

THE INDIGENOUS KNOWLEDGE OF THE
LOCAL COMMUNITY TOWARDS WEEDS AND
ALIEN INVASIVE PLANTS IN THE DINOKANA
AREA, NORTH-WEST PROVINCE, SOUTH
AFRICA.

By

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Dissertation submitted in fulfilment of the requirements for
the degree in M. Environmental Science in the School of
Environmental Science and Development: North-West
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Date of submission: 2008

ABSTRACT

The study was undertaken to determine the indigenous knowledge of the local community of the Dinokana Area, including the perception and attitude towards the declared weeds and alien invasive plants (WIP). The study was conducted in the following villages in the Dinokana Area, namely: Dinokana, Borothisamadi, Mantsie, Maramage, Ntswelotsoku, Madutle, Matlhase, Ikageleng and Khunotswana. These villages are situated in the district of Lehurutshe within the Ramotshere Moiloa Local Municipality of the North West Province in the Republic of South Africa. The following two methods were used, namely: a questionnaire and a vegetation survey. There were 100 questionnaires, which were divided on the basis of the size of the population per village. Vegetation surveys were done at Maramage and Dinokana Villages. Belt transects of 160m² and 80m² were used to carry out the vegetation sampling. The woody components were recorded according to species type, height classes and Tree Equivalent (TE) were calculated through predetermined factors for each height class. The other seven villages were mapped mainly for the individual tree species. The results of the questionnaire indicated a fair knowledge of the occurrences of the declared weeds and alien invasive species in the area with some uses of these plants, such as roof construction. Approximately 56% of the respondents were females and the rests were males. Most of the participants were youth (31%), who were less than 25 years old and 27% were of the age between 26 and 36 years and only 4% of the people were older than 70 years. 45% of the respondents had Grade 8 to 12 while only 9% have higher education qualifications, such as Diploma or a degree. The majority of the people were unemployed (69%). The vegetation survey indicated that there were more *Populus canescens* than other plant species. Approximately 9.4 ha of the land in Maramage Village were invaded by *Populus canescens*. The predominant height classes in terms of Tree Equivalent per hectare (TE/ha) was 2 to 3 meters with a density of 34073 TE/ha, followed by trees of more than 4 meters with a density of 61687 TE/ha.

In the Dinokana Village, the most prominent species was mainly *Opuntia imbricata*. Other species identified were *Melia azedarach* and *Lantana camara*. These results were compared with the outcome of the questionnaire. The indigenous knowledge rated most of the plants as moderate to heavy infestation (Figure 5.5). Capacity building, awareness raising and co-ordination amongst different Government Departments should be enhanced in order to encourage government efforts.

Keyword: Perception, declared weeds and alien invasive plants.

OPSOMMING

Die studie was uitgevoer om die inheemse kennis van die plaaslike gemeenskap van die Dinokana gebied te bepaal ten opsigte van onkruid en indringerplante, asook hulle persepsie en houding in die verband. Die studie was in nege gemeenskappe uitgevoer, nl., Dinokana, Boroathamadi, Mantsi, Maramage, Ntsweletsoku, Madutle, Matlhase, Ikageleng, en Khunotswana. Twee metodes naamlik, 'n vraelys en 'n plantegroeiopname is gebruik. Honderd vraelyste is gebruik wat volgens die grootte van die inwoners per gemeenskap verdeel is. Die plantegroeiopname was in Maramage en Dinokana gemeenskappe gedoen. 'n Lyntransek van 160m² en 80m² was gebruik vir die neem van plantegroeiemonsters. Die houtagtige spesies was volgens spesie, hoogte en bos-ekwivalent met 'n voorafbepaalde faktor vir elke hoogteklaas gedoen. In die ander sewe gemeenskappe was 'n kaart opgestel wat hoofsaaklik die individuele boomspesies aandui. Die uitslag van die vraelyste het aangedui dat daar 'n "redelike" kennis van die voorkoms van onkruid en indringerplante in die gebied bestaan, wat ook enkele gebruike soos dakkonstruksies ingesluit het. Ongeveer 56% van die respondente was vroulike en die res manlik. Die meerderheid (31%) van die vraelyste is deur persone jonger as 25 jaar voltooi, terwyl 27% tussen 26 en 36 jaar oud was. Slegs 4% van die inwoners wat die vraelys voltooi het was bo die ouderdom van 70 jaar. Van die respondente inwoners was slegs 9% in besit van 'n hoër onderwys kwalifikasie, soos byvoorbeeld 'n diploma of 'n graad. Vyf en veertig persent (45%) van die inwoners was slegs in besit van 'n graad 8 tot graad 12 kwalifikasie. Die meerderheid (69%) van die respondente was werkloos. Die plantegroeiopname het aangedui dat *Populus canescens* die mees dominante spesies is en het 9.4 ha van die veld in die Maramage gemeenskap ingeneem het. Die mees prominente hoogteklasse was 2 tot 3 meter (34073 BE/ha) en ook tot 4 meter (61687 BE/ha) in terme van die Boom Ekwivalent per hektaar (BE/ha). *Opuntia imbricata* was die mees opvallende spesies in Dinokana. Ander plant spesies naamlik *Melia azedarach* en *Lantana camara* is ook geïdentifiseer.

Die resultate is vergelyk met die uitslag van die vraelys. Volgens inheemse kennis is die meeste van die plantgroei van gemiddeld tot dig gegradeer (Figuur 5.5). Die samewerking, gewaarwording en koördinasie tussen verskillende regeringsdepartemente moet verbeter word.

Sleutelwoorde: Waarneming, verklaarde onkruiide en vreemde indringerplante

Dedication.

I would like to dedicate this study to the two most important people in my life, being my mother, Mrs. Itholeng Merriam. Mother, you have never had time to learn as much I did but you never deny me the opportunity to learn, even though you did not have anything to assist me with to go thus far. Secondly, this study is dedicated to my one and only daughter, Reatlegile Itholeng. Rea, this I would like it to serve as an example of what your father would wish you to become in life, someone out of nothing!!!

Acknowledgements

I would like to express my sincere gratitude and appreciations to the following persons:

Professor Klaus Kellner and Dr. Luke Sandham, being my study leaders, you helped me very much and guided me all the way. Although the road was not that easy but you took me far and now I can see the road clearly.

Professor Faans Steyn, you became my helper in data interpretation and analysis, you were always there when I was in need of you.

I take the opportunity to thank the Department of Agriculture for their time and financial support, as well as its policies on empowering employees.

I would like to thank my wife for understanding while I was sharing my time between work and studies, and nothing for her. Say thanks to my friends for standing by my side for their support and motivations as well as guidance, and especially to Mr. Mampholo, who motivated me to pursue when I thought I couldn't make it.

How can I forget my mother and the entire family. Mother, you may not have been to any formal education, but you got courage to encourage me and be by my side all the way. We didn't have much but you manage to pull through for us. Let me also thank my late cousin, Tshipa David Montshioagae, I wish you were here to see me finishing what we both started. The year 1985 until 1989 were not easy, but you took me as your child, thanks and God with his angles be with you wherever you are.

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CHAPTER 1

INTRODUCTION AND PROBLEM STATEMENT

1.1 Declared weeds and alien invasive plants

Declared weeds and alien invasive plants (WIP) are regarded as non-natives or exotic plants whose introduction cause or is likely to cause harm to the economy, the environment or to human health (Abrahams, 2003; Evans, 2003). They are introduced intentionally or accidentally by human activities into regions in which they did not evolve (Abrahams, 2003).

These plants have become a world-threatening problem regarding the sustainability of the ecosystem, biodiversity and the integrity of species, water availability and the aesthetic value of natural areas (Barnard & Newby, 2003). According to Barnard and Newby (2003), the occurrence of WIP in the country has serious implications for water availability as these plants use up to 7% of the available soil water annually.

It also reduces the amount of runoff towards streams and rivers, and contributes to the reduction in diversity and cover of indigenous plant species. Animal diversity is also altered significantly (Meyer *et al.* 2002). Some WIP have dominated areas to the extent that natural vegetation has almost been lost (Meyer *et al.* 2002). While the government and scientists warn that the invasive plants pose a multibillion rand threat to the local economy many South Africans are still ignorant towards the problem (Richards, 2003). In the North-West Province, WIP have invaded about 400 000 ha of land, which is 0.005% of the total of 7991 million ha. This represents only 3.9% of the total area of land in South Africa invaded with WIP, but Meyer *et al.* (2002), warned that although WIP are presently not perceived as a priority in the North-West Province, they are being perceived as a greater problem in the commercial than in the communal areas. WIP are also reported to be the major contributor to land degradation (Meyer *et al.* 2002).

1.2 Government intervention

The government introduced legislation to regulate control and management of these plants. The responsibility for the implementation of this legislation is scattered through various Government Departments, which sometimes makes it difficult for the laws to be enforced. In dealing with the problem of controlling declared weeds and alien invasive plants (WIP), the important laws include, among others: the Conservation of Agricultural Resources Act (No 43 of 1983) or CARA, (South Africa, 1984) the National Water Act (No 36 of 1998) (South Africa, 1998), the National Environmental Management Act or NEMA (No 107 of 1998) (South Africa, 1998), as well as the Environment Conservation Act (No 73 of 1989) (South Africa, 1998) or ECA.

These acts stipulate that the occurrences of these plants in any area in the Republic of South Africa are to be controlled and that, whenever a development is considered, it is important to indicate the occurrence of WIP and to take the necessary action to prevent them from spreading. In this study, CARA is used more often, as it deals directly with ensuring the proper management of the natural agricultural resources where the impacts of the WIP are most prevalent.

CARA requires that every landowner should control the declared weeds and alien invaders (WIP) on his/her farmlands. In order to support and make it possible for this objective to be achieved, the government introduced some intervention mechanisms such as the Working for Water (WfW) program of the Department of Water Affairs and Forestry (DWAF), as well as the weed scheme and the Land Care program of the National Department of Agriculture (2001). These programs are there to ensure that there is a plan to manage the problem of declared weeds and alien invasive plants.

1.3 Community responses to government intervention

Despite the government intervention through the Acts and the programs as outlined above, it appears that various communities are not taking sufficient ownership of the problem. This is the biggest challenge for various departments, especially the Departments of Agriculture and Water Affairs and Forestry as they have different focuses. The attitudes and perception of the people prevent them from becoming part of the solution to the problem. According to Schermerhorn *et al.* (2000) perception is referred to a process whereby the people select, organise, interpret, retrieve and respond to the information from the world around them. It can also be regarded as awareness and concern (Dembele, 2006). Attitude is said to be more universal and therefore the perception formed within one's mind is more on a personal, cultural disempowerment level than on a level of temperament or style (Huysemen, 1994). The local community is blamed for poor management of the natural resources leading to degradation of the land which eventually exacerbates the invasion of WIP.

This blaming of the people, especially by outsiders, is based on beliefs and not on long-term empirical data (Dembele, 2006). Richards and Dean (1998) indicated that the causes of conflicting behaviour include lack of knowledge of plants of the local community, inadequate enforcement of the existing policies as well as the inability to predict which plants will be invasive.

According to McNeely (2003) ecologists have recently brought the problems of WIP to the world's attention while Evans (2003) indicated that this problem has intensified within the last few years, making it a serious challenge to global trade. Despite the fact that the problem of declared weeds and alien invader plant species is regarded to be as serious, with negative implications for the environment, and also despite the legislation and the programs that the government has introduced, the problem of WIP still exists on tribal, commercial as well as municipal lands.

The community had limited knowledge about the programs (i.e. Working for Water and Land Care) programs, which are available to assist communities in managing WIP problems. There is a clear indication that these programs are not easily accessible to the communities. One of the reasons for not implementing the programs is that there is no ownership of the land, as indicated during a personal conversation with Jordaan¹ (2004). Another reason from WfW as highlighted during a personal conversation with Roodt² (2003), is that there was some interference from the tribal authority as they want the local people to be employed by the WfW program.

Roodt (2003) indicated that, apart from interference by the tribal authority, there was no warm welcome to the tribal land. The reason for the interference was mainly due to the fact that the community wanted the WfW to adopt its own procedures by indicating specific number of people to be employed by the project. The WfW program was introduced in the Dinokana area, which depends on contractors, some of which are not from the Dinokana area. This caused the people to resent the WfW plan to control WIP in their area. This resistance led to the withdrawal of the program (Roodt, 2003).

In the context of a participatory rural approach, some causes of failure include inappropriate development, poor understanding of the social and cultural context of the development as well as lack of participation, Anon (2005). According to Critchley and Netshikovhela (1998), there is a serious ignorance of the indigenous knowledge about the problems of WIP and there is a perception by scientists that traditional people do not know about or realise the results of their actions on their lands. This misconception causes planners and policy makers to implement programs without consulting the local people (Critchley & Netshikovhela, 1998).

¹ Jordaan, D. 2004. The Land Care Coordinator-Southern region within the Provincial Department of Agriculture, contact details (018) 2975330.

² Roodt, P. 2003. Technical Advisor- The Working for Water Program, contact details (012) 253 1787

The so called “experts” are usually from a different cultural and social background and address those problems of the local community which they perceive to be important, without consulting the community to find out where the real problem exists. The priorities and the need of the supposed “beneficiaries”, who were rarely consulted during the planning phase of the National programs such as Land Care and Working for Water, are not considered, Anon (2005).

1.4 Preliminary study

Before this study was undertaken, a preliminary study was conducted in the area in 2004. The study was done on a small scale with a population size of 30 people from the villages of Goo-Mokgatla and Ikageleng only. The outcome of the study was that all the respondents (100%) were aware of the problem of declared weeds and alien invasive plants. The respondents indicated that they were not going to take part in the control program, since they are not the ones who introduced the plants to the area. The local people have the perception that the Government, through the Departments of Agriculture, both Provincial and National, has an important role to play through awareness raising and financing the control methods.

In terms of attitude towards the control of these plants, unemployment was mentioned as a reason for the resistance against participation in the government’s existing WIP control strategies. These programs did not employ the local community. Most of the people did not know anything about the different programs referred to in the study, such as Working for Water, the Government Subsidy Scheme and Land Care. They were aware of “*Namola Leuba*”, which include any project as long as it created job opportunities. The people were also not aware of any policy dealing with the control of weeds and alien invader plant species.

As a result of this preliminary study, it was considered that it was important to investigate in more detail the problem of attitudes and perceptions of the local community. It is necessary to determine the influence that the local indigenous knowledge has on the occurrence of WIP in the area, and the extent to which the study can rely on the local knowledge to influence decision making in dealing with the control thereof.

The study includes vegetation survey to determine the extent of the area infested with WIP. The two methods, namely the perception survey and vegetation survey, were compared to determine the extent to which the respondent's knowledge relates with the vegetation survey.

1.5 Aim of the study

The purpose of the study was to achieve the following aims:

- To assess perception and attitudes of the indigenous knowledge of the local community towards declared weeds and alien invasive plants (WIP).
- To carry out a vegetation survey to quantify the abundance of the different WIP species and compare the perception and attitudes of the indigenous knowledge by the community of Dinokana Area with the results of vegetation survey.
- To formulate recommendations for the existing programs of WIP control.

1.6 Layout of dissertation.

The study consists of six chapters, where Chapter One introduces the study background and the problem statement. Chapter Two represents a critical review of relevant literature. Possibilities of how the problem can be managed as well as their impacts on the environment and the lives of the local communities are also considered.

Chapter Three describes the location of the study area, including the natural vegetation, the geology and the soil aspect, the climatic conditions as well as infrastructure of development of the area.

Chapter Four explains the materials used and the methods followed in conducting the study, which include using the questionnaires as well as a qualitative vegetative sampling of the affected areas. Chapter Five discusses the results and the outcome of the studies conducted in Chapter Four, while Chapter Six gives the conclusion of the study as well as recommendations resulting from the study.

In the following Chapter, the state of WIP's, as well as the impacts and processes that lead to the invasion of alien plants is briefly discussed.

CHAPTER 2

LITERATURE REVIEW

2.1 Conservation of Agricultural Resources Act (No 43 of 1983)

According to Henderson (2001), there are approximately 198 declared weeds and alien invasive plants (WIP) in South Africa, which are all covered by the Conservation of the Agricultural Resource Act, Act 43 of 1983 (CARA). The newly introduced amended sections 15 and 16 of the CARA legislation mention that these plants are classified into three different categories (National Department of Agriculture. 2001). These categories are:

Category 1: These are weeds, which are prohibited and must be controlled. They are not allowed to occur anywhere in South Africa, except in biologically controlled reserves. An example of one of these species is given in Figure 2.1. (A list of the entire category 1 plants is presented as Appendix C).

Category 2: These are invader plants, which can be grown in demarcated areas providing that there is a permit and that steps are taken to prevent their spreading. They are plants mainly used for economic purposes (commercial forestry and community woodlots) and are only allowed to grow in South Africa in areas that are specifically demarcated for them and in biologically controlled reserves. (A list of the entire category 2 species is presented as Appendix C).

Category 3 includes ornamentally used plants. They may no longer be planted but existing plants may remain, except within the flood line of watercourses and wetlands, as long as all reasonable steps are taken to prevent the spreading thereof, (Henderson, 2001). (A list of the entire list of category 3 plants is presented as Appendix C).

There are also 36 plant species identified to have the potential for invasion (Henderson, 2001). All these three categories will be dealt with in this study.



Figure 2.1: An example of a category one invader plant, *Opuntia imbricata* in Dinokana Area.

Some WIP have been historically regarded as ideal rock garden plants and enthusiasts and collectors are responsible for the rapid dispersal of these species (Ranger, 2003). Many of the declared weeds and alien invasive plants have been introduced intentionally by humans, mainly by nurturing species that are helpful or needed by people, such as for agricultural, ornamental, forestry or even for psychological purposes (McNeely, 2003). The introduction of these species is an integral part of human welfare and local culture. Throughout the world there is danger that additional species will continue to invade the ecosystems, as the people purposefully or accidentally introduce species as a result of the growing global trade.

