 1988). The renosterveld vegetation type occurs on more nutrient rich substrates and is a better source for livestock grazing (Mucina and Rutherford 2006, Winter et al. 2007). As a result of anthropogenic impacts there are now only remnant patches of renosterveld left (Winter et al. 2007). To support livestock farming, farmers use a variety of techniques (i.e. salt lick provisioning, rotational grazing and burning of pastures) (Heydenrych 1999) which include supplementing livestock with fodder from IAPs such as mesquite (*Prosopis* species) (Wise et al. 2012) and leguminous trees (e.g. *A.saligna* and *A. longifolia*) (Heydenrych 1999). The drawback however is that these plants have a significantly high tannin content throughout the year which can be detrimental to livestock (i.e. tannin reduces protein degradation in the rumen of these animals and subsequently increases the flow of amino acids to the small intestine) (Zucker 1983, Kumar and Singh 1984, Abdulrazak et al. 2000, Degen et al. 2000). Heydenrych (1999) argued that IAPs used as fodder cannot be considered economically important. Yet, selected IAP species

proved invaluable to one of the interviewed farmers as livestock feed during a drought and are currently still used as fodder for livestock by farmers in the study area. Low to moderate tannin concentrations can improve livestock's ingestion ability, digestibility as well as performance (Norton 1994, Abdulrazak et al. 1996) and compared to grasses, leguminous trees (such as Acacias) also have a relatively higher protein content as well as minerals and nutrients that aid with digestion (Abdulrazak et al. 2000, Degen et al. 2000). Overall, invasive leguminous as fodder can thus be considered economically important to some extent (*cf.* Heydenrych 1999). *Leptospermum laevigatum* was however considered a problem by one of the livestock farmers as their animals did not feed on it and this why the species' impact on grazing potential are being regarded as substantially high (Van Wilgen et al. 2008). Invasive alien plants as shade for livestock was only mentioned by a single farmer though it was frequently noted in the field. One can postulate that not only farmers, but society at large have become so accustomed to shade provided by alien trees that they perceive it as an integral part of the landscape (Shackleton et al. 2007). The perceived valuation of IAPs as a source of shade still has to be wholly assessed (Heydenrych 1999).

Mulching made from IAPs was mentioned by a single farmer who displayed a positive attitude towards the process and its effects, but the high financial costs associated with it caused for the operation to be ceased. Kitenge (2011) found that a wood chipper's operation rate is directly proportional to its production rate, with high biomass and minimal travelling contributing positively to productivity. As the interviewed farmer indicated that mulching was done on the farm, travelling costs can be considered negligible. However, low biomass and in turn low operation rate could be the possible contributing factors to the low production rate and thus high costs. High soil nitrogen content contributed by IAPs can however be detrimental to fynbos species and result in the prolific growth of weedy grass species (Yelenik et al. 2004).

4.4.3 Invasive alien plant management on private land

4.4.3.1 Relationship between land-use, invasion and farmers' attitudes

Most of the interviewed farmers, except one, had negative attitudes towards IAPs, were passionately outspoken against these plants and regarded them as a nuisance which threatens their livelihoods. As with Urgenson and others (2013), results suggest that farmers' attitudes

were indeed in a reciprocal relationship with the environment itself i.e. level of infestation is attributable to the degree of land management or the intensity thereof, and in turn, farmers who had significant infestation of IAPs on their land, in general, did not have positive attitudes towards IAPs. Most of the farms in the study area are located in high lying, mountainous areas with a river running adjacent to or through them. Associated farmers reported more challenges related to IAPs, since invasives are known to be dominant in these landscapes (Le Maitre et al. 1996, Le Maitre et al. 2002, Henderson 2007, Van Wilgen 2009). Species such as *Pinus radiata* and *Hakea sericea* are especially invasive in mountain fynbos (Henderson 2007, Van Wilgen 2009). Invasives are also known to thrive and spread along river banks and watercourses (Le Maitre et al. 1996, Le Maitre et al. 2002). Invasive alien plants' ability to consume vast amounts of water (Le Maitre et al. 1996, Dye et al. 2001, Le Maitre et al. 2002, Le Maitre et al. 2007, Marais and Wannenburg 2008) was confirmed by interviewees in the study area. Farmers were aware of the changes in water volumes caused by IAPs as their livelihoods (i.e. agricultural activities) are directly dependent on water. The complexity of the landscape that surrounds Elim (i.e. it is topographically heterogeneous; page 6) is thus a contributing factor to the excessive growth of IAPs.

4.4.3.2 *Invasive alien management costs*

There seemed to be a level of inexperience and lack of knowledge regarding effective ways to manage IAPs. This was apparent when one farmer stated that he burned stands of refuse *A. saligna* biomass without indicating follow up control of seedlings. Fire is known to contribute to *A. saligna*'s prolific growth (Binns et al. 2001, Holmes et al. 2005). Two farmers were also uninformed regarding particular detail with regard to herbicide application and communicated their lack of communication regarding logistics with respect to the LandCare alien clearing funding project.