2.2 Invasion process of declared weeds and alien invasive plants (WIP)

Schwartz (1997) suggested that one of the first objectives in making decisions about managing a potentially problematic species invasion is to determine whether that species is a natural component of, or is indigenous to the community in question. There are several ways in which the distribution of species can change (Schwartz, 1997; Chapman & Le Maitre, 2001):

- Suitable climatic conditions, such as humidity and temperature, which can influence the natural distribution process of species (i.e. independent of human factors), by the dispersal and colonization of new habitats.
- As a result of a change in habitats caused by human land use or disturbance regimes.
- Fragmentation of the landscape, which creates extensive ecotones and corridors for invasions.
- Changes in the availability of the limiting factors, e.g. temperature and rainfall.
- Persistent seed banks in situ or the ability to colonise via effective dispersal and the ability to recover through vegetative means.
- The ability to establish immediately after disturbances or between disturbances.
- Timing of reproductive maturity, lifespan and longevity of seed banks relative to the timing of disturbances.
- High tolerance against environmental extremes and greater adaptability in a wide range of environmental conditions such as an increase in moisture availability, light and nutrient use efficiencies, zero or very short dormancy periods, high productivity and high reproductive potential (Raghubanshi *et al.* 2005).

These and other factors that influence the distribution of species and contribute to vegetation change are discussed below. Initially, species have to be transported into a new region, which in the case of declared weeds and alien invasive plants is usually supported deliberately or unknowingly by human activities (Brock *et al.* 1997). Often the transport of plant species is across geographic barriers that separate them. In the natural system, propagule dispersal is restricted to a distance of 10 to 30 meters and the number of propagules decreases rapidly and non-linearly with increasing distance from the source (Chapman & Le Maitre, 2001). Even if only a few individuals of invasive species succeed in the natural system, they could radically transform the system they invade.

According to Chapman and Le Maitre (2001), there are approximately 750 introduced tree species in South Africa, but only 70 of these are considered major invaders. The role of anthropogenic factors in the introduction of new propagules makes the impact of invasions difficult to predict. Human activities are influenced by a political system, state of the economy, as well as international relations, since goods and products are being exchanged between, for example, Botswana and South African markets. The invader plants in Botswana are not considered to be proclaimed invader plants. According to (personal subjective observation), it seems that the Government of Botswana has done very little since the 1980's to control these plants. In the former homeland of Bophuthatswana, which shares the border with Botswana, people were working under the drought relief schemes (Namola leuba) to get rid of the plants.

The degree of utilization and manipulation of the environment for natural resources, such as firewood and food, depends on the degree of poverty, access to agricultural equipment or finances, stock management, as well as the grazing patterns. Many alien species are incapable of becoming established as in some cases seedlings fail to develop into mature plants. Many species may remain sterile, or if they flower, they do not develop fruit, or the seeds are not viable.

Those species that failed to become established are mainly *ephemerophytes* (Chapman & Le Maitre, 2001). These plants are characterized not so much by their rate of establishment, which is likely to be very low, but by the ability of the species to maintain itself at a few locations over a number of years. In South Africa, the invasiveness of plants is categorised according to Provinces (National Department of Agriculture, 2001).

A plant can be regarded as an invader in one Province and regarded as a weed in another Province (Henderson, 2001). It is important that, to prevent a potentially invasive species from developing further, action should be taken during the so called lag phase in the plant's life cycle and development (Brock *et al.* 1997). However, given that the species is not always known, identification is likely to be very difficult in most administrative areas. According to personal communication with ³Modungwa (2003), another problem that occurs in most sites of the study area, is that there is a lack of knowledge regarding the impact of WIP on the natural agricultural resources, especially by the local agricultural practitioners. She indicated that there is problem of *Lantana camara* (Lantana or Cherry pie) in Dinokana, which poses a serious threat to livestock production due to its toxicity. The North West Provincial Department of Agriculture (NWPDA) has, however, taken no action to address the problem as most people are unaware that *L. camara* poses a problem to the livestock production system.

2.3 Results of the disturbance of declared weeds and alien invasive plants (WIP)

The primary determinants of plant community "invasibilities" is the number of safe sites for seed germination in the community.

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This means that non-indigenous plant species are most likely to invade sites that experience disturbance that differ in type or frequency from their natural disturbance regime (Belsky & Gelbard, 2000). Areas with disturbed soil provide an optimal habitat for the development of declared weeds and alien invasive plants.

Most of the “problems” with WIP in the Dinokana area have evolved from mismanagement practices, such as overgrazing and continuous veld burning, which causes disturbance and soil erosion (Sheley *et al.* 1995). The influence and spatial spread of species in an environment is a result of a combination of intrinsic and extrinsic factors that govern the species population dynamics.

As indicated by Pyke and Knick (2003) “intrinsic” factors include the dispersal, growth, survival and reproduction constraints dictated by the species’ physiological and morphological capabilities, whereas extrinsic factors include the spatial and temporal availability of suitable habitat for survival, growth and reproduction and suitable corridors and vectors for dispersal”. Declared weeds and alien invasive species may respond to human induced environmental changes or they may initiate environmental changes through their dominance of the landscape. High intensity disturbances that transform the landscape often occur at a local spatial scale. Land transformation from rangeland to human habitation, such as village expansions, are concentrated near the fringe of human population centers. Low intensity disturbances that result in degradation are often more diffusely distributed throughout the landscape. Invasive species may directly benefit from the land transformations and degradation (Pyke & Knick, 2003). Transformation often results in large land disturbances. Disturbances are characterised by extended patch sizes, fragmentation distribution, and the dispersal ability which interact to influence invasions and spread. Invasive species have an equal probability of spread regardless of the distribution of the disturbance, even when the extent exceeds the threshold area.

“When the proportion of the landscape disturbed is below a certain threshold level, the distributions of disturbance and the dispersal ability interact to affect the probability of the spread for invasive organisms” (Pyke & Knick, 2003). Changing disturbance frequency or intensity may cause ecosystem modifications. Invasive plants may contribute to modifications, for example in the natural fire cycles, providing a positive feedback which enhances their spread. Pysek *et al.* (2005), indicated that “man-made” habitats, especially in settlements, are prone to invasions by alien species, which is attributable to habitat heterogeneity, frequent and diverse disturbance and intensive propagule pressure. Arable land, a human-made habitat with a high representation of alien species, is an environment with a specific disturbance regime.

Pysek *et al.* (2005) indicated that studies to analyze the determinants of weed species richness are rare and hardly any have focused on detecting general patterns of alien species invasions. The difference in diversity of the weed flora is mainly attributed to lack of specific type of management and partly to crop specific agricultural practices, as well as to the general intensification of management of arable land in the past (Pysek *et al.* 2005). According to Sheley *et al.* (1999), disturbance creates available sites, thus succession can be controlled by altering the size, severity, frequency and patchiness of disturbance in a manner favourable to desirable plant species. Historically the disturbances were designed by experts through cultivation, grazing and burning. The usefulness of any disturbance for invasions will depend on the range site, plant community type, invading weed species, history of the site as well as “other environmental conditions”. As indicated by Sheley *et al.* (1999), a site vulnerable to invasion, must be occupied by the desirable indigenous plant species to prevent WIP to establish. This is termed ‘controlled colonization’ which intentionally affect succession. Controlled species performance includes using methods to alter growth and reproduction of specific plants, thereby contributing to a desirable shift in the plant community.

This requires understanding of the factors that influence the competitive balance such as grazing, disease, resource availability, allelopathy (the inhibition of growth in one species by chemicals from another species), predators, growth rates and their complex ecological interactions.

Since the process of WIP invasion was discussed and the results of WIP invasion outlined, the following section will deal with the impacts of WIP on different environmental variances.

2.3.1 Impacts on the functioning of riparian areas

Riparian areas are the greener zones along rivers and streams, around potholes, springs, bogs, lakes and ponds (Sheley *et al.* 2001). Healthy riparian systems purify water by removing sediments as they move through the vegetation. WIP can be extremely competitive in a riparian system. Riparian systems are prone to WIP invasions because of their dynamic nature and high nutrient level. They overcrowd valuable native species by forming solid stands and they can also alter the hydrological cycles of the riparian areas. WIP also lower water tables and, in some areas, eliminate surface water and native vegetation needed by wildlife, and also affect the carrying capacity of the flooding cycles (Sheley *et al.* 2001).

According to Smith and Panetta (2002), riparian ecosystems are important for maintaining biodiversity and ecosystem functioning within landscapes. Riparian systems are prone to WIP invasions because of their dynamic nature and high nutrient level. Some of the invasive species, called “transformer species”, are capable of markedly changing ecosystem structure and functioning. When the functional values of a riparian system are compromised, downstream ecosystems may be negatively affected. This may occur via reduced water quality and increased nutrient and sediment flows. Once invaded, the riparian vegetation can act as a source of weed propagules for downstream and upstream habitats.

As landscape corridors, they present major foci for long distance dispersal and range expansion of invasive weeds (Smith & Panetta, 2002). More restricted stock access along waterways has led to reduced grazing pressure on riparian weeds. Farmers from villages situated along the river, such as Maramage, depend on the river to graze and water their livestock.

If WIP alter the infiltration process due to different canopy architecture, or contribute to the production of more hydrophobic litter layers, they may significantly influence soil water balance as they become increasingly dominant in the community. This phenomenon, according to Schwartz (1997), has been estimated to reduce winter soil moisture recharge by more than 50% in dense stands. If invasive species result in greater surface disturbances, this may have a negative impact on surface water balance as the runoff water after large and heavy rainfalls is thereby increased.

2.3.2 Economic loss

The development of an understanding of the environmental impacts and consequences of declared weeds and alien invasive plant species would be extremely useful for the quantification of their economic impact. Unfortunately no standard system exists for the objective quantification of the many and varied environmental impacts of WIP worldwide (Van Wilgen *et al.* 2001). Currently there is, unfortunately, no agreed criterion for the minimum damage, spread or even the size of the population needed for alien species to be considered invasive (Mc Neely *et al.* 2004). The effect of the invasion of plants can either be negative, neutral or even positive. Negative or neutral impacts of an invading plant species occur if the invader grows slower than, or at similar rate to the species it replaces (Lawrence *et al.* 1997). Invasive species may cause major financial losses to the national economy. The loss could be the result of direct problems caused by invasive species, loss of living resources, and losses due to any pest brought with the invasive species.

In South Africa, figures are not readily available but it is estimated that the control of plant invasions cost R10.5 billion each year (Howard, s.a). The potential loss of biodiversity is difficult to quantify or translate into monetary terms, because the value of many species or ecosystems is unexplored, for instance the loss of potentially productive land, the loss of grazing and the increased costs of fire protection and damage by wildfires. Declared weeds and alien plants also cause major economic impacts through the non-productive use of water. These plants are also responsible for reducing stream flow from catchment areas and for reducing ground water supplies. These reductions impact the economy in two ways (Howard, s.a):

Firstly, they reduce the ability of existing water supply schemes to deliver sufficient water to meet demands, especially in the dry periods. This necessitates the building of new or bigger supply schemes at considerable expenses in order to meet the demands. Secondly, they reduce the total amount of water available for human use. Because water is a limiting resource for economic development, removing water from the hydrological cycle means that the scope for development is reduced significantly (Howard, s.a).

In terms of the economic dimension, the invasive species can be seen from two perspectives: that economics is central to the cause of biological invasiveness, and the results of pest incursions go far beyond direct damage or control costs. Most cases of invasions can be linked to the intended or unintended consequences of economic activities and, as a result, knowledge of economic applications is essential in order to understand the problem and to provide more accurate and comprehensive assessments of the benefits and costs of control alternatives. The assessment of the costs and benefits of the control of WIP is essential in order to increase the effectiveness and efficiency of public funded programs such as Working for Water and Land Care (Howard, s.a). Furthermore, modeling the economic and trade impacts of technical trade barriers is becoming more important (Evans, 2003).

Common among such barriers are those dealing with trade restrictions that can be imposed by a country in an attempt to prevent entry of invasive species (Evans, 2003). According to the Global Invasive Species Program (GISP, 2006), annual losses to pests were estimated at US\$6.24 billion in Australia, US\$42.60 billion in Brazil, US\$78.50 billion in USA, US\$5.56 billion in the UK, US\$91.02 billion in India and US\$4.30 billion in South Africa.

Globally the costs of damage caused by WIP have been put at US\$1.4 trillion per year – nearly 5% of the global Gross Domestic Product (GDP). These figures provide an interesting comparison between developing and developed countries. The estimated damage caused by WIP in developed countries was 53% of agricultural GDP in the USA, 31% in the UK and 48% in Australia. By contrast, the damage in developing countries, such as South Africa, India and Brazil amounted to 96%, 78% and 112% of the agricultural GDP, respectively (GISP, 2006).

2.3.3 Biodiversity loss

The term “biodiversity” is described as the diversity of life on earth, encompassing all genes, species, populations, landscapes, and ecosystems, ecological and evolutionary processes that allow these elements of biodiversity to persist over time (GISP, 2006). It is essential for the functioning of a healthy ecosystem, which in turn provides a variety of services vital for human wellbeing (Van Ruijven, 2005). The diversity of life on earth is affected by human alteration of ecosystem (Diaz, 2006). These ecosystem services include resources such as food, water, building materials and traditional medicines, processes regulating water purification, soil formation, flood attenuation, erosion control, crop pollination and nutrient cycling, as well as cultural aspects such as recreational opportunities and spiritual fulfilments (GISP, 2006).

The loss of biodiversity and the degradation of ecosystems inevitably affect human well-being, contributing to lower food security, harsher living conditions, worsening health and reduced wealth. According to the GISP (2006), there has been an increased rate of species extinction over the past few years of as much as 1000 times, and that amongst the higher taxa, the majority of species are in decline (GISP, 2006).

The South Africa's biodiversity provides an important basis for economic growth and development. The loss of biodiversity puts aspects of the economy and quality of life at risk and reduces socio-economic options for the future generation. This is one of the negative results of the introduction of declared weeds and alien invasive plant species that could lead to marginalization or even elimination of native species. The declared weeds and alien invasive plant species are regarded as the second largest threat to biodiversity, after direct habitat destructions (Feany, 2004; Raghubanshi *et al.* 2005).

The invasive species grow fast as they do not have any natural predators in the invaded areas and as such draw more nutrients and moisture from the ground. Due to the frequent presence of toxic metabolites, they also impair native species through *allelopathy*. Whenever declared weeds and alien invasive species invade a habitat, they also eliminate the natural fauna, since fauna always depends on natural flora. The people are ultimately dependent on living, functioning ecosystems and the services they provide and therefore the loss of biodiversity leads to ecosystem degradation and subsequent loss of important services, which tend to harm the poor more directly (Raghubanshi *et al.* 2005).

The effective management of biodiversity does not guarantee sustainable development, but sustainable development is not possible without it (Diaz, 2006). The principal negative impacts of these plants on biodiversity are displacement by direct competition, reduced structural diversity, increased biomass and disruption of the prevailing vegetation dynamics (Diaz, 2006).

Declared weeds and alien invasive plants may also change the structure and function of an ecosystem completely, resulting in large scale changes in the environmental conditions of that area. This occurs when the invasive species change the soil composition due to *allelopathic* substances released from their roots or leaf litter. The chemical nature and decomposition rate of their leaf litter and other dead parts may also alter the nutrient cycle in an ecosystem. When fast growing species invade a certain catchment area, they may drastically reduce the flow of streams and rivers due to a high rate of evapo-transpiration as well as displacement of threatened and endangered species and soil nutrients due to the invasion by WIP. Rare species are vulnerable to the environmental changes caused by infestations of WIP, Sheley *et al.* (2001).

According to the CSIR Division of water, environment and forestry technology, there is strong evidence that current rates of extinctions and loss of biodiversity are thousands of times higher than the natural rates of extinctions (Howard, s.a.). Conservationists currently estimate about 27000 annual losses of species globally. There are only a handful of proven cases where alien invasive plants have resulted in extinctions of species in South Africa. “However, almost 1900 of the 3435 plant species listed in the ‘red data lists’ for South Africa are threatened wholly or in part by alien invasive plant species (Howard, s.a)”. According to Schwartz (1997), invasive plants may not have effects on levels of particular nutrients if those nutrients are not limiting.

Invasive plants can lower soil nutrient levels directly through competition, or indirectly through addition of nutrient poor litter, or via accumulation of salts which decrease the availability of nutrients or dramatically alter the soil pH. Invaders that increase fire frequency or severity can indirectly cause increased volatilisation of nitrogen, which may lead to a decline in soil nitrogen. Changes in nutrient levels in plant tissues due to invasive plants are therefore mediated through changes in soil nutrient levels (Schwartz, 1997).

Invasive plants can strongly impact on soil water content and landscape water balance of indigenous communities, with positive and negative effects. The most direct negative impact is that invasive species use more water than the indigenous species they are replacing (Schwartz, 1997). This is a result of the WIP species having intrinsically higher transpiration rates per unit leaf area.

2.3.4 Land degradation

Invasive plants can influence landscape water balance by effectively changing the land surface characteristics of the habitats. Land degradation is defined as any form of deterioration of the natural potential of land that affects ecosystem integrity either in terms of reducing its sustainable ecological productivity or in terms of its native biological richness and maintenance of resilience (GEF, 2003). The causes of land degradation are not only biophysical but also socio-economical (e.g. land tenure, income and human health) and political factors (World Meteorological Organization, 2005). There are three causes of land degradation: natural phenomena, direct causes as well as underlying causes (Hoffman & Ashwell, 2001). These are discussed below in more details.

2.3.4.1 Natural causes of land degradation

Natural disasters such as droughts, floods and climate change contribute to land degradation (Morris, 1995). The land surface is an important part of the climate system. Changes in vegetation type can modify the characteristics of the regional atmospheric circulation and the external moisture fluxes. Changes in surface energy budgets resulting from land surface changes can have a profound influence on the earth surface (World Meteorological Organization, 2005). Land transformation also has the potential to directly and indirectly influence climate change. Climate changes facilitate invasions where the invaders are more tolerant of or better able to exploit the altered conditions, such as increased frequency of droughts and increased nitrogen availability.

Climate changes, which may be very rapid also allowing invading exotic species to expand their ranges in areas where climatic factors, such as temperature and rainfall allow their distribution (Chapman & Le Maitre, 2001). Drought stimulates land degradation because a lack of rainfall aggravates the effects of poor land management (Hoffman & Ashwell, 2001). The rainfall amounts vary substantially from one region to another and from one year to another.

An increase in temperature affects the water cycle and changes the water pattern which could have a serious impact on land degradation. This will give an opportunity for declared weeds and alien invader species to encroach as the environmental conditions change. These plants would not have any competition for the available nutrients (Hoffman & Ashwell, 2001). The current global warming occurrences are unusual and are increased by human activities, especially the greenhouse gas emissions from the burning of fossil fuels.

The loss of vegetation in the headwaters of dry land rivers as a result of floods can increase sediment loads and lead to a dramatic change in the characters of the rivers to become less stable, more seasonal and characterised by rapidly shifting series of channels (World Meteorological Organization, 2005).

Agriculture and land use changes, as well as other industrial processes that release greenhouse gases, also contribute to climate change, as the carbon dioxide (CO₂) concentration in the lower atmosphere has increased dramatically. These changes in the concentration of CO₂ and other greenhouse gases have led to changes in the climate. The climate is warming in most parts of the world, with an average increase of global temperature of up to 0.7°C per annum (Reid, 2006). According to Meyer *et al.* (2002), changing temperature and water availability conditions are likely to induce stress in vegetation and other plant species, which might encourage mobile organisms to alter their distribution.

Climatic change will possibly also cause a gradual increased pressure on the tolerance limits of native species and could thereby favour the success and spread of alien plant species (Meyer *et al.* 2002).

In contrast to the historical migration responses, species today must move through a landscape that is increasingly impassable due to the widespread loss and fragmentation of habitats (Hugo *et al.* 1997). Some of the impacts of climatic changes on biodiversity include species ranges as a result of the changes in temperature, precipitation and phenology, causing shifts in the reproductive cycles and growing seasons of certain species. Changes in competitive ability may also emerge as a result of changes in species interactions. For instance, early leafing trees will get a two-week head start on their competitors in terms of growth and thereby occupy an increasing proportion of the woodlands (Reid, 2006).

The dying back of trees would release carbon stored in those biomes and surrounding soils and further accelerate global warming. Climatic change also relates to extreme events such as diseases, drought, fire or an oscillation effect and can also seriously affect change in biodiversity (World Meteorological Organization, 2005). These extreme events will eventually affect organisms, populations and the ecosystem more than gradual global or regional changes (Reid, 2006).

2.3.4.2 Direct causes of land degradation

(a) Overgrazing

Overgrazing affects land in two ways. It leads to the loss of the rangeland vegetation cover in areas where the livestock density exceeds the carrying capacity (GEF, 2003). High livestock densities result in soil compaction because of trampling. In both instances, the soil becomes more vulnerable to water or wind erosion (Hoffman & Ashwell, 2001).

Once the loss of vegetation takes place, there is a change in plant species composition. The loss of vegetation cover and the changes in species composition are the first visible signs of land degradation, although it is often still difficult to distinguish between changes due to environmental factors, such as annual rainfall and those due to mismanagement, such as overgrazing of the land (Meadows & Hoffman, 2002). Some animals have a varied diet and can feed on a wide number of plant species, while others are highly specialised and may be restricted to feeding on several or even a single plant species.

Certain species of invading plants can have a positive effect on the environment as they lead to an increase in the Nitrogen (N) content of the soil with a symbiotic relationship with nitrogen fixing bacteria. Non-native plant species have a greater nutrient and water uptake and retention rates which lead to decreased species diversity and drier, more nutrient-poor habitats. Livestock prefer to graze native plant species while avoiding most WIP, which are poor forage and have a low palatability due to toxins, spines and distasteful compounds (Meadows & Hoffman, 2002).

As a result, the size, density and competitive vigour of native species are reduced while WIP species are released from competition since their competitors are reduced. With continuous livestock grazing, native grass species decline in density and cover, leaving bare patches that are already colonized by weedy annuals (Belsky & Gelbard, 2000). Overgrazing is said to contribute to almost 50% of soil degradation in Africa (World Meteorological Organization, 2005), while Morris (1995) regarded water erosion as being the most pervasive cause of land degradation, contributing between 50-70% of all degraded land.

Cattle and sheep can reach all areas including the steepest slopes and areas furthest from the water. According to Belsky and Gelbard (2000), livestock are the most likely causes of weed introductions into non-recreational or remote areas away from roads or trails.

The effectiveness of livestock as WIP seed vectors is illustrated by their ability to transport viable seeds in their hair, digestive track and mud on their feet. Cattle are more important dispersers of WIP seeds than sheep, because cattle are known to be more extensive grazers than sheep and therefore are able to reach even the furthest places (Belsky & Gelbard, 2000).

The invasion of alien shrubs into grassland is also caused by the shifts in the types of livestock species kept. Many of the changes occurring across the communal land are components of degradation expressed as human-induced reduction in productivity, leading to degradation and loss of biodiversity. Communal areas, especially those under grazing, appear to be particularly susceptible to decline in veld condition, so that the former homelands, such as Bophuthatswana where this study was carried out, are highlighted as problematic in this regard (Meadows & Hoffman, 2002).

Bush encroachment is another form of land degradation that results from overgrazing. It is characterised either by the invasion of grasslands by woody elements, or by an increase in the biomass of woody elements in savanna woodland areas (Meadows & Hoffman, 2002). Bush encroachment and bush thickening are problems affecting mainly cattle farming grassland areas, changing them to savanna thickets. Both these processes reduce the relative amount of grass, and therefore cattle production (Hoffman & Ashwell, 2001).

The bush encroachment process is regarded as serious and a rapid density of woody plants occurs, and has increased by as much as 30% in the last decades in some communally farmed areas in respect to the local extinction of indigenous browsing herbivores and changes in fire regimes (Meadows & Hoffman, 2001). Colonisation by declared weeds and alien plants would also cause a major loss of biological diversity and significant changes in catchment hydrology.

(b) Soil degradation

According to Fuggle and Rabie (1992), Miller (1998) and Morris (1995), soil erosion is considered to be a natural process and is regarded as the movement of a soil component, especially surface litter and topsoil, from one place to another, mainly due to wind and the flowing of water. Wind and water move the eroded particles to new locations, where they are deposited as sediments. During this process, the soil particles take along seedlings of plants, including that of WIP. After deposition of the soil, seeds start to germinate, bringing new types of WIP to the location where they did not occur before.

In South Africa, the rate of soil formation varies from 0.38 tons per hectare per year for light textured soil to 0.25 tons per hectare per year for heavy textured soils. Unfortunately, South African soils are susceptible to soil loss and this is due to a variety of physical factors (geology, steep slope and climate) as well as the human use of the land. The major causes of soil degradation include overgrazing, deforestation, agricultural activities and overexploitation of vegetation (Morris, 1995). Soil is one of the South Africa's most basic resources but it is being lost to erosion at a frightening rate, yet the South African population appears to be complacent about it (Fuggle & Rabie, 1992).

The more topsoil that is lost through erosion, the more the fertility of that soil is affected and therefore sensitive grass and other plant materials die off, making a new niche for WIP to establish. According to Miller (1998) and Hugo *et al.* (1997), there are three kinds of soil erosion. Sheet erosion occurs when surface water moves down a slope or across a field in a wide flow and peels off relatively uniform sheets or layers of soil. With rill erosion, the surface water forms fast flowing little rivulets that cut small channels in the soil. The last form of soil erosion is gully erosion in which rivulets of fast flowing water join together and cut the channels wider and deeper with each succeeding rain until they become ditches or gullies.

Losing topsoil makes a soil less fertile and less able to hold water. The resulting sediments are the largest sources of water pollution. It clog irrigation ditches, reservoirs and lakes. The sediments-laden water tastes “bad”, fish die and flood risks increases (Miller, 1998). Soil degradation is a serious problem, since it depletes the soil of nutrients needed by the indigenous plants, leaving the soil barren for invaders to take the opportunity and colonise the area.

(c) Deforestation.

The causes of deforestation are inseparable from poverty and underdevelopment, which inevitably have their roots in the past policies of this country. The former homeland territories endure this problem most intensively (Meadows & Hoffman, 2002), especially in Dinokana Area where the study was carried out. Amede (2003) indicated that there are two ways in which deforestation affects land degradation. Firstly, deforested land is easily susceptible to erosion, which causes considerable nutrient movement. Secondly, the amount of litter that could have contributed to maintaining the soil organic matter is significantly reduced. The local farmers are using the manure and crop residues, which could have been used for soil fertility replenishment, as cooking fuels. The three main causes of the loss of woodlands are the over-harvesting of fuel wood for energy, the conversion of woodlands for large scale crops or for livestock production, as well as uncontrolled veld fires (GEF, 2003; Lloyd *et al.* 2005). The reason for this is that many people are unemployed and therefore cannot afford electricity services, which resulted in these people continuing to fetch wood from the veld. This practice has led to the destruction of the indigenous trees due to harvesting for firewood. The most serious effect of deforestation is the disturbance of the gas balance of the atmosphere by oxidation (Lloyd *et al.* 2005). The increase in carbon dioxide (CO₂) and other gases will probably lead to an increase in temperature of at least 2°C by the year 2050 and 5°C by 2100 as a result of the greenhouse (Hugo *et al.* 1997).

According to Hugo *et al.* (1997), the extinction of one plant species as a result of habitat destruction is equivalent to the elimination of 30 animal species. Although large-scale reforestation can improve the gas balance in the atmosphere, it can never compensate for the loss of species diversity. Certain cultural traditions also disappear together with the disappearance of flora and fauna. The loss of trees through deforestation is known to have been prevalent for many decades, unlike bush encroachment which seems to be a relative recent environmental problem in South Africa (Meadows & Hoffman, 2002). The current demand on woodlands, especially for fuel wood has exceeded the supply and it is estimated that part of South Africa may be denuded of these natural woodlands within the next 25 years (Meadows & Hoffman, 2002).

(d) Over-exploitation

There are two categories of resources i.e. renewable as well as non-renewable resources. Renewable resources are those resources that can be used without them running out, either because they can be recycled rapidly or because they can replace themselves or be propagated quickly. Non-renewable resources are those resources whose consumption necessarily involves their depletion. Renewable resources are the base of all economies. People cannot live without it and it includes soil and water, as well as products produced from the wild such as timber. If all these resources are used in a sustainable manner, it will perpetually renew themselves (Beazley, 1993). The exploitation of natural resources for medicinal, nutritional, housing and energy purposes, as well as to generate much needed income, has led to the depletion of these resources and the degradation of the ecosystem. The impact of these has resulted in soil erosion, bush encroachment and veld degradation (Meyer *et al.* 2002). The problem with overexploitation is that once all the natural resources are removed from the area, especially the flora, people start planting other plants that will be quick to establish. Overexploitation gives a competitive advantage to WIP over indigenous resources.

(e) Fire

Fire is a management tool and ecosystems are partly defined on the basis of the specific frequency, intensity, extent, type and seasonality of disturbance regimes (Matthew *et al.* 2004). Effects of invader are particularly dramatic when they alter disturbance regimes beyond the range of variations to which native species are adapted. Some of the effects of plant invasions on fire regimes have been focused on one well-known type of change, i.e. that fire-grass invasions increase fuel bed-flammability. According to Matthew *et al.* (2004), fire frequency can be defined as a measure of the fire cycle which is the average time for fire to burn an area equal in size to the given area of interest.

Fire intensity is the amount of heat released on biotic and abiotic ecosystem properties, while fire extent includes both the size and the spatial homogeneity of burning (Matthew *et al.* 2004). Disturbance regimes affect ecosystem properties such as the rate of soil erosion or formation, pathways and temporal patterns of nutrient cycling as well as energy flow. These disturbances can also act as a selective force affecting the life history traits of individual species, composition, structure and emergent properties of an entire group of organisms. A fire regime can promote coexistences of plant species, with different life forms dominating different stages of post fire successions (Matthew *et al.* 2004). A new fire regime coupled with the localised loss of native plant species creates opportunities for other species to colonise or expand their cover in sites they could not previously dominate. Many WIP are suited for rapid dispersal into altered landscapes and persistence under altered disturbance regimes. Invasive plants can first cause an altered fire regime by changing fuel conditions and then flourish under the new condition they have created (Matthew *et al.* 2004).

High fire frequencies have contributed to the type of conversion from shrub lands and closed woodlands to annual grasslands dominated by alien grasses and forbs (Keeley, 2001). According to Keeley (2001), pre-fire fuel manipulations may contribute to alien plant invasions. The use of prescription burning on sites that currently has higher than natural fire frequencies could potentially favour aliens. Post-fire site rehabilitations are responsible for the widespread introduction of alien species which may increase fire frequency and thereby further increase the expansions of aliens (Keeley, 2001).

Plant invasions often involve the establishment of new life forms, which may have intrinsic fuel properties that differ from those of native species (Matthew *et al.* 2004). Globally, biomass burning is estimated to produce 40% of the carbon dioxide (CO₂), 32% of the carbon monoxide (CO), 20% of the particles and 50% of the highly carcinogenic polyaromatic hydrocarbons produced by all sources. The decrease in basal cover due to fire, exposes the soil to the natural elements and therefore to higher soil temperature and soil compaction, which in turn lead to lower soil water content and a decline in soil infiltration ability (World Meteorological Organization, 2005).

2.3.4.3 Indirect causes of land degradation

(a) Land tenure

Meadows and Hoffman (2002) and the World Meteorological Organisation (2005) indicated that higher population density do not necessarily lead to impacts causing more soil erosion. The World Meteorological Organisation (2005), warned that it is rather what these populations do to the land which determines the extent of degradation. When increasing populations put more pressure on the limited land and other natural resources, the results, in the absence of technological and institutional innovations, are poverty and unsustainable use of the natural resources (Otsuka & Place, 2001).

People can be a major asset in reversing a trend towards degradation. In South Africa, forced overpopulation of areas due to previous policies concentrated large numbers of people on relatively small areas of land (Meadows & Hoffman, 2002).

The term 'land tenure' is derived from the Latin word *tenere*, which means 'to hold' (Waiganjo & Ngugi, 2001). Tenure defines the social relations between people in respect of the object of the tenure, in this case being the land. It also defines the methods by which individuals or groups acquire, hold, transfer or transmit property rights in land (Waiganjo & Ngugi, 2001). The formal rules of tenure therefore define the nature and the contents of property rights in land or other resources and the conditions under which those rights are to be held and enjoyed (Waiganjo & Ngugi, 2001).

Compared to weak or insufficient property rights, the tenure system increases credit usage through greater incentives for investment, improved credit worthiness of projects and enhanced collateral value of land. It also increases land transactions, facilitating land transfers from less efficient to more efficient users by increasing the certainty of contracts and lowering enforcement costs. It reduces the incidence of land disputes through clearer definitions and protection of rights, and raises productivity through increased agricultural investment (Roth & Haase, 1998).

The land tenure system can take various forms which include statutory, customary, religious as well as informal forms of land tenure. The major characteristics of customary tenure are that the land is regarded as belonging to the whole social group and not to an individual. This was found to be the case in the study area, where the land right is vested in the chief and his tribal authorities. It is sometimes referred to as an unwritten land ownership practices by certain communities under customary law (Waiganjo & Ngugi, 2001).

It is also referred to as a system in which the ownership of the land is vested in a collective while the individual enjoys virtually unrestricted rights of usage. The communal land is a social resource and also has some religious significance. It is only through his or her relationship with the land that an individual perceives a sense of place and personality (De Meijere & Mends, 2006). Land tenure present a complex mosaic derived from history, colonial legacy and current economic pressures and opportunities, as well as from their natural and ecological characteristics.

The policies and objectives of land management were clear in the traditional land ownership, that ownership of land resides in the collective and individuals only had rights of use, the objective being to ensure easy access to land for every household (De Meijere & Mends, 2006). Therefore, proper utilization of the land to ensure the prevention of occurrences of WIP was never given to specific individuals. People did not have any obligation of investing on land to ensure that if there is WIP problem, it should be the people's responsibility.

(b) Poverty and population growth

Poverty comprises the inability of "individuals, households or entire communities to acquire sufficient resources to satisfy a socially acceptable minimum standard of living" (Department of Social Development, South Africa, 2003).

People would not behave in a way that would destroy resources necessary for their survival or that of their future generations, unless they are under very strong pressure to do so (Anonymous, 2005). These pressures include the increase in population, the decline in common property resources, international pressure such as a change in the interest rate as well as technology transfer. Other pressures come from the inefficient regulation of common property resources, land tenure systems that do not secure long term rights to land use, and policies that distort the pieces of non-renewable resources.

The underlying cause of land degradation in rural areas is poverty (Morris, 1995). This is as a result of a lack of alternative income generating activities since the majority of the rural households are dependent on land-based small-scale farming. Another pressure is on cultivated land, because as the population grows, the need for food production also increases (Morris, 1995).

The agricultural sector plays an important role in many areas in supporting food production, employment and export earnings. Many family farmers in the rural areas cultivate their own land largely for own consumption (Sompolvorachai, 2004). Since WIP primary affects agriculture and forestry, the greater dependence of the poor producers on primary production makes them more vulnerable to the effects of biological invasion (Perrings, 2005). Many people in the study area were found to be planting the *Opuntia imbricata* and other types of WIP for fencing material because they cannot afford proper fencing material. According to Sompolvorachai (2004), poor families tend to have more children than non-poor ones since the poor rely heavily on their children for old age and farming support. A high rate of population growth and population density in poor areas can exacerbate the poverty problem. Since many of the population depend on land-based subsistence production, the relationship between population and land degradation is of significance.

“The relationship between population, poverty and land degradation could hardly be direct, since low living standards in the rural areas contribute to increased pressure on natural resources, which in turn aggravates poverty” (Sompolvorachai, 2004). The problem with poverty and population growth in relation to WIP invasion was that people felt that they need incentives because the majority of them are not working, therefore taking the responsibility for their environment becomes of less importance or of low priority. The poor do not wilfully degrade the environment, but poor families often lack the resources to avoid degrading their environment.

The very poor, struggling at the edge of subsistence is pre-occupied with day to day survival. Their fragile and limited resources are often poorly defined property rights and their limited access to credit and insurance markets prevent them from investing as much as they should in environmental protection. When they do make an investment, they need quicker results (Anonymous, 2005). As indicated by Malik (1998), there is no hard evidence to prove that the poor as opposed to the non-poor behave differently in key aspects and especially in terms of natural resource management. There are five types of rural poverty:

- Materials
- Deprivation
- Alienation causing interstitial poverty
- Pockets of poverty surrounded by power affluence and
- The ownership of assets.

Material deprivation arising from population pressure and limits on resources will breed alienation and overcrowding poverty. Vulnerability to natural calamities (e.g. drought), labour displacement and insecurity, produce traumatic or sporadic poverty. Environmental degradation leads to both transitory and chronic poverty and affects smallholders, landless, nomadic pastorals, ethnic groups and households headed by women (Malik, 1998). The relationship of poverty and land is intimate, given the prevalence of poverty in rural areas. Rural poor depend more on agriculture than the rural non-poor. The lack of land and rural poverty are generally observed to co-exist (Malik, 1998).