Invasive alien plant clearing success was perceived to be variable amongst the interviewed farmers. Aside from the conventional approaches to clear and manage IAPs, some farmers also indicated innovative ways that they have incorporated for this purpose which included the incorporation of alien clearing and management tasks within the duties of the farm labourers, livestock to manage IAPs as well planting of *P. clandestinum* (Kikuyu grass) pastures. The latter method is somewhat ironic as *P. clandestinum* is also a non-indigenous species (Henderson 2001). The general consensus amongst farmers is that ploughing and

cultivating a piece of land is the most successful way to rid an area of IAPs. Even though this practice is perceived as economically more viable, it poses detrimental threats to natural fynbos vegetation and biodiversity (Treurnicht 2010). Although large parts of the Agulhas Plain have already been transformed (Wolfart 2006, Paige 2012), farmers' livelihoods are dependent on the success of their agricultural practices and resorting to ploughing and cultivating are deemed only options to rid an area of IAPs.

Additional costs include the constant removal of seedlings from arable land as well as the reduced productivity of grazing areas (*cf.* Shackleton et al. 2007). Weeds and problem plants perceived as invasive by livestock and cash crop farmers are not specifically targeted by WfW on state land. As a result spill over from the latter to privately-owned land will thus remain a problem to landowners until plausible solutions are obtained. Though WfW relies on landholders for IAP clearing and management (Urgenson et al. 2013, Van Wilgen et al. 2012), farmers in the study group regarded it as a process that demands excessive financial resources, time and commitment with some unable to sustain this task. Farmers realised that the responsibility of alien clearing lay with them as the land-user and in most cases the land-owner, but they also felt that more responsibility should lie with government than what they are currently receiving (*cf.* Van Wilgen et al. 2012:2, Urgenson et al. 2013). This thus calls for a united and more structured cooperation between government and private landowners with regard to alien clearing in order to attain the desired outcomes (Urgenson et al. 2013, Van Wilgen et al. 2012).

4.5 Conclusion

Decreases in antagonistic attitudes towards IAPs were displayed when benefits were attached to IAPs, indicating that individual's economic circumstances play a vital role in the valuation and utilization of IAPs. There seemed to exist a level of inexperience and lack of knowledge amongst farmers regarding effective ways to clear and manage IAPs as well as policies and logistics regarding funding. There was no cohesive attitude expressed with regard to institutional accountability regarding alien clearing and management though farmers demanded more support from government.

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Chapter 5:

Key findings, recommendations and conclusion

5.1 Introduction

This thesis investigated the impacts that invasive alien plants (IAPs) have on the livelihoods of rural-land users by means of qualitative interviewing and a grounded theory approach to data analysis. Interviews were conducted with landholders (referred to as farmers) and individuals from a marginalized community in Elim on the southern Cape coast of the Agulhas Plain, South Africa.

Evidence regarding the values and impacts (positive and negative) of IAPs are imperative for the success of national alien vegetation clearing programmes such as Working for Water (WfW) and LandCare as well as for the formulation of legislation and policies that pertain to IAP management. Valuation frameworks have been designed, yet these either neglect the full impacts of IAPs (*cf.* Emerton and Howard 2008:44) or totally exclude IAP valuation (*cf.* Total Economic Value framework, page 29). Previous IAP assessment studies have mainly focused on the negative impacts of IAPs while the benefits that they hold for local people are usually undermined. A holistic perspective on IAP impact can direct attention towards a more value-orientated alien clearing and management framework. This thesis aimed to address these points through several key questions (see below). Experimental data collected and analysed in aid of this research can offer environmental managers and decision-makers in the area a better understanding of the social perspective and valuation of IAPs which in turn can advise future managerial frameworks.

5.2 Methodology: significance, limitations and reflections

Snowball sampling was applied in the selection of interviewees. Communication with identified land-users was facilitated by a community member from Elim who contributed immensely to the research project. Questions were formulated with land-users and the newly appointed sustainable economic development officer, responsible for community livelihood

development and land-use decision-making, at a workshop hosted by Flower Valley in March 2011.

Communities are usually suspicious of ‘outsiders’ asking questions and this person thus acted as a means of providing access to the local land-users and setting apprehensive individuals at ease (Sixsmith et al. 2003). The time needed to identify and locate interviewees was also vastly reduced as the researcher could readily draw on the individual’s knowledge of the study area and the people who live in the landscape. The community member who aided with the identification of potential interviewees sat in on some of the interviews and this however could have made some of the respondents reluctant to share information with the researcher. Yet, interviewees were assured that their responses would be kept anonymous.

Qualitative interviewing as a means of data collection proved a useful tool for capturing knowledge and providing a holistic view of the perceived impacts of invasive alien plants (IAPs) on rural land-users’ livelihoods in Elim and the surrounding farming communities. Thematic analysis of the transcribed interviews allowed for all the information to be depicted and helped to avoid interview bias (Botha et al. 2008). The possible occurrence of further bias was prevented by not using adverbs (e.g. seldom, often, many, etc.) to quantify results (Botha et al. 2008). Instead, superscripts, as a more precise indication of the exact number of times a theme was mentioned by the number of interviewees in a group, was used (Botha et al. 2008). Thematic analysis also facilitated the efficient organization and assimilation of an extensive amount of information (Botha et al. 2008). Several of the perceptions expressed by interviewees were in common with that of other interviewees within and across the two land-user groups (i.e. farmers and marginalized community). Common themes emerged, characterised by the high frequency of specific coded data, (e.g. IAPs used as firewood by the marginalized community (Chapter 3, page 67), limitations of wood used by the marginalized community (Chapter 3, page 72), socially profound experience gained through the Working for Water program (Chapter 3, page 71) and the high costs associated with alien clearing by farmers (Chapter 4, page 108)). The broad distribution of knowledge and differing frequencies of code recordings is a clear indication that IAP impact on human livelihood is complex and that a multitude of factors needs to be regarded concerning policies and legislations pertaining to IAP clearing and management.

This type of research, where land-users’ local knowledge are retrieved and used by natural scientists, is, as with any other type of research method, still in progress and not exempt from

error (Huntington 2000, Gilchrist et al. 2005). Numerous researchers have however shown that local land-users possess valuable, detailed knowledge about the ecosystems in which they live and work (e.g. Huntington 2000, Robertson and McGee 2003, De Neergaard et al. 2005, Drew 2005, Winter et al. 2007, Botha et al. 2008, Snyman 2010, Urgenson et al. 2013).

5.3 Key findings

Interviewed stakeholders' attitudes towards and perceptions of invasive alien plants (IAPs), varied considerably. This was so for farmers as well as for individuals from the marginalized community (i.e. wood merchants, flower pickers and individuals that have worked on alien clearing programmes to supplement the household's monthly income). What is notable for the two land-user groups is that the number of unique codes generated for the perceived benefits derived from IAPs was higher for the marginalized community as opposed to the farmers (65 vs. 51). However, the number of unique codes generated for the perceived costs associated with IAPs was higher for the farmers when compared to the marginalized community (67 vs. 53, see and compare Tables 3.1 and 4.1, pages 65 and 95).

Chapters 3 and 4 addressed the values of IAPs as perceived by the interviewees (both rural-land-user groups in the study area). The marginalized community in Elim (Chapter 3) and the surrounding farming community (Chapter 4) engaged with IAPs on different levels and the significance of IAPs as resources varied.

The key findings from these chapters that pertained to **IAP value and use as perceived by both the land-user groups (marginalized community and farmers)** were as follows:

- a) Both groups used folk names, distinct to the area, for three of the IAPs i.e. *Acacia cyclops* (Afr. Hoenderhout), *Acacia longifolia* (Afr. Waaisand, Wysand) and *Acacia saligna* (Afr. Rooibas).
- b) Where value and benefits were derived from IAPs, both land-user groups' perceptions of those species were positive.
- c) The use of invasive alien plants for firewood was more frequently identified by the marginalized community compared with the farmers.

- d) Farmers mentioned more species of non-native plants (N = 17 of which 12 are invasive) than individuals from the marginalized community (N = 10, of which all are invasive). This difference might be due to the differences in education. Additionally, the difference might also be due to the different interview protocols for the land-user groups (see Appendix B, page 140).
- e) Whereas the marginalized community was more concerned with direct uses of plants (i.e. for firewood and as a source of income from selling wood), farmer's knowledge regarding IAPs was more focused on the impacts of invasive species on their farming practices.
- f) *Leptospermum laevigatum* was favoured as fuelwood by both the farmers and the marginalized community owing to its essential qualities i.e. high combustion temperature and long-lived coals.
- g) The interviewees from the marginalized community were certainly more aware of the different wood types that can be used as fuelwood and for construction purposes through their intrinsic qualities (i.e. combustion temperature, longevity of coals, durability of wood). This might be a display of their dependence on IAPs as a freely available resource.
- h) Although frequency of IAP use was recorded at a lower number for farmers as opposed to the interviewees from the marginalized community, farmers did exhibit more innovative uses for IAPs than just the general use as fuelwood (i.e. income generating purposes from a private sawmill company and certain IAPs (more specifically *A. saligna* and *A. longifolia*) was used as fodder and in the form of mulch, fence poles and furniture, as well as for ornamental objects, production of mulch and mitigation of baboon impact on fruit orchards).
- i) A low number of wood merchants (two interviews were conducted) were identified in the study area which was indicative of a restricted market. Businesses operated by the interviewed wood merchants were small and their target markets were the more affluent households who buy in bulk.