Declared weeds and alien plant species threatened food security. They may also affect the productive capacity of the land and increase agricultural labour time, affecting human well-being by threatening the availability of food as well as reducing the time people have for recreation and other non-work activities, such as participating in community events.

Most often the responsibility for weeding falls on women and children (Chenje, 2003). WIP may also increase the physical threats to human habitats. Many WIP produces flammable standing, dead materials and many re-sprout quickly, giving them competitive advantage over native species. This may threaten homes and other infrastructure (Chenje, 2003).

2.3.4.4 Fragmentation of the landscape

According to Chapman and Le Maitre (2001), land transformation by human activities is increasing steadily. Fragmentation of natural vegetation leaves “islands” or remnants of the natural community in a “sea” of transformed land cover, which is sometimes linked by strips or corridors of untransformed vegetation. The effects of this process are remnants which contain subsets of the original communities and species in proportion to their size and spatial distribution.

The second effect is the increase in the extent of the edge of the communities. Small patches are affected more than larger ones because the ratio of the perimeter to the area increases non-linearly as the size decreases (Chapman & Le Maitre, 2001). The converse of the effect of the relationship between the number of species and the area leads to the development of the island “biogeography theory”.

This postulates that there is equilibrium between species immigration and extinctions, as well as the size of the island. The number of species at equilibrium is related to the island size, and that the immigration rate is in inverse proportion to the distance from the main source of immigration. Many invasive exotic species seem to be able to benefit from fragmentation of plantations and exploit the vulnerability of the remnants.

Increased vulnerability of the remnant communities are due to altered disturbance regimes, microclimate and other factors in the remnants (Chapman & Le Maitre, 2001). The ability of many invaders to persist at a low population size and disperse over large distances, enables them to succeed and invade more readily than the indigenous plants (Chapman & Le Maitre, 2001). The loss in biodiversity is attributed to habitat loss and fragmentation of the natural landscapes (Roy & Joshi, 2007). Fragmentation generally results in remnant areas of native vegetation surrounded by a matrix of agricultural or other developed land. This has an important influence on the biota within the remnant patches, especially in the areas at or near the edge between the patches and the surrounding matrix. These results vary with the distance from the patches and connectivity with the other patches. The distances and influences modify the size, shape and the position in the patch and its constituents.

The natural ecosystem and its functioning should be a guiding factor for human activities in the biosphere. However, overriding priorities and the human activities modify the landscapes to suit their own needs. These intensive human land uses include agriculture, industries and settlements. These land uses alter the ecological character of the land in which they occur, and they tend to be permanent modifications at ecological time scales (Roy & Joshi, 2007). The impact of any land use actively depends on two issues, i.e. the degree of habitat modification and the spatial extent and pattern of the habitat modifications (Roy & Joshi, 2007). Spatial organization of landscape connectivity is important for sustained ecological functioning.

Connectivity can exert strong influences on ecological processes such as the movement and dispersal of organisms, the use of resources by animals i.e. corridors, gene flow and spread of disturbance. Changing the landscape patterns through fragmentation can disrupt ecological processes that depend on movement within the landscape.

The recent rates of extinction of known animals and plant species from diverse environments in diverse regions are 100 to 1000 times greater than their pre-human levels due to the anthropogenic reasons (Monkkonen *et al.* 2006). Patch size reduction translates into increased exposure at patch edges and increasing levels of patch isolation. It is important to distinguish between the effect of pure habitat loss and fragmentation. When a habitat is lost from the landscape, the individuals inhabiting it are lost as well, which results in a decline in the population.

However, in terms of habitat loss alone, without fragmentation effects, there is a linear relationship between the number of individuals and the habitats area, so that the density of individuals per unit area remains constant (Monkkonen *et al.* 2006). Fragmentation effects (patch size reduction and isolation) can exacerbate the effects of pure habitat loss, potentially producing even greater population decline, which may result in population extinction even if suitable habitats are still available.

Chenje (2003), indicated that the increased movement of people and their interaction are the driver in the spread of WIP. This interaction has broken down the natural barriers of mountains, rivers and deserts, which provided the isolation essential for unique species and ecosystems to evolve.

2.3.5 Indigenous knowledge system, perception and attitudes of the local people

Indigenous knowledge systems (IKS) exist and are developed around specific condition of population (Rozani, 2006). Barac (2003), defines indigenous knowledge system as knowledge, innovation and practices of indigenous and local communities and people around the world. Over many centuries human beings have been producing knowledge and strategies enabling them to survive in a balanced relation with their natural and social environment.

Indigenous knowledge is dynamic and is a result of a continuous process of experimentation, innovation and adaptation. Indigenous knowledge has the capacity to blend with knowledge based on science and technology (Rozani, 2006). The disadvantage with Indigenous knowledge is that IK is not captured and stored in a systematic way.

There is a dominance of the Western knowledge system which has largely led to prevailing situation in which indigenous knowledge is ignored and neglected, creating implicit changes that IKS becomes extinct (Rozani, 2006). For many years the local communities made local rules to protect important resources, such as useful plants, watersheds and rivers (Gadzirayi *et al.* 2006). The indigenous knowledge is specific to people indigenous to particular geographic areas and cannot be generalized to larger population, it therefore means that it IK is determined by the people living in a particular locality or region or in the social environment to meet the needs of that particular community (Rozani, 2006).

Today, there is a growing appreciation for the value of indigenous knowledge, seeing that it is valuable not only to those who depends on it in their daily lives, but also to the growing modern industries (Barac, 2003). Indigenous knowledge can make a good contribution to the sustainable development of Southern Africa.

Perception refers to a process whereby people select, organise, interpret, retrieve and respond to the information from the world around them (Schermerhorn *et al.* 2000). The information perceived comes from hearing, seeing, touch, smell and taste. Perception and reality is not necessarily the same thing. Through perception, people process information inputs into responses involving feelings and actions. Perception is a way of forming impressions about oneself, other people and daily life expectations. Perception serves as a filter through which the information passes before it has an effect on people. The quality or accuracy of a person's perception has a major impact on his or her response to a given situation (Schermerhorn *et al.* 2000).

Eser (1998), indicated that practical evaluation of facts as desirable or undesirable is not a question of science. This belief argues against the idea that a better scientific description of the consequence would facilitate the assessment of species introductions. Better knowledge will and should influence evaluation as well as legislation, but still the evaluation of any empirical fact depends on subjective performance and values.

Although the separation of facts and values is a reasonable norm for science, it is contrary to scientific practices. Science is deeply rooted in and depends on the historical context (Schermerhorn *et al.* 2000). As a social enterprise, science is necessarily biased. To call plant species invasive or neophytes implies to evaluate it as non-desirable from the perspective of nature conservation. Scientists play an important role in the influencing of public opinion. It is the responsibility of scientists to contribute to public awareness of risks related to human actions by providing a better understanding of ecological consequences of species introductions. Due to the great influence on public opinion, scientists need to be aware of the historic and social context in which they speak and act. This means the choice of language and the possibility of biased perception has to be considered before drawing political conclusions.

Factors affecting perceptions and attitudes (Schermerhorn *et al.* 2000) include:

- Perceiver: A person's past experiences, needs or motives, personality, values and attitudes are all influential towards the perceptual process.
- The setting: The physical, social and organisational context of the perceptual setting influences the perceptual process.
- The perceived: The characteristics of the perceived person, object or event such as contrast, size, intensity, motion and repetition, has an impact on perception.

- Temperament: Individual attitude in the community context is favoured by temperament. Four existing habitat systems of temperament are:
 - Harm avoidance producing behavioural inhibition.
 - Reward dependence producing behavioural modification.
 - Novelty seeking producing behavioural activation.
 - Persistence producing behavioural activation.

Attitudes are more universal. This means that the difficulties do not lie at the levels of temperament or style but rather with personal and cultural dis-empowerment. Different individuals can respond differently to the same situation. The preferred response of each individual (and each individual family and each individual culture) is likely to be different, simply because of differences in temperament (Schermerhorn *et al.* 2000).

Many reasons can contribute to people living unsustainable lives, such as poverty which can force people to do things that will help them to survive for the present, even though they know they are creating problems for the future. Attitude surveys showed that the links between individual lifestyle, the alleviation of poverty, the use of resources, and world economic and trading patterns are not well understood (Beazley, 1993). Personality traits and interests are conceptualised as attributes which are manifested in a variety of situations and which are relatively permanent.

2.4 Management of declared weeds and alien invasive plants (WIP)

According to Barac (2003), dealing with the environmental problems, which include declared weeds and alien invasive plants requires the ability of both land managers and policy makers to make wise management decisions. In order to arrive at the right decisions, it is important that there is adequate relevant knowledge, which is dependent on both quality and availability of relevant knowledge.

According to Sheley *et al.* (1999), there are three mechanisms which cause succession, namely: (a) disturbance, (b) colonization as well as (c) performance, and all these must be treated as separate entities. When developing an ecologically-based weed management plan, options can be placed in categories of designed disturbance, controlled colonisation and controlled species performance (Sheley *et al.*, 1999).

Under the ecologically-based WIP management methods, disturbance is used to alter the process to drive succession in a desirable direction, which minimizes the need for continuous high-energy inputs. Each technique must be carefully tested for its effectiveness in directing plant succession in a desirable direction. Designing successful WIP management strategies requires careful integrating techniques aimed at addressing each of the three general causes of succession, and these management strategies must be carefully chosen to ensure that the techniques are complementary to one another (Sheley *et al.*, 1999). Once this is achieved the conversion from a WIP community to a desirable one can occur. The management of WIP is of the utmost importance. The potential pathways for invasions should be known, and potential invasive species be identified to enable good management of declared weeds and alien invasive species (Raghubanshi *et al.* 2005).

An understanding of the ecology of plant invasion requires information on the rate and mechanisms of transport and movement of organisms, on characteristics allowing a species to become a successful invader and also on the properties of ecosystems that make them susceptible to the invaders.

According to Wilson *et al.* (s.a), partnerships must be established and strengthened with all land users, landowners, and land managers as well as conservation organisations. There is a need for collaboration of efforts from all the different role players dealing with management of WIP.

Without group cooperation, any effort is destined to fail. The solution for many natural resource problems is more of a social than a biological nature. The prevention of new infestation forms an integral component of the management program of any WIP.

Each site must be mapped immediately so that the location is well documented for follow-up inspections of the management efforts. According to Sheley *et al.* (1999), most rangeland managers and landowners have focused their WIP management efforts on control and therefore pay very little attention to the existing or the resulting plant community. It is becoming clear that weed management decisions must be based on environmental, ecological as well as economic principles. Sheley *et al.* (1999), further suggested that land use objectives must be developed before WIP management decisions can be made. An integrated WIP management plan can be formulated once the use of the land is known. It is therefore very important to develop a sustainable plant community which will be able to fill open niches, and withstand competition.

Although little is known about the role of many species within the plant community, it is generally accepted that maximum diversity is optimum for energy flow through the system as well as nutrient and water cycling (Sheley *et al.* 1999). Once a desirable plant community has been chosen, an ecologically based weed management plan can be developed. In order to assess the impacts of invasive species, long term studies are needed as adverse effects take time to appear (Raghubanshi *et al.* 2005).

It is also necessary to ascertain whether a certain species proposed for introduction has been shown to be invasive in other situations and then make an assessment of the risk that introduction will entail. If the proposed introduction of species is being assessed, but the information for effective risk assessment is not readily available, a precautionary approach should be followed (Howard, s.a).

In terms of a detailed management of WIP, it is important to refrain from driving vehicles and machinery through WIP infested areas during the seeding periods. *Datura ferox* is highly invasive if not controlled before seed production. It is difficult to control as large amounts of seed are being spread to uninfested areas by especially vehicles and machines (Sheley *et al.* 1995). Wildlife and livestock disperse seeds in two ways. Firstly, animals ingest the seed, which can pass through the stomach unaffected, and introduce such seeds into new areas. Secondly, many weed seeds can become tangled in the hairy coat of an animal and when the animal moves to a WIP free area; these seeds fall to the ground and germinate at a later stage when conditions become favourable.

According to the Conservation of Agricultural Resources Act (no 43 of 1983), if any weed adheres to an animal that is conveyed in a vehicle or offered for sale at a livestock auction, the executive officer may issue an order that the weed concerned be removed from that animal (South Africa, 1984). In order to manage WIP effectively, the following approach must be followed as indicated by Brooks and Berry (1999):

- *Coordination among the land managers:* WIP management is effective when efforts transcend jurisdictional boundaries to encompass entire eco-regions. This is effective in preventing new invasions.
- *Develop a list of alien species already in the region:* All land managers should begin to develop a list of all the alien species in order to determine the extent of the invasion and to identify possible hotspots of invasions. By assessing the invasiveness of WIP and evaluating the patterns of trade that may bring these plant species to the region, one would be able to compile a list of potential invaders. When an incipient population of these species is found, their potential for spreading and thus their priority for control would be known.

- *Develop remote sensing techniques for aliens:* Although this technique may not be sensitive enough to reliably detect new invasions, it may be extremely useful in monitoring species that are already widespread or locally abundant.
- *Evaluate effects of aliens on ecosystem integrity:* As we need to understand ecosystem level effects of aliens to develop an appropriate management action, we need to step up ecosystem level research. More research is needed in all areas affected by invasions, given the scale at which clearing operation are being conducted, we need better improved understanding of how to manage ecosystem recovery (Richardson & Van Wilgen, 2004). This is especially critical for riparian system, which are usually densely invaded, and subject to soil erosion after clearing. Further strategy is needed to direct appropriate research in the field of invasion ecology while giving attention to capacity building and social transformation (Richardson & Van Wilgen, 2004).
- *Establish a monitoring program to detect new invaders:* Monitoring may focus on hotspots for invasions, such as along roads or at the urban wild lands interface. Coordination among land managers is particularly important, because monitoring is useless if some managers fail to identify new invasions and allow them to become established in the region.
- *Evaluate effects of aliens on threatened and endangered plants and animals:* More research is still needed, especially on those organisms living in the threatened habitats or those characteristic of wide-spread ecosystems, to ensure that recovery efforts will be effective.
- *Develop methods to control alien plants:* Mechanical weeding or herbicide applications are options for small infestations. Biological control agents are the only feasible option for widespread alien plants. However, not all WIP have biological agents readily available. Climatic conditions in most of the areas are not suitable for some of these biological agents.
- *Evaluate the mechanisms of plant invasion:* Much research is still necessary to describe the characteristics that make species invasive and habitat vulnerable to invasion.

- *Working for Water*: In South Africa attempts of managing WIP are done through the program of Working for Water (Robertson *et al.* 2003), with its strong emphasis on multi-departmental involvement and international cooperation (Richardson *et al.* 2004). There is a considerable change from considering single-species problems to the incorporation of invasive species as a complex component of global change requiring sustainable investment at multiple scales of time and space.
- *Education and outreach programs*: According to Richardson *et al.* (2004), there is a need for developing an outreach program looking specifically at materials for different audiences such as school children.

2.5 Summary for literature review

Literature review presented in this Chapter investigated policy relating to the control and management of the declared weeds and alien invasive plants mainly from the Conservation of Agricultural Resources Act (No 43 of 1983) perspective. It also investigated the pathway of the introduction of the WIP problem in a new and existing area. The researcher concludes that people are deliberately or unknowingly introduces WIP into new locations as a result of their activities and also create suitable niches for WIP survivals. The climatic factors such as drought, temperature and erratic rainfall were also found to contribute significantly to the proliferation of WIP.

CHAPTER 3

THE STUDY AREA

3.1 Location of the study area

The study area is located near Dinokana in the North West Province of South Africa (Figure 3.1). The study area is approximately 56044.3 ha in size and is located on the grids $25^{\circ} 46' 00''$ South and $25^{\circ} 42' 00''$ East. Zeerust is the only town found in the area which is approximately 24 kilometres from Dinokana.

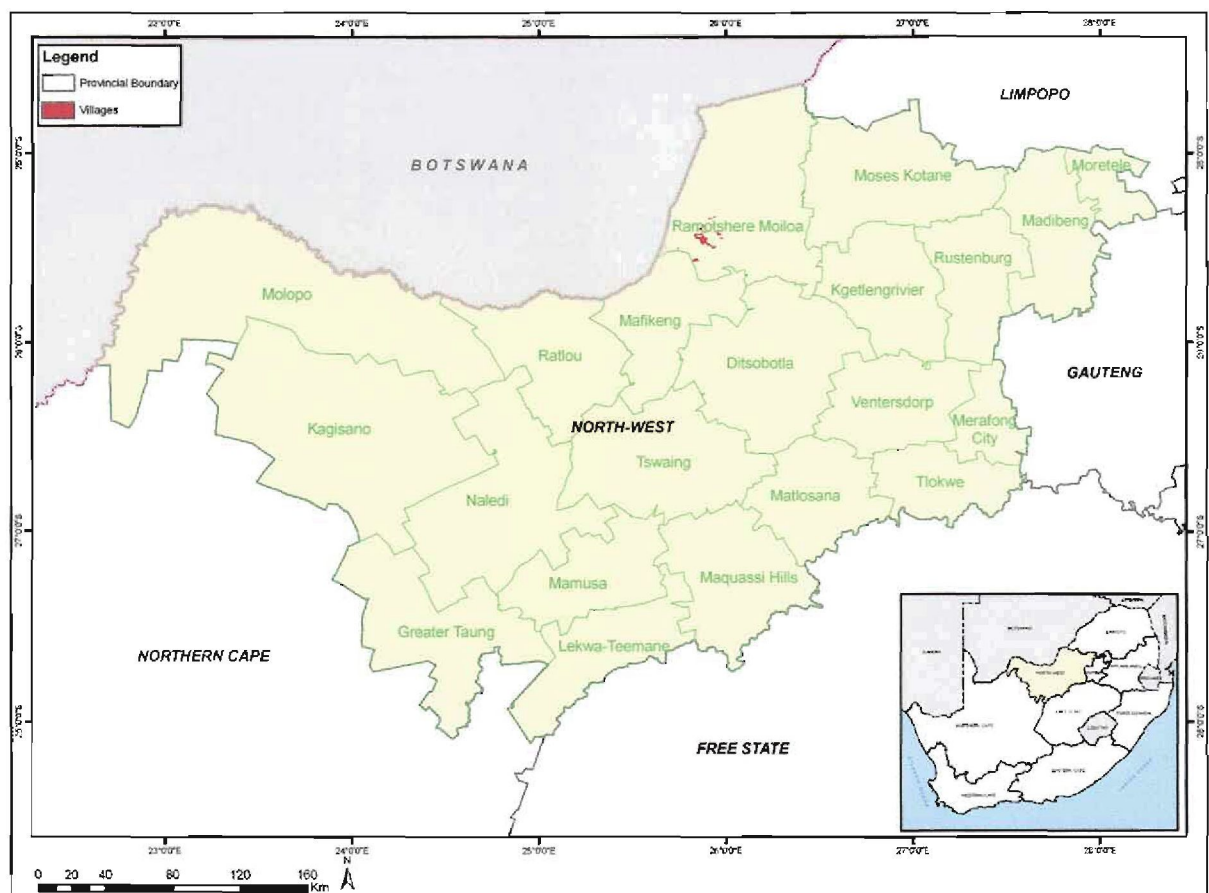


Figure 3.1: A map indicating the location of the North West Province in South Africa (ArcView/GIS, 2007).