- j) The economic value of certain IAPs (*L. laevigatum*, *Acacia mearnsii*, *A. cyclops* and *Eucalyptus spp.*) as marketable fuelwood is considerably higher than other wood species which is reflected in their selling price (R450 – R600 for a 1000 pieces). Wood merchants indicated that it was increasingly more challenging to acquire adequate supplies of *A. cyclops*.
- k) Few interviewees from both land-user groups perceived IAPs to have aesthetic, cultural and intrinsic appeal. Working on alien clearing programmes appeared to enhance individuals' intrinsic value for nature.
- l) The number of unique codes identified for costs associated with direct (marketed and non-marketed) consumptive use and opportunity costs (benefits lost) was higher for the marginalized community compared to the farmers (see Tables 3.1 and 4.1, pages 65 and 95). This might be due to the fact that wood is more freely available to farmers on their farms compared to wood availability on Elim ground and that community members have to go to greater lengths (i.e. transport costs, machinery, accessibility issues for wood merchants) to obtain wood. Yet farmers can also experience costs as they too may have to travel distances to portions of their farm to obtain wood. One can also argue that that this factor might have been not as important to farmers during the interviewing thus the lower values.

The study also aimed to address issues pertaining to IAP management and people's perception thereof. Chapter 3 and 4 addressed the **impacts (both positive and negative) of IAPs on land production and the perceptions of IAP impacts on alien clearing and management and in turn on people's livelihoods.**

The key findings from these chapters for both land-user groups are as follows:

- a) Invasive alien plant management costs were only recorded for farmers. This is as alien clearing on privately-owned land is done by farmers themselves and members of the marginalized community are normally not directly involved with the costs (expenditures) thereof.

- b) Invasive alien plants were perceived as being detrimental to ecosystem goods and services. Not only were they perceived to consume vast amounts of water and contributed to fire hazards, but a lack in alien management and clearing undermined peoples' livelihoods and hampered flower picking.
- c) It was observed that farms under low intensity land management (notably those managed for growing wild flowers) usually corresponded with severe invasion by IAPs. These observations were also supported by statements from interviewees.
- d) The perceived link between low intensity farming and the severity of invasion by IAPs increased antagonistic attitudes towards IAPs amongst farmers.
- e) Farmers' approaches to eradicate and manage IAPs included manual removal, mechanized techniques, burning, and the application of herbicide on residual stumps. IAP clearing success was perceived to be variable; farmers emphasised that it is a protracted process that demands extensive financial resources.
- f) The general consensus amongst farmers was that ploughing and cultivating a piece of land is the most successful way to rid an area of IAPs.
- g) There seemed to be a general lack of knowledge (or information) amongst farmers with regard to effective alien clearing methods as well as policies and legislation pertaining to IAP clearing.
- h) No clear consensus was expressed by farmers regarding responsibility for alien clearing and management i.e. there was no clear indication of who the onus should rest with, either institutionally or individually.
- i) Apart from the conventional social development goals (i.e. job creation, poverty alleviation and skills training) set out by Working for Water (WfW), knock-on social development benefits (i.e. pride, community union, conflict management skills, feelings of responsibility and enhanced work ethic amongst others) were also realised.

The trade-offs that this community makes by allowing IAPs to grow in certain areas are associated with costs such as reduced grazing land, reduced water availability, increase in fire hazards as well as the reduction in the abundance of indigenous fynbos species otherwise used for income generation from wildflower harvesting or collection of thatch. In return, people had reliable sources of firewood, fodder and shade for livestock, construction material and the potential to use it for the dried flower industry. These could be accessed by individuals on their own property, yet they were excluded from accessing it on properties owned by other individuals (e.g. wood merchants could not freely access privately owned property to obtain wood). Taking everything into account, the number and the nature of benefits, as perceived by the local land-users themselves, exceeded the negative impacts (see Appendix D, page 146).

5.4 Implications and recommendations for conservation management and policies

Invasive alien plants are detrimental to ecosystem goods and services on which land-users' livelihoods are based. Clearing and management of invasive alien plants should thus definitely continue, especially for ecologically sensitive areas such as riparian zones. These programmes should however avoid adversely impacting on economically marginalized communities (Kull et al. 2011). This is as IAPs proved to be of great importance, especially to the marginalized who utilized them for direct consumption as well as economic benefit. This is in stark contrast with the farmers who depended less on IAPs as a major contribution to livelihood. In a country like South Africa, native tree species are primarily slow growing and do not meet the high demand for firewood, timber, tannins, charcoal, shade, windbreaks, etc. (Nyoka 2003) while IAPs are freely available resources (Shackleton et al. 2007).

The perceived declines in certain favourable wood species (i.e. *A. cyclops* and *A. mearnsii*) are a challenge faced by individuals reliant on wood for sustenance and income (livelihood). These declines have the potential to reduce livelihood strategies making them less flexible (see Livelihood and livelihood strategies, page 18). A suggestion is that alien clearing should be centred away from the peripheries of settlements and woodlots where communities can source wood. Future directions should include rigorous biome-scale assessments of IAP impact coupled with livelihood impact assessment. This is as climate (temperature and

rainfall) and by implication conditions that favour IAP growth, varies between the nine biomes of South Africa. Hence, the population structure of South Africa also varies with the varying climatic conditions. Results from these assessments should give decision-makers and alien clearing and management programmes a holistic perspective of IAP impact and shift the focus towards e.g. high impact, low benefit species.

The negative connotation and labelling of invasive plants was found to be economic and socially specific (*cf.* Shackleton et al. 2007). Interviewees who perceived IAPs as a benefit through their uses and positive impacts did not regard them as invasive. The statement by Carruthers and others (2011:818) that “a weed is only a weed in the eye of the beholder”, rings true. This is an important reality for alien management in that future directions should include educating society at large in order to shift perceptions and make people more aware of the adverse effects of IAPs. Propagule spread must be minimised. Holmes and Cowling (1997) suggested that propagules, large stems and branches must be removed before the burning of IAPs. The latter can be offered to the local firewood trade. This was done by farmers in the study who ‘gave’ wood from trees after felling to marginalized communities to avoid build-up of dry biomass that can possibly cause wildfires. A low intensity fire is suggested as smog and heat will stimulate the germination of fynbos, on condition that burning is executed in the suitable season (Holmes and Cowling 1997).

It was found that individuals that have previously worked on alien clearing programmes such as WfW, obtained various social development benefits aside from WfW’s set social development goals. On several occasions these individuals also denounced WfW’s approach to people development. For the continuous success of WfW, it is thus advised that management follow an approach that would inform of employee’s needs, notions and grievances in order to build on the social development benefits resonating from the programme. One can argue that when these knock-on social development outcomes are better endorsed and sustained, their impacts would evidently enhance the current social development goals set out by WfW (Buch and Dixon 2009).

Government is advised to adequately inform farmers regarding effective alien clearing methods as well as policies and legislation pertaining to IAP clearing. This information is not always readily available to rural landholders i.e. it is either available online (e.g. DEA 2012, DWA and WFWP 2008, DWA 2012) or in hard copy that is not easy access. Closer relationships are encouraged between private landholders and government with monetary

incentives as well as stricter enforcement of policies and regulations (CARA* and NEMBA†) regarding alien clearing (Van Wilgen et al. 2012, Urgenson et al. 2013). Different policies concerning alien clearing and management on private and state owned land is also proposed as various stakeholders involved have different needs and requirements (Van Wilgen et al. 2012). This is so that guaranteed positive results can be obtained with regard to alien clearing and management.

A joint effort is proposed between private and public role players i.e. the implementation of community forestry where ‘alien clearing is done by the community for the community’ (Traynor et al. 2008). Invasive alien plants will then be sustainably removed with the aim of commercial exploitation by marginalized community. There are however implications involved as stated by De Lange and others (2012:76) (i.e. “increase financial dependency on these plants...which could create adverse incentives to illegally grow these plants”). Yet with a proper structured approach this can prove to be a successful and sustainable method for alien clearing and the management thereof.

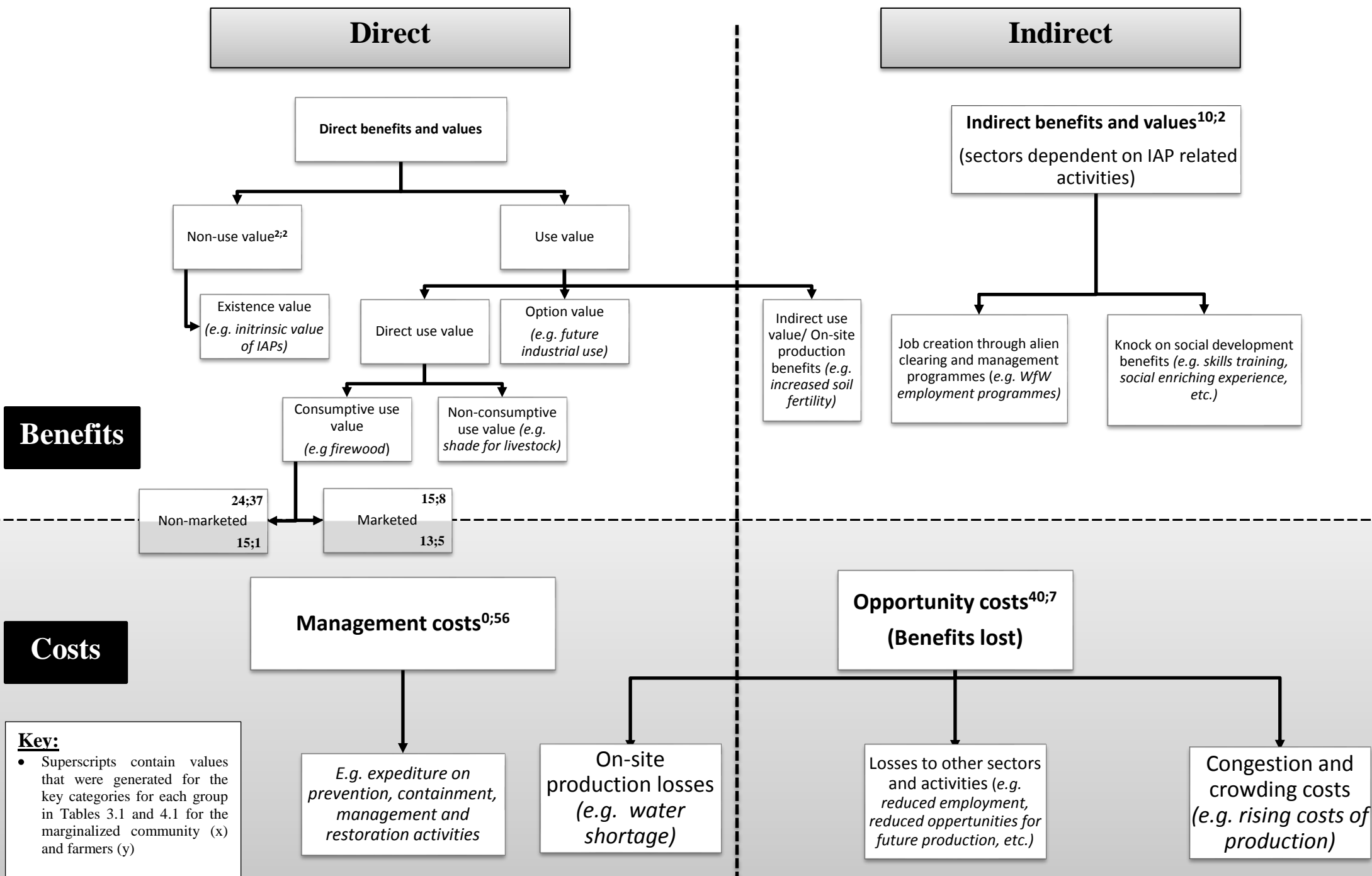
5.5 The impacts and values of invasive alien species’ framework