The Province is divided into different Local Municipalities (Figure 3.2). The study area is situated in the Zeerust local municipality currently known as Ramotshere Moiloa Local Municipality. Nine villages in the Dinokana area were used in the study, i.e. Dinokana, Boroathamadi, Maramage, Mantsie, Ikageleng, Madutle, Khunotswana, Ntsweletsoku and Matlhaase villages (Figure 3.2). The people in these villages are dependent on agricultural activities.

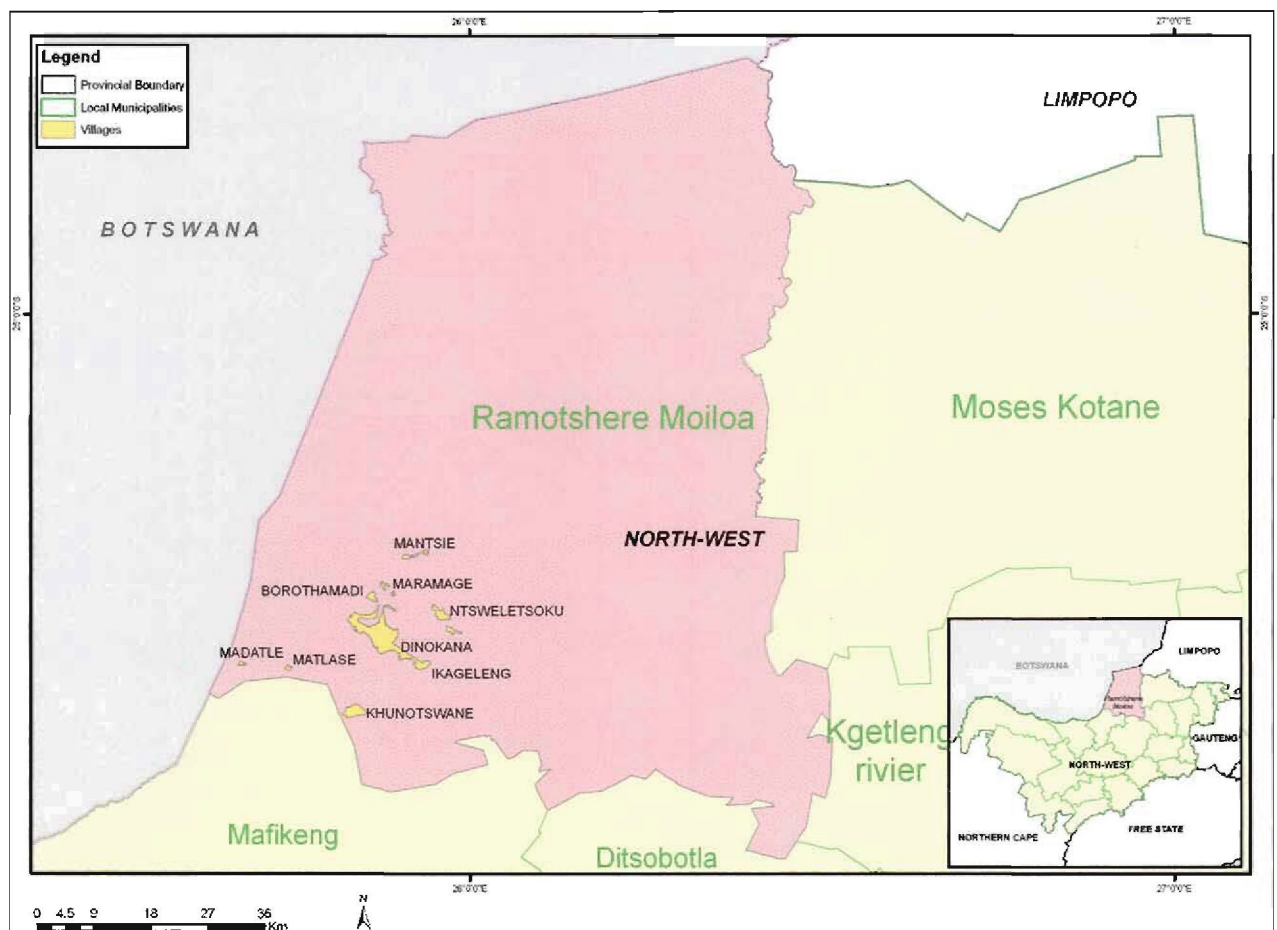


Figure 3.2: The location of the Dinokana Area in the Ramotshere Moiloa Local Municipality of the North West Province (ArcView/GIS, 2007).

The area used for grazing is controlled by the tribal authority situated at Dinokana Village. The most common farming practice in the area is livestock production.

Crop production only occurs at a small scale, mainly in individual backyards. The population density for each village in the Dinokana Area is given in Figure 3.3 (Statistic South Africa, 2001).

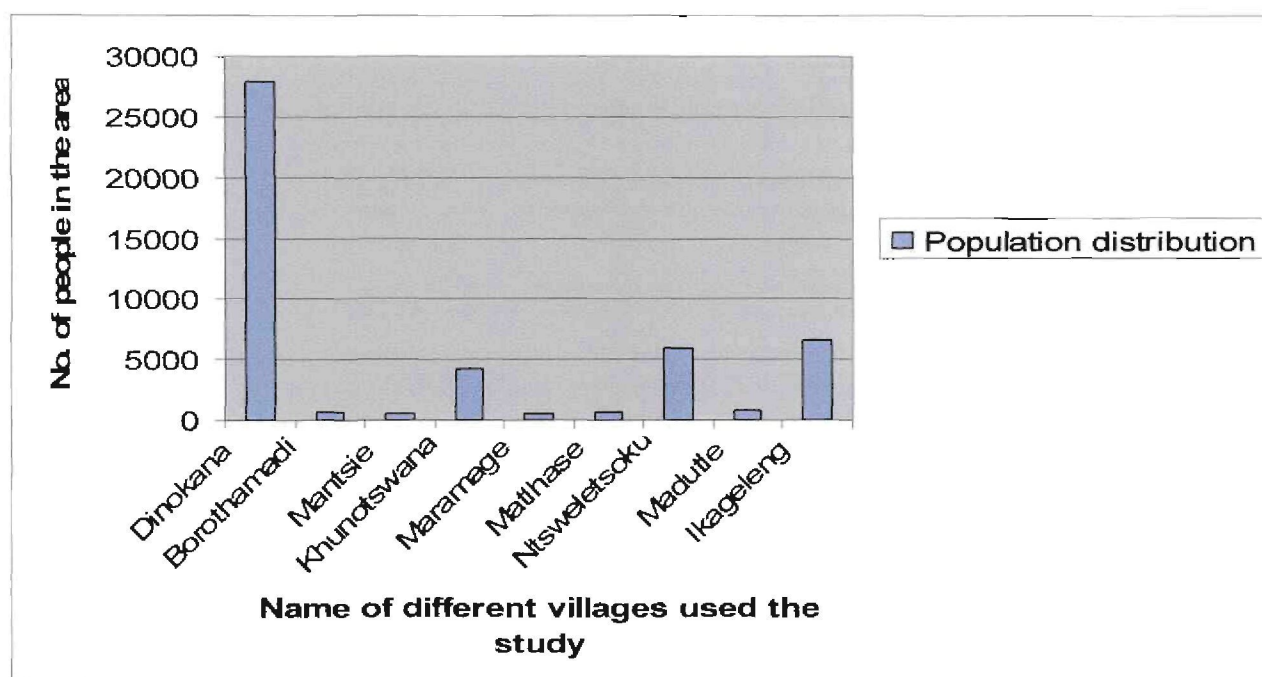


Figure 3.3: Population distribution for Dinokana Area per village (Statistics South Africa, 2001).

According to Figure 3.4, approximately 28000 people lived in Dinokana Village during the survey. Ikageleng and Ntsweletsoku had approximately 6000 and Khunotswana had approximately less than 5000 people. The rest of the Villages (Mantsie, Maramage, Madutle, Borothamadi and Matlhase) had approximately 1000 or less inhabitants (Figure 3.3). The number of households of every community used in the study is represented in Figure 3.4.

The number of questionnaires completed per village, as indicated in Chapter 4 (materials and methods) was determined according to the number of households in each Village.

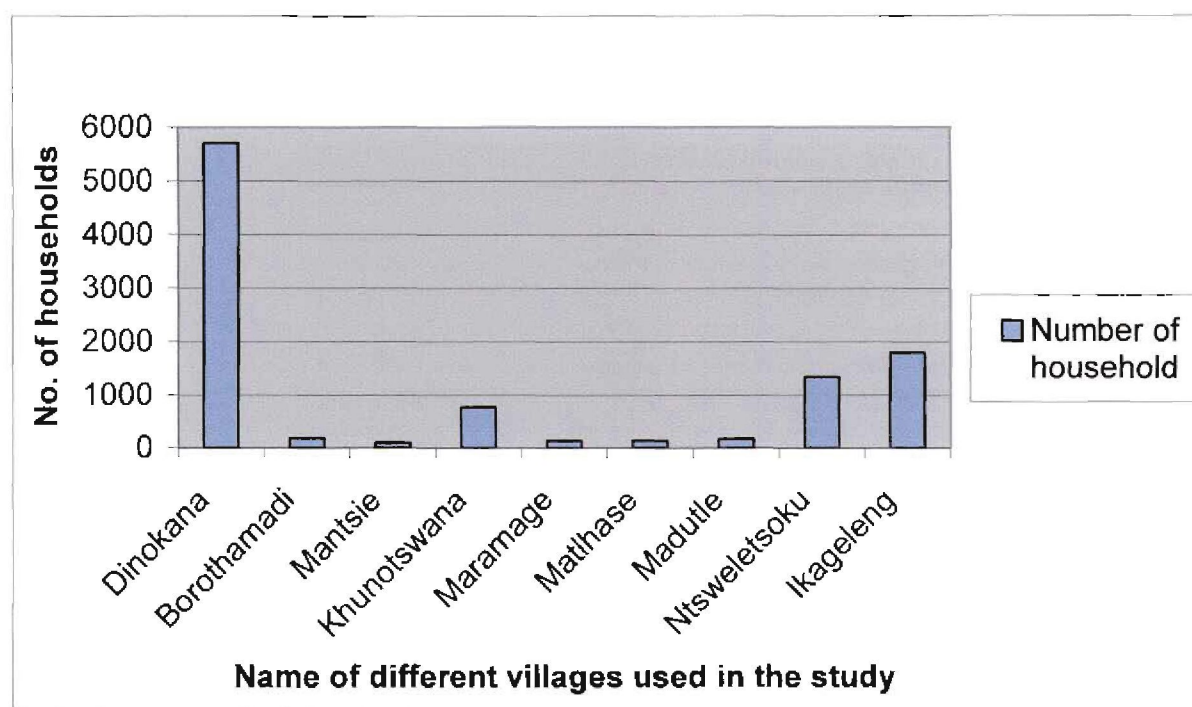


Figure 3.4: Number of households per community studied in the different villages (Statistics South Africa, 2001).

The population of the area of Dinokana constituted 20% of the total population of Ramotshere Moiloa Local Municipality (Statistics South Africa, 2001). The tribal authorities' offices are located at Dinokana village and all other Villages examined in the study are ruled by different headmen.

3.2 Natural vegetation

According to Acocks (1988), the largest part of the study area falls within the sourish mixed bushveld type No 19, as indicated in Figure 3.5. This veld is more clearly defined than the mixed bushveld, occupying an irregular belt on the gentle slopes to the mountains, between the sour types and the mixed types of the plains and valleys.

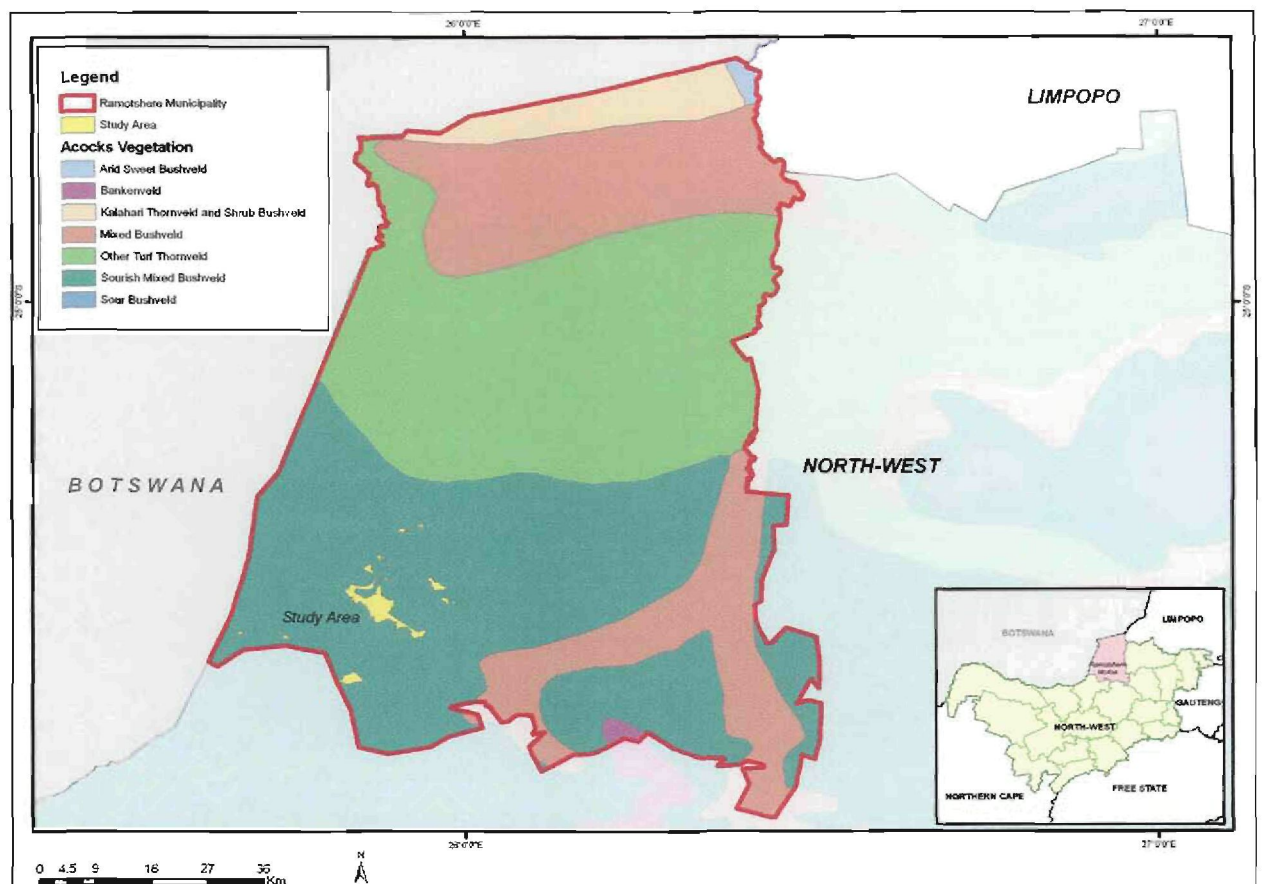


Figure 3.5: Sourish mixed bushveld (Veld Type 19; Acocks, 1988) in the Dinokana Area.

This veld type is characterized by an open savanna with *Acacia caffra* being the dominant “tree”. The fairly tall and dense grassland is dominated by *Cymbopogon plurinodis*, *Themeda triandra*, *Elionurus muticus* and *Hyparrhenia* species. Table 3.1 indicates principal trees and grass species of this veld type (Acocks, 1988).

Table 3.1: The principal trees and grass species of the sourish mixed bushveld type No 19 (Acocks, 1988).

Principal trees and shrubs	Common name for trees and shrubs	Principal grasses	Common names for grasses
<i>Acacia caffra</i>	Common hook-thorn	<i>Cymbopogon plurinodis</i>	Narrow leaved turpentine grass
<i>Acacia karroo</i>	Sweet thorn	<i>Themeda triandra</i>	Red grass
<i>Acacia robusta</i> subsp. <i>robusta</i>	Black thorn	<i>Elionurus muticus</i>	Wire grass
<i>Acacia tortilis</i> subsp. <i>Heteracantha</i>	Umbrella thorn	<i>Heteropogon contortus</i>	Spear grass
<i>Rhus lancea</i>	Karee	<i>Aristida canescens</i>	Pale Three awn
<i>Grewia spp</i>	Velvet raisin	<i>Eragrostis superba</i>	Saw tooth loved grass
<i>Peltophorum africanum</i>	Weeping wattle	<i>Brachiaria nigropedata</i>	Black footed grass
<i>Acacia gerrardii</i> var. <i>gerrardii</i>	Red thorn	<i>Antheophora pubescens</i>	Wool grass
<i>Pappea capensis</i>	Jacket plum	<i>Aristida stipitata</i> subsp. <i>graciliflora</i>	Long awned grass
<i>Dichrostachys cineria</i>	Sickle bush	<i>Panicum maximum</i>	Guinea grass
<i>Dombeya rotundifolia</i>	Common wild pear		
<i>Combretum zeyheri</i>	Large fruited bush willow		
<i>Sclerocarpa birrea</i> subsp. <i>Caffra</i>	Marula		
<i>Ziziphus mucronata</i>	Buffalo thorn		
<i>Burkea africana</i>	White seringa		

3.3 Geology and soil of the study area

The soil type found in the area derived from different parent materials, ArcView/GIS (2007) and (Resource Identification and Utilization, 2001), (Figure 3.6), namely:

(a) Quartzite (Rga, R-VA and Vd) rock material gives rise to deep red sandy soil with prominent medium sand, after weathering has taken place. The soils accumulate on the upper foot slopes at the base of quartzite ridges. Certain valleys in the study area on shale are covered by quartzite derived soils. The soil is valuable for crop production but its fertility is very low and trace element deficiency is common. Base saturation is moderate to low and soil with a low pH.