To define the impacts, benefits and costs of invasive alien plants (IAPs) requires that both the direct and indirect (secondary/tertiary) positive and negative effects be taken into account (Emerton and Howard 2008). As defined by Emerton and Howard (2008:41), direct impacts “arise from the effects of the invading species on the host habitat/ecosystem and measures to manage the invasive species” while indirect impacts “refer to the effects on other sites, sectors and times in terms of market, health, nutrition, trade, the environment and public and private spending.”

The gaps and links within the Total Economic Value (TEV) and the Direct and Indirect Economic Impact frameworks (Emerton and Howard 2008) with regard to IAPs was drawn upon (see Chapter 2 pages 28 - 33); results obtained from this thesis were then combined to generate a framework addressing the holistic impacts and values of IAPs as perceived by rural land-users (see Figure 5.1).

*Conservation of Agricultural Resources Act No. 43 of 1983

†National Environmental Management Biodiversity Act No. 10 of 2004



Key:

- Superscripts contain values that were generated for the key categories for each group in Tables 3.1 and 4.1 for the marginalized community (x) and farmers (y)

- Can have both benefits (white) and costs (grey).

Figure 5.1: The holistic impacts of invasive alien plants (IAPs) are displayed in the body of the framework. Results from this thesis as well as key categories from the TEV and Direct and Indirect Economic Impact frameworks (Emerton and Howard 2008:44) were drawn upon to construct the framework.

The values found in Tables 3.1 (page 65) and 4.1 (page 95) for the key categories that were generated for each of the groups (marginalized community and farmers) were included as superscripts within the framework (whereas the first value (x) constitutes the value for the marginalized community and the second value (y) that of the farmers). Direct marketed and non-marketed consumptive uses of IAPs were found to have both benefits (superscripts in white area) and costs (superscripts in grey area). For full definitions of the key categories used see the TEV and Emerton and Howard (2008:44).

5.6 Conclusion

This thesis has attempted to draw on nuanced information as well as emphasize what has previously been recognized as essential for IAP management i.e. holistic valuation of IAP impact on local land-users as this information is essential for decision-making processes. When one compares the two groups of land-users (farmers and marginalized community) with each other, it is evident that the effects and impacts of IAPs on human livelihoods are complex. Various potentially conflict species have both positive and negative impact on livelihoods. An example of this is *L. laevigatum* which was perceived as an excellent fuelwood and used to make droppers with, yet its reported negative impacts on biodiversity and on grazing is very high and it cannot be utilized by livestock. The complex nature of IAP impacts has not fully been encapsulated in previous frameworks. Thus, apart from the detrimental impacts imposed by these plants, all impacts (both positive and negative) as well as values must be considered within planning and decision-making frameworks.

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Appendix A:

A glance at Elim, a Moravian mission station on the southern Cape coast of the Agulhas Plain, South Africa



Image A.1: Visitors are welcomed at each entrance to the town with a sign indicative of the authority of the Overseer's Council (Afr. *Opsiensraad*) (a). Since its inauguration in 1835, the Church (b) has been the focal point of the town which is a display of the strong religious nature of this Moravian mission station. Church Street (c) was the first street proclaimed in Elim in 1830. Vegetable gardens practiced by small-scale farmers for subsistence are located on the northern periphery of the town (d). The local private conservancy *Geelkop* (Eng. Yellow Head) is located behind the vegetable gardens. People's livelihood in this town is centred on the rich biodiversity located in the region which is continuously threatened by invasive alien species (e). Community development, -outreach as well as festivals displaying Elim's cultural and floral diversity are at the heart of this town (f, g and h). (Credit: Carlo Cloete)

Appendix B:

Interview Protocol

B.1: Interview protocol for farmers

Interviewees were introduced to the interview with a set of questions focusing on the demographic profile of the interviewee and the farm profile i.e. residency of the interviewee (either manager or owner), establishing the tenancy of the interviewee, period of ownership and current farming activities as well as the percentage income that the latter is responsible for. Questions relating to the size of the farm as well as estimates of the area that are still natural fynbos followed.

The interview then focused on the following aspects:

- Presence and density of IAPs on the individual's farm
- Invasiveness of the different IAPs
- Attitudes towards IAPs
- Their perception of the influences of IAPs on the different farming activities on their farm
- Management of IAPs
 - Methods used during clearing
 - Estimates of the costs involved
 - Frequency of clearing
 - Follow-up
- Methods used to do follow-up
 - Time after initial clearing
 - Frequency of follow-up
- Possible benefits of IAPs to either them or the farm workers associated with their farm.

B.2: Interview protocol for marginalized community

In-depth interviews were conducted using a predetermined interview schedule. The interview commenced by asking the interviewee basic background questions (e.g. “*Please tell me (more) about yourself*”). The interview then continued with focusing on the following aspects:

- Energy sources in their dwelling/house (see if and where wood fits in in these people’s livelihood)
- Use of IAPs
 - Direct use
 - Preference of wood/IAP type
 - Purpose(s) that specific wood/IAPs are used for
 - Accessibility of wood
 - Economic use
 - Do they buy, collect or sell wood
 - The frequency thereof, source, costs and time associated with above
- Impact of IAPs on their working environment
- Impact of IAP management

In the event where wood merchants were interviewed, details describing the types of wood that were sold, the accessibility of wood sources and the financial viability of this livelihood strategy were addressed.

Appendix C:

Code Memo

Table C.1: Code memo which includes code descriptions used to distinguish between themes during coding. Codes that were generated were then grouped into seven unique categories under the two main groups i.e. the perceived positive (Benefits) and negative (Costs) impacts of invasive and problem plants. Where applicable, categories were further divided into sub-categories were also formed. These categories are in accordance with the categories found within the Total Economic Value and the Direct and Indirect Economic Impacts frameworks; see Chapter 2, page 28 - page 33. Please note that the key categories found within these respective frameworks were only used to identify they key categories in the table below; frameworks were not used to analyse the data.

Benefits/Costs	Category	Sub-categories (only where applicable)	Code description
Benefits	Direct non-marketed consumptive use of IAPs	<ul style="list-style-type: none"> ▪ Fuelwood ▪ Shade and fodder for livestock ▪ Construction material ▪ Additional uses 	Direct use of IAPs e.g. as firewood, for construction purposes, etc.
	Direct marketed consumptive use of IAPs		Economic benefit - Any source of income generated from wood e.g. selling wood as firewood as well as income generated from sawmill cutting large Pine trees.

	Non-use value of IAPs	<ul style="list-style-type: none"> ▪ Reflective and cultural valuation 	Cultural, spiritual, aesthetic, tourism, history, education, heritage, science, inspirational benefit.
	Indirect economic benefits associated with IAPs	<ul style="list-style-type: none"> ▪ Alien clearing programmes 	Benefits in terms of employment/job creation, supplies of inputs and commodities, prices of inputs and commodities, water services, erosion control services, storm and flood control, options for future production and consumption, etc. (adapted from Emerton and Howard 2008).
Costs	Costs associated with non-marketed consumptive direct use of IAPs		Any cost incurred from directly making use of wood e.g. transport cost, time spend collecting wood, etc.
	Costs associated with marketed consumptive use of IAPs		Any cost incurred from generating a source of income from wood e.g. transport, time, effort in collecting wood.
	Opportunity costs (Benefits lost)	<ul style="list-style-type: none"> ▪ Ecological costs ▪ Costs to (other) livelihood strategies ▪ Alien clearing programmes 	Costs in term of: Cultural, spiritual, aesthetic, tourism, history, education, heritage, science, inspiration. Losses to production in the area where invasion has occurred such as: decreasing yield and productivity, increased sedimentation and siltation, a reduction in options for future production and growth, etc. (adapted from Emerton and Howard 2008).

			Impacts on enterprises as well as sectors that depend on the invaded ecosystem such as: reduced employment, declining earnings, reduced supplies of inputs and commodities, higher prices of inputs and commodities, storm and flood damage, water shortage, etc. (adapted from Emerton and Howard 2008).
	Management costs	<ul style="list-style-type: none"> ▪ Management methods ▪ Financial costs ▪ Governmental involvement ▪ Time spent on management ▪ Follow-up 	Any cost associated or related to management of IAPs – clearing (physical control and bio control measures) and management (periodic clearance of IAPs, monitoring). Expenses on prevention, clearing, management and restoration activities such as: equipment, wages, infrastructure, transport, maintenance, etc. (adapted from Emerton and Howard 2008).