(b) Granite rock (Rga, R-VA and Vd): It forms undulating plains with small hills, castle koppies. Soils are predominantly shallow and sandy with medium and coarse sand (Glenrosa soil form is evident). The relatively high sodium and low Ca and Mg content and sandiness of the parent materials, cause Estcourt soils to develop. Because granite is low in Ca, Mg and Fe, the soil tends to be acidic and have only moderate base saturation. Trace element concentration is moderate to low and only zinc and molybdenum are present in moderate amounts. Deficiencies of trace elements can be expected in these soils (Resource Identification and Utilization, 2001).

(c) Iron formation, shale (Vp and Vs): The parent rock materials are fairly soft and undergo rapid mechanical weathering. The soil type found in the area is inclined to have a high clay content, as well as prominent fine sand. Potassium and magnesium contents in the soil are comparatively high. Mudstone and shale from the Karroo sequence are freshwater sediments and carry a considerable amount of smectite clay and thus give rise to clayey soils with strong swell-shrink properties (Resource Identification and Utilization, 2001).

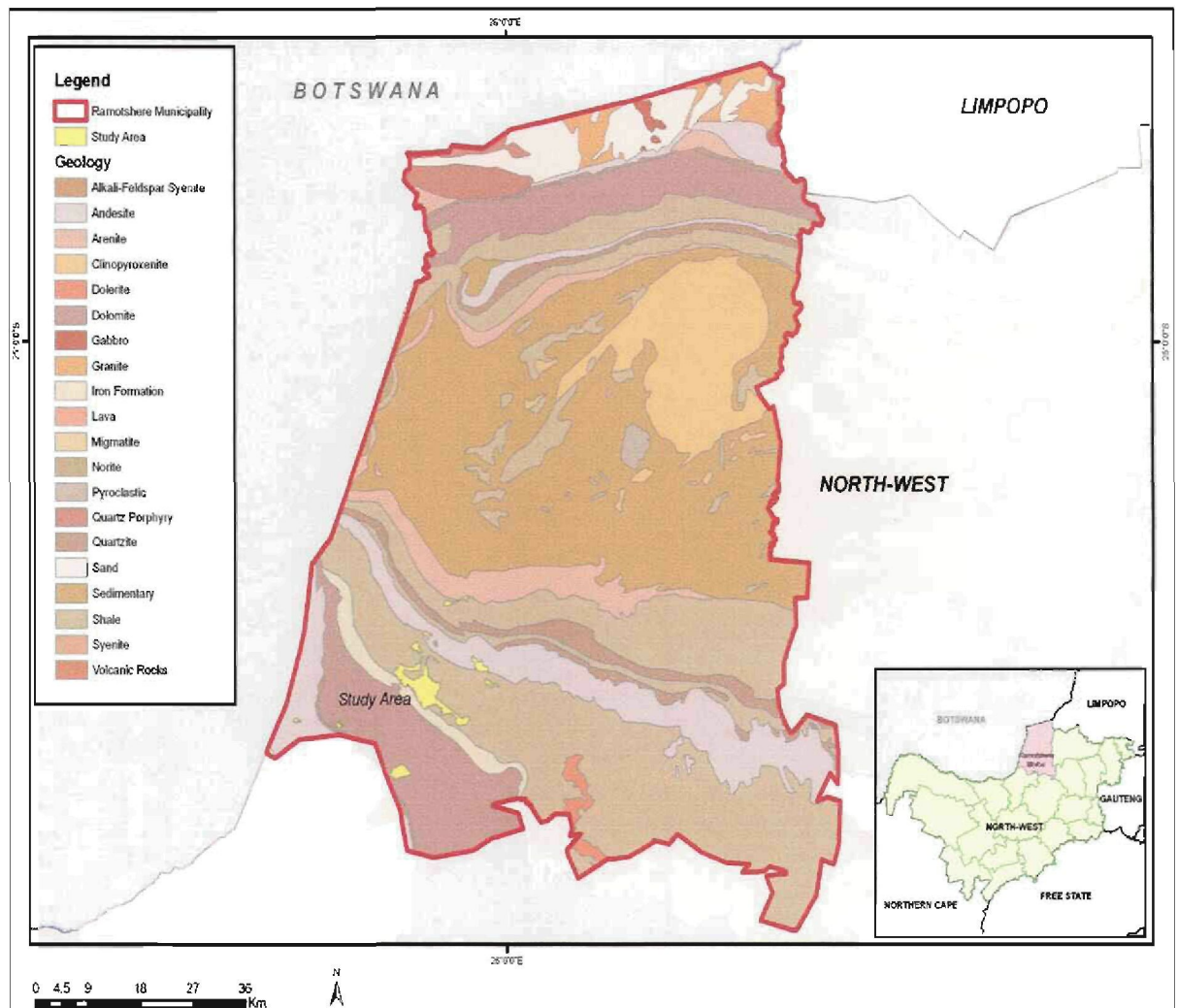


Figure 3.6: Geology and soil for the study area (ArcView/GIS, 2007).

Duplex soils with black clays are common. Trace elements are fairly common but are particularly enriched in carbonaceous black shale, which occur in the Pretoria Group where even toxic amounts for plants and animals may often occur (Resource Identification and Utilization, 2001).

(d) Gabbro, norite, pyroxenite (Rmd): These rocks are physically hard but readily undergo chemical weathering. The soil derived from diabase, dolerite, norite, and gabbro always have a high clay content and vertic black turf or red structured clayey soil may result (Arcadia and Shortland soils forms respectively) (Resource Identification and Utilization, 2001). Where permeability and drainage of the clay is poor, vertic black clay soil high in smectic clay are formed. Generally, the soil is fertile, high in Ca and Mg, usually with adequate phosphorus. Trace elements like Copper, Manganese, Cobalt and Zinc are common while quantities of boron and molybdenum are moderate to low. Base saturation of soils is high. In Shortlands soils, hematite is present, with very little organic matter while in the Arcadia soil form, more organic matter is present. Soil pH gives information about the soil acid and alkalinity content. Therefore different plants will grow at different acid and alkaline levels depending on their level of tolerance of the prevailing conditions (Resource Identification and Utilization, 2001).

3.4 Climatic conditions

The study area falls within the summer rainfall region of South Africa. The region is characterized by very cold to mild winters, with the occurrence of frost. The summer conditions are very hot and the temperature at night ranges from 10°C to 20°C, with an average daily temperature of 14°C to 34°C (Provincial Department of Agriculture, 2007). Thunderstorms may occur during November to March. The prevailing wind direction is north and northeasterly during the months of August to May and west to southerly during the other months (Provincial Department of Agriculture, 2007).

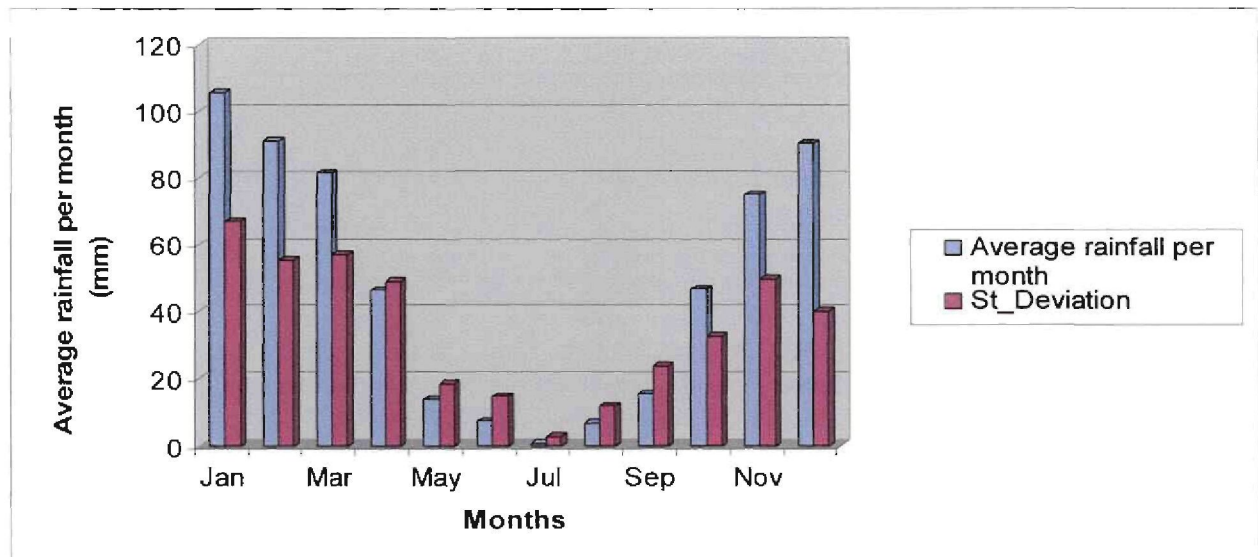


Figure 3.7: Average monthly rainfall and Standard deviation for Ramotshere Moiloa Local Municipality from 1960 until 2007 (ARC, 2007).

Figure 3.7 shows the average monthly rainfall over a period of 47 years from 1960 until 2007 (ARC, 2007). The average rainfall per month for the first three months of the year, i.e. January till March was 105.6mm, 90.9mm and 81.5mm respectively, which was the highest compared to the other months in a year. The average rainfall drops in April with 46.2mm and 0.8mm in July. Figure 3.7 shows that there is more rainfall in January until March, hence grouping the study area within the summer rainfall area. Higher rainfall is experienced in November and December with an average of 75mm and 90.3mm, respectively. From Figure 3.7, a close correlation of the number of days with the average rainfall can be observed, i.e. January, February and March with 8.8, 7.3 and 6.4 days, respectively, with 4.1 days in April until July with 0.2 days and only 0.8 days in June. According to Figure 3.7 the average number of rainfall days for the 47 year period (1960-2007) was 52.3 days with the total rainfall being 508.3mm per annum.

3.5 Infrastructure and development in the study area

Most of the people depend on farming activities for survival, with either crop or livestock production. There are also some industries, including retails shops and garages. Many people are working in the public sector, as the private sector is not really contributing significantly to employment.

Although the people are dependent on farming, the land used for farming is not fenced and no necessary infrastructure, such as proper water reticulation, is available for the farmers. Livestock have to travel long distances in search of better grazing. This also increases the footpaths and continues to contribute to the degradation of the area. Many farmers are losing their livestock to accidents.

There is no formal management of the grazing land for the areas used in the study. The grazing is controlled from the tribal authority offices in Dinokana Village. Crop production is only found in areas such as Madutle, Matlhase and Khunotswana.

In terms of the health care system, the nearest hospital is found at Welbedacht, which is about 20 km from Dinokana. There is only one clinic each at Khunotswana, Ikageleng and Ntsweletsoku, and a clinic and health centre in Dinokana. There are no clinics at Mantsie, Madutle, Matlhase, Boroathamadi and Maramage communities (Northwest Premier's Office, 2007).

The next Chapter will concentrate on the materials and methods used in carrying out the research.

CHAPTER 4

MATERIAL AND METHODS

4.1 Indigenous knowledge sampling

A questionnaire was developed to interview the local community about the problem of declared weeds and alien invasive plants species (WIP) in the Dinokana Area. Questionnaire is attached as Appendix A. According to Kothari (1990), population sample size should neither be excessively large nor too small while conducting population study. A too large sample results in a waste of resources. A sample size which is just large enough would enable research to meet the requirements for reliability (Alreck & Settle, 1985). The questionnaire consisted of four Sections:

- (a) The demography of the study area which includes gender, age, education and employment status of the respondent.
- (b) Investigation of the indigenous knowledge of the local community regarding the declared weeds and alien invasive plants. This section probes the general knowledge such as where the plants are normally observed. The ratings of the occurrences of plants as well as what the people think how these plants can be used.
- (c) The questionnaire deals with the control of declared weeds and alien invasive plants (Appendix A). It investigated whether there is a need for eradicating these plants. The questionnaire investigated different control methods whether the people could participate in the eradication programs “(if asked)”. The question further assessed the knowledge of the local community on different programs that the government Departments put in place for the control of WIP.

- (d) The fourth section of the questionnaire investigated the knowledge of the local community regarding policy specifically those policies charged with WIP.

After the format and contents of the questionnaire was approved by the study leader, the field work was undertaken by the researcher. Respondents were represented by young people (from less than 25 to 35 years old) and old people (from 36 to more than 70 years old). Most of the old people couldn't understand the questions in English and therefore the researcher explain it in the local language (which is Setswana). There was a problem when dealing with names of plants, especially those which the local names was unknown, such as *Lantana camara* which resulted in a very low scores (ratings). This problem was observed in both old and young people.

A simple random sampling method was used and the questionnaire was divided in accordance with the size of each community. Dinokana Village had 28000 people and therefore the majority of the questionnaire was given to this community. A total of 55 questionnaires were done in Dinokana Village. Ikageleng Village was the next village with the second highest population size and 23 questionnaires were done in this village. The remaining 22 questionnaire were divided equally amongst the remaining seven villages. Preference was given to areas where these plants occur as indicated by members of the community. The research was conducted during weekends with the intention of getting access to people who are normally unavailable during the week such as workers.

The data was used for the compilation of available information and to broaden the knowledge of the researcher study (Kothari, 1990). Depending on the aim, the procedure it adopted and the number of people interviewed, generalizations would be made about the people in the Dinokana. The overall measurement of the research depends entirely on the accuracy of the use of the methodologies (Leedy, 1999).

4.2 Vegetation sampling



Figure 4.1: Invasion by *Lantana camara* (a) and *Eucalyptus* species (b) at the school in the Dinokana Village.

A field survey of the declared weeds and alien invasive plants in the area was conducted. The survey aimed firstly:

- (a) To identify the different plant species occurring in the area that contributes to invasions,
- (b) To quantify the extent of the land infested with declared weeds and alien invasive plants.

The area where WIP occurred was identified, using a (GPS) Global Positioning System apparatus. The GPS was used to indicate the exact location of the area, as well as to determine the size of the infested area. The identified points with the GPS were plotted in GIS program (Arc/View, 2007) in order to form an area (or polygon).

This was then overlaid on the 1:50 000 map features such as rivers, roads and other land use types such as grazing and cultivated lands. The points representing an occurrence of single trees were then treated as points and not as areas as in the case of cluster patterns. The purpose of creating these areas was to be able to determine the extent of infestation of each plant species in a certain area, either in square meters or hectares. Although the individual points, not forming polygons, were not significant because these plants only occurred singly, all plants were recorded including the single ones.

The degree of infestation of plants in clusters was determined by using a belt transect method of 40x4 meters (160m²) and 20x4 meters (80m²) in size, depending on the size of the study area. For each transect, a rope of 40 metres long was used, with a 2 metres rod held at right angles to either side of the transect. All plants that were rooted within this 80m² were recorded. Two sites of 160m² were sampled next to the clinic in Dinokana. These were the only two sites identified where WIP occurred in a clustered form.

The same method used at Dinokana was repeated for the Maramage Village. At Maramage, two sites which were mostly covered with *Populus* species were identified in the stream. The species were identified and the density of plants determined. The density of the trees were determined by tree counts and expressed in terms of tree equivalent per hectare (TE/ha).

The density of species was defined as the number of individuals per unit area in relation to other species occurring at a given site (Van Vuuren, 2003). The density was established at different height classes, namely <0.5m, >0.5m-1.0m, >1.0m-2.0m, >2.0m-3.0m, >3.0m-4.0m as well as >4.0m (Table 4.1). The Tree equivalents were determined per hectare and also per structure class to obtain the density of the woody species. A bush equivalent is defined as a woody plant within a height class of 1.5 meters (Tainton, 1999).

Table 4.1: Densities of *Lantana camara* and *Populus canescens* according to different height classes in the study area.

Height Class	<0.5m	>0.5m-1.0m	>1.0m-2.0m	>2.0m-3.0m	>3.0m-4.0m	>4.0m
<i>Lantana camara</i>	7.5	0	33			
<i>Populus canescens</i>				43.42	0	0

4.3 Data analysis

4.3.1 Indigenous knowledge, perception and attitudes of the people interviewed

One hundred (100) questionnaires were used to collect data regarding the knowledge of the local community of the Dinokana. The response rate was 100% since the interviews were conducted by the researcher. The questionnaire also determined personal information of the respondents to give an indication of how representative the respondents are of the population under review.

The aim of questionnaire analysis was to examine patterns among replies to questions and explore the relationship between variables (May, 1993). The sample data was obtained and thoroughly checked for completeness. The sample data was analyzed using the Microsoft Excel program. Data analysis was done by Statistics Department of the North West University (Potchefstroom Campus) using the SAS system (SAS, 1999). A descriptive data statistics was used for analysis purpose. This is a method of analysis using the frequency table where the number (frequency) and percentage of categorical responses are reported (SAS, 1999). The results of the questionnaire were then used to discuss the outcome with the respondents from the Dinokana community who have participated in the questionnaire project.

4.3.2 Vegetation data analysis

The analysis of vegetation data started by adding all the individual trees to determine the density at every height class for all species identified during vegetation sampling. The data was analysed using Tree equivalent factors at different height classes. The Tree equivalent was used to express the tree population of different sites in a common currency (Tainton, 1999). The following tree equivalent factors were used for the species height classes: $f=0.33$ for a height class of $<0.5\text{m}$, $f=0.5$ for $>0.5\text{-}1.0\text{m}$, $f=1.00$ for $>1.0\text{-}2.0\text{m}$, $f=1.67$ for $>2.0\text{-}3.0\text{m}$, $f=2.33$ for $>3.0\text{-}4.0\text{m}$ and $f=3.0$ for the height class of more than 4 meters. The tree factor is an analysis technique which is used to determine the tree equivalent of species height classes in hectare (Mampholo, 2006).

The tree equivalent is defined as a 1.5 meter tall tree or shrub (Tainton, 1999). The definition of bush equivalent is not different from tree equivalent (Mampholo, 2006). Tree equivalents (TE) were measured in trees/hectare, but to compare the different species with each other, the percentage of tree equivalent of each species was calculated. The Tree Equivalent per hectare (TE/ha) for one species is then divided by the total TE/ha for all species to calculate the relative percentage of the species contribution to the TE/ha in each sample site. The density was calculated by the number of trees per belt transect of 160m^2 and 80m^2 , respectively, and converted to the number of trees per hectare. The most prevalent WIP type sampled was *Populus canescens* (Poplar tree) and the other types of WIP was mostly intertwined with this one and therefore they were not measured separate from *Populus* species, except in some minor instances where they might occur on their own. The total tree densities for each species were determined. The results were used to calculate tree equivalent of all species per hectare over the entire area. A quadrant of five plots of 10×10 metres was used for the canopy cover estimates of the *Opuntia* species. *Opuntia* species was not counted or measured as a result of the nature of their growth and their spines.

CHAPTER 5

RESULTS AND DISCUSSION

5.1 Introduction

This chapter focuses on the outcome of the two methods used in carrying out the study, thus questionnaire and a vegetation sampling. It investigated population demography, which will include age, education and employment as well as gender. The important aspect in relation to the questionnaire was the indigenous knowledge of the local community of the Dinokana Area, including perception and attitudes towards the declared weeds and alien invasive plants. This section would be concluded by the role of the government Departments especially Department of Agriculture and Department of Water Affairs and Forestry assessing some intervention mechanisms that are in place to assist in the control of the problem plants.

5.2 Population demography

5.2.1 Age classes

A total of 100 people in the Dinokana Area were interviewed. Of the participants, 56% of the respondents were females and the rest were males. Six age groups were interviewed, namely:

- From less than 25 years old
- between 26 and 36
- between 37 and 47
- between 48 and 58
- between 59 and 69, as well as
- above 70 years of age

Of the people interviewed, 31% were less than 25 years of age, 27% were between 26 and 36 years of age, 12% were between 37 and 47, 12% were between 48 and 58 and 14% were between 59 and 69, while only 4% of the people interviewed were above 70 years old (Figure 5.1).

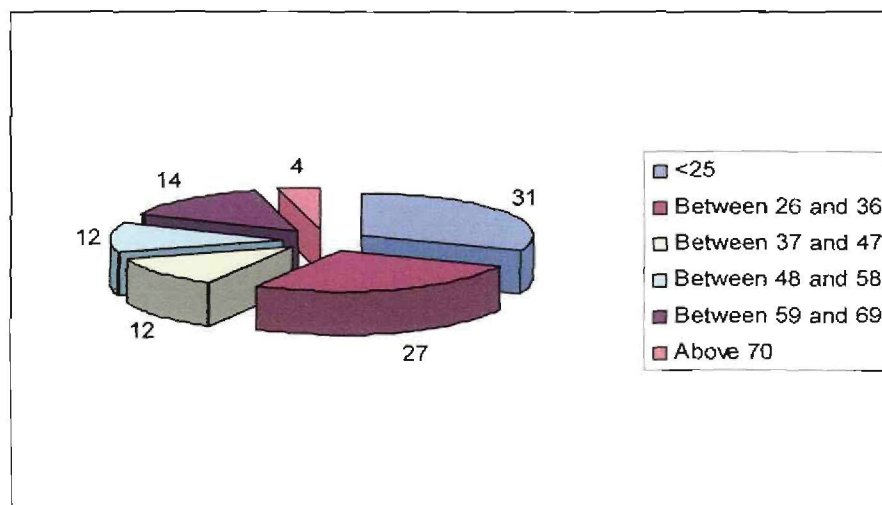


Figure 5.1: Age distribution of respondents in Dinokana Area on knowledge of declared weeds and alien invasive plants.

5.2.2 Level of education

Figure 5.2 represents the level of education of the respondents. Of those interviewed, 25% never attended school but can read and write, 21% have the maximum education level of Grade 7, 45% have maximum Grade 12 and only 9% of the respondents had a maximum higher education qualification, i.e. either a diploma or a degree. The level of education was important to analyse since it assisted in designing an appropriate method for intervention regarding the empowerment of the community to enable them to make decisions regarding the problem of declared weeds and alien invaders.

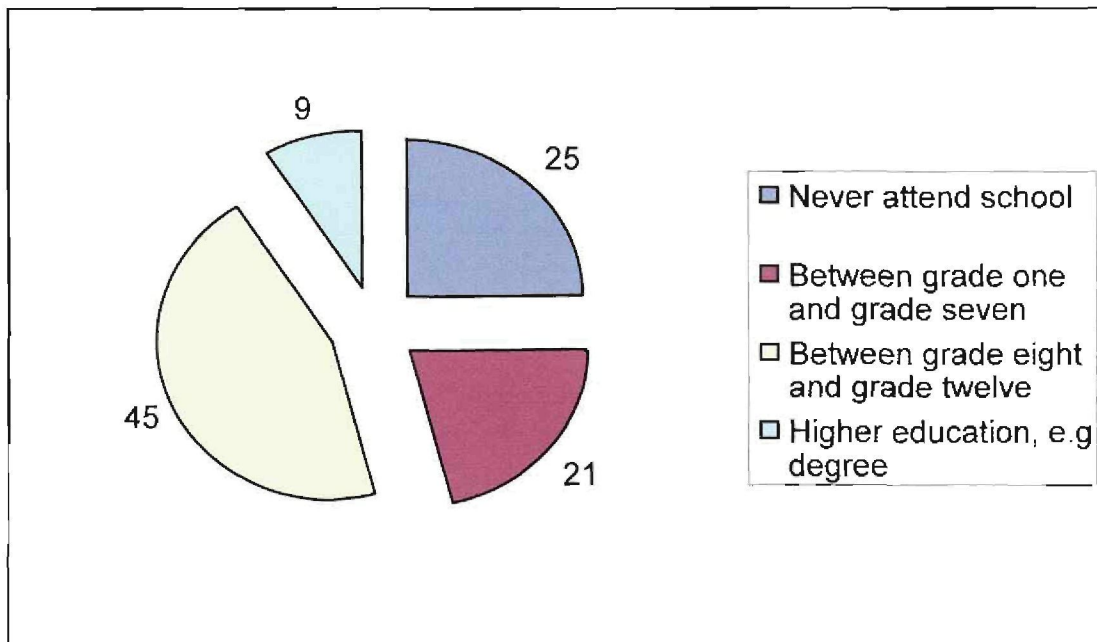


Figure 5.2: Education status of the respondents interviewed (%) on their knowledge of declared weeds and invader plants in the Dinokana Area.

5.2.3 Occupation

There were six questions probing the occupational class of the people, namely:

- Working for a government institution (4.1).
- Municipal employee (4.2).
- Unemployed (4.3).
- Self employed, including farmers (4.4).
- Students (4.5).
- Working for private companies, including industrial work (4.6).

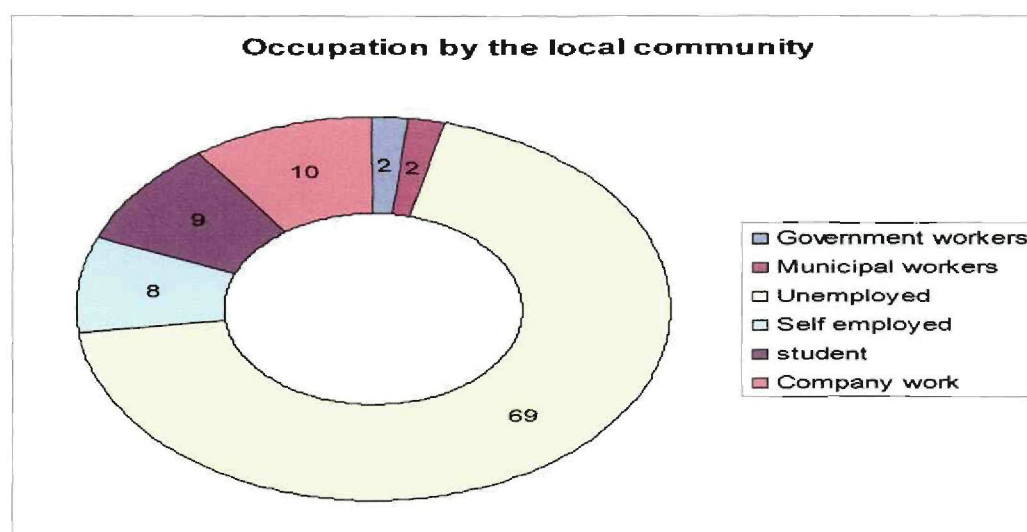


Figure 5.3: Different occupations of the local community interviewed (%) on their knowledge of declared weeds and invader plants in the Dinokana Area.

According to Figure 5.3 most of the respondents, approximately 69% were unemployed. Approximately 2% was employees in government departments while 2% was employed by municipalities and 8% of the people were not in the labour market but are self employed, such as farmers (including headers and farm workers) or running small business of their own (e.g. tuck-shops or public telephones). Students represented approximately 9% of the population and 10% are employed by private companies, such as mining. The demographic information was an important element of this study to give a picture of the particular society under review in order to understand what type of lifestyle the communities could afford. This could have an important impact on whether people of the community can afford the control of WIP.

5.3 Indigenous knowledge of the declared weeds and alien invasive plants (WIP) in the local community

The knowledge of the people interviewed regarding declared weeds and alien invasive plants indicated that 84% knew that some of the plants are declared weeds and alien invasive species, while 91% of them indicated that some of these plants occur in their area. After analysing the response of the people regarding knowledge of WIP, 84% had more detailed information of the plants, while 91% indicated that the plants do occur in their area but their knowledge of these plants are limited. Most of the people did not know that the plants were declared weeds or alien invaders.

When a list of plants was shown to the people, many realised that they do know some of the plants and referred to them as declared weeds and alien invasive plants. The level of understanding of WIP was increased with the labelling of the plants. Figure 5.4 shows the knowledge of the people regarding different plant species that were identified in the area. According to Figure 5.4, a well known WIP species was *Opuntia imbricata* with 97% followed by *Eucalyptus* species with 95% of the respondents. The least known WIP species were *Nerium oleander* with 9% and *Lantana camara* with only 4% of the respondents. The knowledge of the interviewed people about other WIP species was regarded as being "fair". During the interview, people admitted to having planted declared weeds and alien invasive plants. For instance, in one of the stands the lady indicated that she used *Opuntia imbricata* as a fence around her house since she does not have money to purchase a fence. She however, did not know the name of the plant or the category of WIP under which the plant is classified. Other plants that people could not be identified were *Lantana camara* (only 4% indicated that they know it), and *Nerium oleander*. Only 9% of the respondents indicated that they were aware of these species (Figure 5.4).

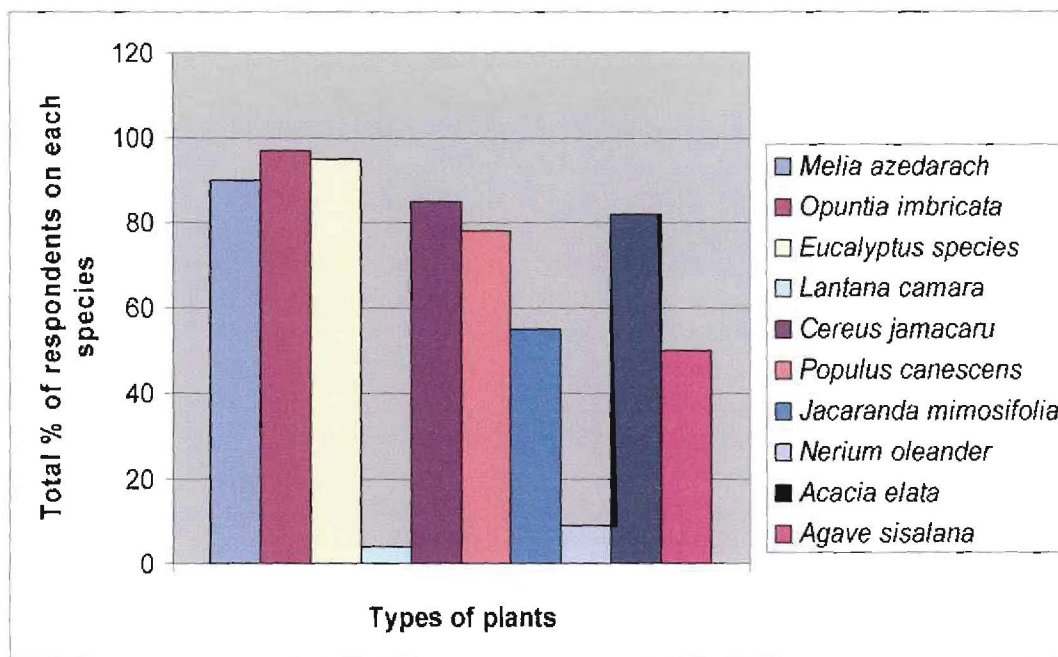


Figure 5.4: The indigenous knowledge of the local community (%) regarding different species of plants used in the study.

In order to test the knowledge of the local community of the study area at Dinokana, one of the question (Appendix A) referred to the people was to give the ratings of the occurrences of WIP after the different species were explained to them by the researcher, using the same plant species (Figure 5.4). The results of the ratings are given in Figure 5.5. The ratings were made after the different species were explained to the people by the researcher.

Table 5.1: Ratings of the degree of occurrences of different species of WIP by the local community in the Dinokana Area.

Plant species types	Very light infestation	Light infestation	Moderate infestation	Heavy infestation
<i>Opuntia imbricata</i>	3.51	15.79	40.35	40.35
<i>Eucalyptus species</i>	13.79	32.76	34.48	18.97
<i>Lantana camara</i>	0	33.33	0	66.67
<i>Cereus jamacaru</i>	7.69	23.08	40.38	28.85
<i>Populus canescens</i>	12.5	21.43	39.29	26.79
<i>Melia azedarach</i>	15.69	9.8	33.33	41.18
<i>Jacaranda mimosifolia</i>	27.91	16.28	37.21	18.60
<i>Nerium oleander</i>	45.45	36.36	9.09	9.09
<i>Acacia elata</i>	18.52	33.33	37.04	11.11
<i>Agave sisalana</i>	45.24	16.67	30.95	7.14

Not all of the people who participated in the research could score the plants in terms of the degree of infestations. Of the total of 100 people who participated in this study, only 57% could score the degree of *Opuntia imbricata* infestation. Only 4% gave it a rating of very light infestation, whereas 16% as light and 40% of the respondents scored the infestations as both moderate and heavy (Table 5.1). In general, the people of Dinokana regard their area to be moderately to heavily infested with *Opuntia imbricata*. This is because this species was planted along their fences to keep intruders out, since they are afraid of the spines of this plant. This was confirmed from the practical investigation as this plant surrounded a few yards which was shown by the data used to map the infestations.

Another invader plant was the *Eucalyptus* species where the community confirms that they are using it for shade. *Eucalyptus* trees are also used as a woodlot for fuel and construction. Approximately 58% of the respondents scored *Eucalyptus* species. Of the 58%, 14% rated the plant as very light infestation, 33% rated it as being light infestation and 34% rated it as being moderate while only 19% rated it as heavy infestation (Table 5.1).

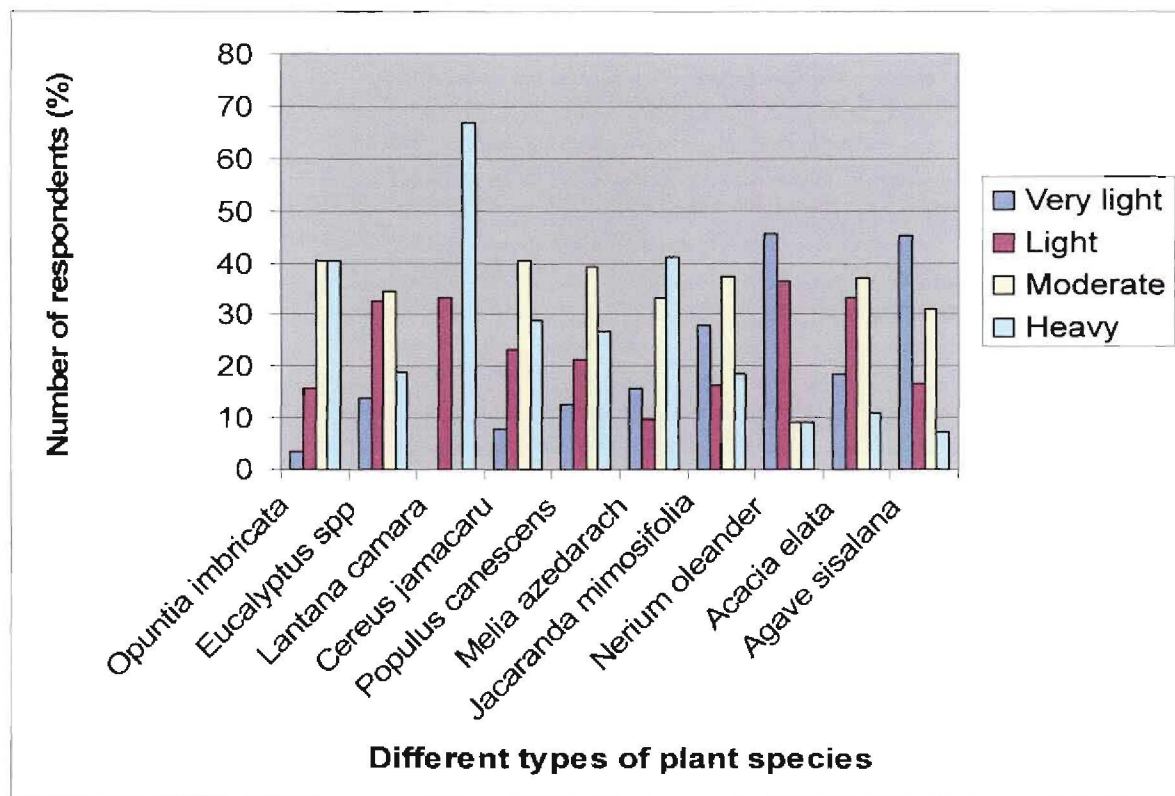


Figure 5.5: Ratings of the degree of occurrences of the different declared weeds and alien invasive species by the local community (% of respondents) in the Dinokana Area.

The general perception of the respondents was that the degree of infestation of the area by the plants is between light to moderate. *Eucalyptus* is classified as one of the plants where the land user or landowner can be granted a permit to grow them, provided that they can prove that they are not growing outside the demarcated area (National Department of Agriculture, 2001).