Appendix D:

A summary of the perceived positive and negative impacts of invasive alien plant infestation at Elim on the southern Cape coast of the Agulhas Plain.

Invasive alien and problem plants	Positives	Negatives
<i>Acacia cyclops</i>	<ul style="list-style-type: none"> • Source of firewood. • Source of income for wood merchants from selling wood as firewood. 	<ul style="list-style-type: none"> • High demand and impact reduces availability.
<i>Acacia longifolia</i>	<ul style="list-style-type: none"> • Source of fodder for livestock. • Source of firewood. 	<ul style="list-style-type: none"> • Wood burns out quickly and produces ash.
<i>Acacia mearnsii</i>	<ul style="list-style-type: none"> • Source of firewood. • Source of fodder for livestock. • Source of income for wood merchants from selling wood as firewood. • Aesthetic appeal. 	
<i>Acacia saligna</i>	<ul style="list-style-type: none"> • Source of fodder for livestock. • Source of firewood. • Used to construct droppers (small wooden spars). • Collected by one farmer for furniture manufacturing. 	<ul style="list-style-type: none"> • Wood burns out quickly and produces ash.

<i>Eucalyptus diversicolor</i>	<ul style="list-style-type: none"> • Seed capsules used for flower industry. 	
<i>Eucalyptus lehmannii</i>	<ul style="list-style-type: none"> • Source of firewood. • Dried out seed capsules used for flower industry. 	<ul style="list-style-type: none"> • Produces noxious gasses when burned.
<i>Eucalyptus spp.</i>	<ul style="list-style-type: none"> • Sentimental value attached to these trees by one farmer. • Source of firewood. • Used to construct droppers (small wooden spars). • Source of income for wood merchants from selling wood as firewood. 	
<i>Hakea gibbosa</i>	<ul style="list-style-type: none"> • Dried out seed capsules used for flower industry. 	
<i>Hakea spp.</i>		<ul style="list-style-type: none"> • Hampered alien clearing and flower picking.
<i>Leptospermum laevigatum</i>	<ul style="list-style-type: none"> • Excellent source of firewood, produce long lasting coals. • Used to construct droppers (small wooden spars). • Source of income for wood merchants from selling wood as firewood. 	<ul style="list-style-type: none"> • Cannot be utilized as fodder. • Detrimental impacts on grazing land and biodiversity due to invasiveness.
<i>Pinus spp.</i>	<ul style="list-style-type: none"> • Used as kindling. • Source of firewood. • Used as construction material (trusses and beams of houses). 	<ul style="list-style-type: none"> • Wood burns out quickly and produces ash. • Cannot be used for construction purposes without being chemically treated. • Trees cut down by sawmill company promotes

	<ul style="list-style-type: none"> • Source of fodder for livestock. • Acts as buffer to mitigate the impact of baboons on fruit orchards. • Source of income from sawmill company. 	growth of seedlings; detrimental in long-run.
<i>Parenthesis lophantha</i>		<ul style="list-style-type: none"> • Cannot be utilized as fodder, noxious plant.
<i>Pennisetum clandestinum</i>	<ul style="list-style-type: none"> • Source of fodder for livestock 	
<i>Aristides junciformis</i>		<ul style="list-style-type: none"> • Decrease grazing potential.
<i>Cirsium vulgare</i>		<ul style="list-style-type: none"> • Decreased grazing potential and detrimental to livestock.
<i>Berkheya coriacea</i>		<ul style="list-style-type: none"> • Decreased grazing potential and detrimental to livestock.
<i>Tribulus terrestris</i>		<ul style="list-style-type: none"> • Decreased grazing potential and detrimental to livestock.
No specified invasive or problem plant	<ul style="list-style-type: none"> • Used to make mulching for green manure. 	<ul style="list-style-type: none"> • Mulching is a cost ineffective process.
	<ul style="list-style-type: none"> • Source of shade for livestock. 	<ul style="list-style-type: none"> • Sourcing wood for household and economic use is time consuming and people are limited by transport and tools used to cut wood.
	<ul style="list-style-type: none"> • Sourced for building material, firewood for general use and celebrations as well as economic income. 	<ul style="list-style-type: none"> • Decreased availability of water and clog waterways.
	<ul style="list-style-type: none"> • Intrinsic and cultural value attached to IAPs. 	<ul style="list-style-type: none"> • Decreased abundance of specialized flowers and indigenous vegetation.

	<ul style="list-style-type: none">• Alien eradication programmes is a source of job creation, poverty alleviation, provides valuable skill training and social development benefits.	<ul style="list-style-type: none">• Reduced people's (especially flower pickers') livelihood potential.
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