Heavy infestation of *Lantana camara* is found in the vicinity of the primary schools in the Dinokana Village along the tarred road to Gopane Village. Many people are however, not aware that this is an alien invader. Only 3% of the people in the village have noted that this plant grows locally. Approximately 33% of the respondents indicated that “they think” that the degree of infestation was light and 67% of the respondents had the “feeling” that there was a heavy degree of infestation (Table 5.1).

Cereus jamacaru is classified under category one (see section 2.1). The locals referred to this species as “Ngoro”. The people also indicated that the plant is directly linked to rainfall because they use the closing and opening of the flowers of this plant to predict rain. A total of 57% of the respondents participated in the rating of this plant. Approximately 8% of the people indicated that there is a very light degree of infestation (i.e. score 1), 23% said that there is a light degree of infestation of this plant in the area, 40% felt that the infestation of this plant in the area is moderate, while 29% of the respondents said that the infestation is heavy (Table 5.1). In general, the local community perceives the plant to be a problem in the area since most regarded this plant as being moderately to heavy infested.

Populus canescens was one of the most abundant plant species in the area despite the plants being the first to be targeted under the Working for Water (WfW) program of the Department of Water Affairs and Forestry (DWAF), Roodt (2003). The locals use the plant mainly for the construction of roofs and also for firewood. From the total of 56% of the respondents who rated the plant, 13% rated the plant infestation as very light, 21% rated the infestation as being light, 39% rated it as being moderate and 27% said that there is a heavy infestation of *Populus canescens* in the area (Table 5.1). There is a problem with these plants, especially along the streams between the Dinokana and Maramage Villages. As already highlighted, there are areas where some of the local people indicated that the trees are privately owned and no one will be allowed to eradicate them.

Melia azedarach is used by the local community for shade. Seedlings that grow outside the cultivated environment ultimately grow into bigger trees and start posing a problem, but the owners that are growing them inside their yards do not remove them. There were approximately 50% of the respondents who participated in rating the degree of infestations. Of these, 16% rated the degree of infestation as being very light, another 10% rated the infestation was light, 33% rated it as being moderate and 41% of the respondents said that there is a heavy infestation (Table 5.1). Some of these plants are managed and well looked after, but in some areas these plants grow outside the controlled sites.

Jacaranda mimosifolia was also identified at some sites in the study area. This plant is also planted mainly to provide shade. There were 43% of the respondents who gave their opinion regarding the infestation of this plant. Approximately 28% of 43% of the respondents were of the opinion that there is a light degree of infestation and therefore do not worry about the plant. Approximately 16% of the respondents felt that the infestation is light, while 37% of the respondents indicated that the infestation is moderate and 19% said that there is a heavy degree of infestation of this plant in the area (Table 5.1). The general interpretation is that *Jacaranda mimosifolia* is regarded as being light to moderately infested. The majority of the respondents indicated that there is an even distribution of this problem plant throughout the study area.

Most of the local community have planted *Nerium oleander* in their properties. They were unaware that this plant is classified as a declared weed and alien invasive plant. Therefore, only 11% of the people participated in rating this plant (i.e. *Nerium oleander*). Approximately 46% of the total (i.e. 11%) participants indicated that the degree of infestation is light while 9% rated the degree of infestation both as moderate and heavy (Table 5.1). *Acacia elata* and *Agave sisalana* were found in the stands as individual trees and were used for shade. Approximately 54% of the respondents took part in the rating of *Acacia elata*.

Light infestation of the plant in the area was rated by approximately 19% of the respondents (Table 5.1). A light infestation was indicated by 33% of the respondents while 37% indicated that there was moderate infestation and 11% indicated that there is heavy infestation (Table 5.1). The perception of the people is that there is a light to moderate degree of infestation of this plant in the area. Approximately 42% of the respondents participated in the rating of *Agave sisalana* and 45% of the 42% indicated that there is light degree of infestation, approximately 31% of the respondents indicated that the problem is moderate, while few of the respondents (7%) indicated that there is a heavy infestation of the area with this plant (Table 5.1). Generally, the perception of the people interviewed is that there is a very light degree of infestation of this plant in the area.

In summary, people believe that the declared weeds and alien invasive plants were found mainly near the households. This perception was supported by 56% of the respondents, whereas 23% believed that these plants were found where livestock is concentrated such as around watering points in the grazing area. Approximately 18% of the respondents indicated that the plants were found along the streams and only 3% indicated that the plants were found along the streets and the main roads. The people also believed that declared weeds and alien invasive plants usually occurred in areas with bare soil showing signs of soil erosion.

Approximately 71% of the respondents indicated that WIP occur in the area that has bare soil, 54% said that signs of soil erosion was also visible, while only 18% indicated that WIP occur in areas where there is a good grass cover. In appendix B some photos of the identified plant species within the study area are given, while the types and the categories under which these plants are classified are listed in appendix C (Henderson, 2001). According to the interviews, 44% of the respondents believed that the plants identified as WIP are not useful to the local community, while 56% believe the plants are of some use (Figure 5.6).

5.4 Problems with plant identification

The biggest stumbling block was the age of the people, especially when other languages than “Setswana”, were used. Younger respondents could read the names and easily understand them, unlike their older counterparts who could only speak and read in Tswana, which is the local language mostly used by the community members. The level of education was not seen as an important factor in answering the question dealing with the indigenous knowledge (Figure 5.2). The education of most of the respondents was not relevant regarding the identification of the plants. Due to the difference of plant names used in the different languages, the names were often not understood. For example, *Melia azedarach* is known as “mogolagodimo” in Tswana while others refers to it as “morolwana”.

This is especially significant for the planners and policy makers when formulating programs and policies governing the control of these plants as it can be realized from the discussions that sometimes problems occur not because of ignorance but because the local community has not been properly informed and are unaware of the problem due to the differences in names given to the plants. As indicated in the global strategy on invasive alien species (Jeffrey *et al.* 2004), awareness raising and education should be given high priority in the action plans while incentives for prevention of higher infestation rates are much needed.



Figure 5.6: People from the village of Boroathamadi fetching *Populus canescens* for roof constructions.

5.5 Attitude of the local community towards the control of declared weeds and alien invasive plants (WIP)

A serious concern identified was that the local community put a great value on the existence of some WIP plants, such as the *Populus* spp, which proves that there is still a big miscommunication between the people and the Government Departments in the sense that the Government identified this plant as a problem for resource management, whereas the whole community in this area regards the plant as being important to them, for different uses as already outline elsewhere in this document. When respondents were approached with the policies and legislation on the land, they become violent, making the approach unacceptable. Approximately 64% of the respondents believed that the land can be used for agricultural purposes, such as food gardens, while 36% indicated that the land is too small to be used for other purposes and that WIP may be a problem.

The main concern was that the land was communally owned and the people would prefer the land to be used for housing and not for agricultural purposes due to continuous population increase continually and limited space.

5.5.1 Use of land

According to perceptions of the respondents, the land was initially mainly used for agricultural purposes, either for cultivation or for grazing. The areas which were previously cultivated are mainly invaded by *Populus canescens*. The respondents indicated further that the declared weeds and alien invasive plants are mostly found in the stands near households and therefore do not interfere with their livestock in the grazing fields.

In terms of the control of WIP, the local community agreed that the control of these plants should be a priority. Approximately 63% of the respondents indicated that they support the control of WIP, whereas 37% indicated that they do not think that it is important to control WIP.

5.5.2 Control of WIP

Social, economic, as well as political factors are linked to the lack of commitment by the local community to control declared weeds and alien invasive plants (Figure 5.7). Approximately 47% of the respondents indicated that the social factor was the reason for lack of commitments towards the control of WIP. According to Figure 5.7, approximately 42% of the respondents indicated that economic factors was of important while 12% indicated that political factors was important for lack of commitment to control WIP and approximately 18% responded by indicating that a combination of the factors mentioned above (Figure 5.7). The local community felt that they would not concentrate on controlling declared weeds and alien invasive plants as they receive no compensation for their work.

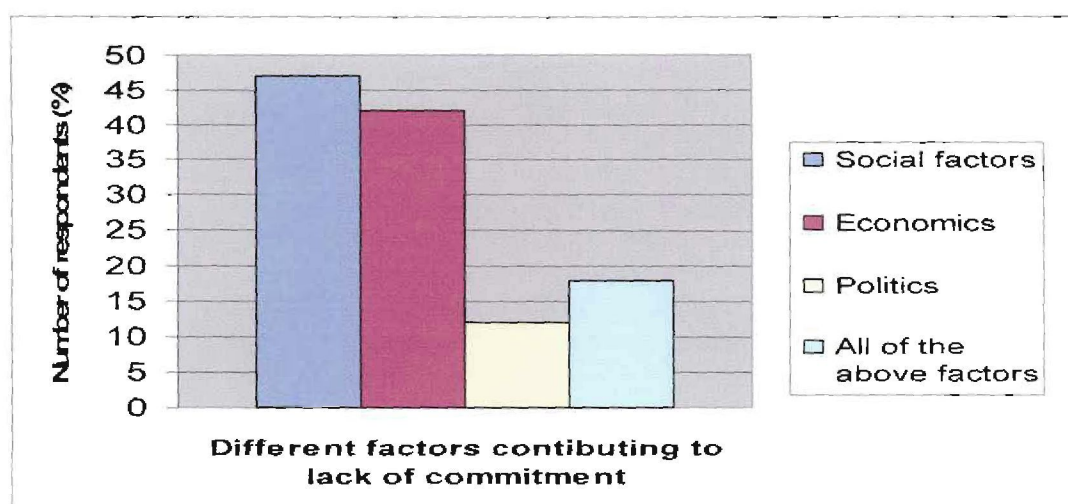


Figure 5.7: Factors that contribute to lack of commitment by the local community in controlling declared weeds and alien invasive plants (WIP).

Most respondents who were willing to control WIP prefer mechanical methods, mainly as this method are labour intensive and would contribute to the employment of the local people. This argument was supported by 42% of the respondents, while about 35% supported the use of the herbicides (Figure 5.8).

The use of herbicides was mainly preferred by the people who understand or who know how to use herbicides, although they fear that the herbicides might also affect the activities of some of the bacteria found in the soil. The local community support the use of herbicides, mainly because they said that the herbicides were effective and quick to give visible results. Therefore, those in favour of the use of herbicides indicated that thorough training would be required, especially in ensuring the safety of the people who will be using the herbicides as well as ensuring that the correct application methods are used. This would help to prevent the contamination of surface and underground water. The Department of Agriculture used the Monosodium Acid Methane arsonate (MSMA) to control *Opuntia* species which is the only herbicide that the Department is using and this is the herbicide that they are giving subsidy for.

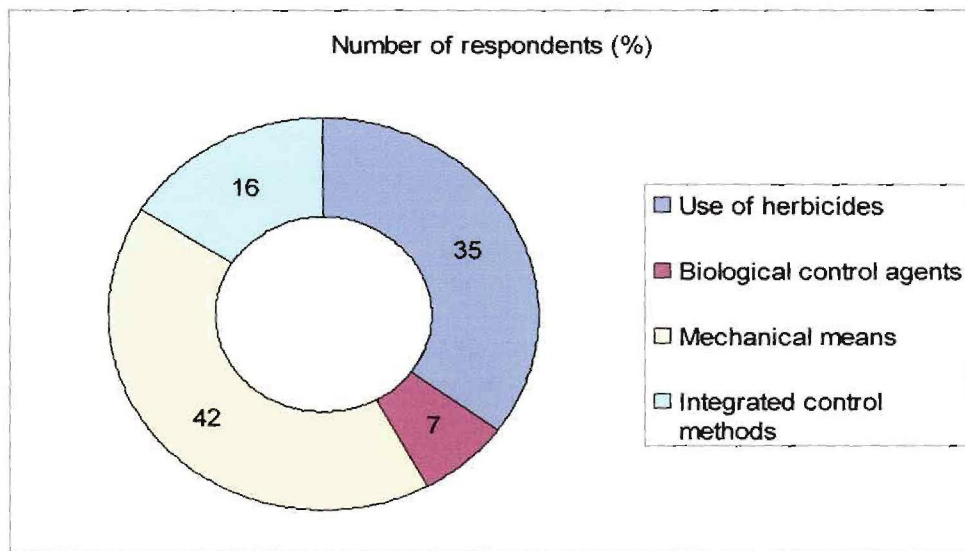


Figure 5.8: Response of the local community regarding the use of different control methods for declared weeds and alien invasive plants.

There is a limited knowledge among the community regarding the use of biological control agents. Approximately 7% of the respondents supported the use of the biological control agents (Figure 5.8). The local community also felt that the biological control agents normally take long time before any positive results can be seen, especially when a fully matured plant is treated. Approximately 16% felt that an integrated method of control should be used (Figure 5.8).

5.6 Support by the Department of Agriculture for the control of WIP

Another factor considered during the study was to investigate whether the communities support the control of WIP in their areas according to the approach subscribed by the Department of Agriculture, where the people of a specific area are expected to purchase the herbicide while the Department only subsidises them.

5.6.1 Department of Agriculture Subsidy Scheme

The general feelings is that, if the government strongly believes declared weeds and alien invasive plants to be a threat to the environment or to the people, then the government must put the necessary mechanisms in place to support the policy, rather than only having a policy without any supporting mechanisms. The community felt that, since there is a high rate of unemployment, the control of WIP should be used as a means of uplifting them through job creation projects, thereby making them more involved in the programs of the Department of Agriculture, rather than forcing them to control WIP through the Act.

If the government still uses a “top down” approach and forces people, they tend to resist, which will eventually lead to a failure of the control program. For the community to participate in the subsidy scheme of the Department of Agriculture in acquiring the herbicide to control WIP in their area, they are obliged to pay a certain amount of money to the government.

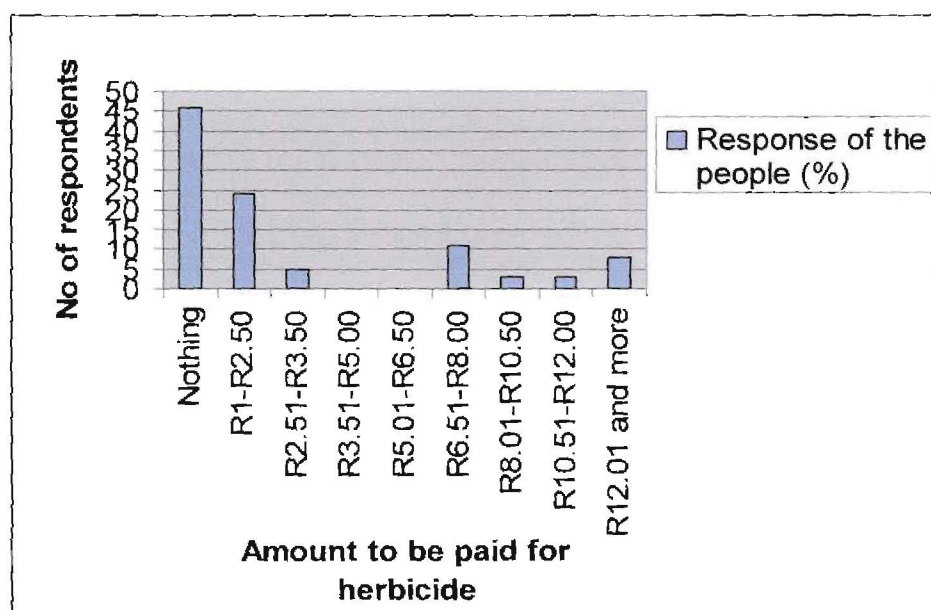


Figure 5.9: The response regarding the amount of money that the people are willing to contribute for the purchasing of the herbicides.

People of Dinokana were asked how much they were willing to contribute if they make use of the subsidy scheme (Appendix A: C6). Figure 5.9 indicated the response of people regarding their willingness to pay. Approximately 46% of the total respondents said they will not contribute anything, while 24% said that they can pay between R1.00 and R2.50 per litre of herbicide (Figure 5.9). A further 11% indicated that they will be willing to pay between R3.51 and R5.00 per litre of herbicide. The total price that the Department of Agriculture is expecting them to pay is R10.69 (Figure 5.9).

The majority of the respondents (64%) indicated that they were not willing to volunteer to control WIP without any form of rewards (Figure 5.10). Approximately 36% indicated that they will volunteer, if they were asked and this will be on condition that they are employed (Figure 5.10). Therefore, it can be concluded that the majority of the people are of the opinion that they will not take part in the control of WIP if there is no comprehensive approach from the Department of Agriculture. The control of WIP is mainly mandated to the National Departments, including the Department of Water Affairs and Forestry as well as the Department of Agriculture.

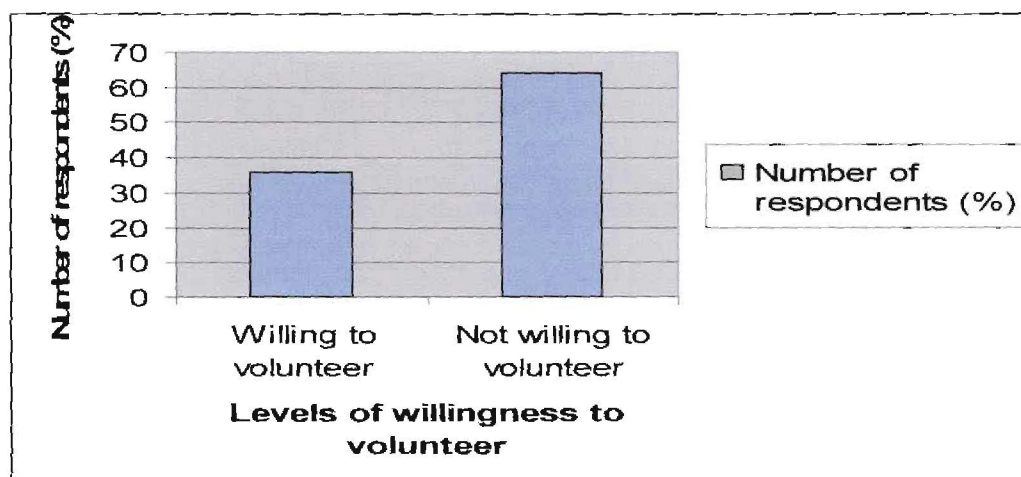


Figure 5.10: Respondent's willingness to volunteer in the control of declared weeds and alien invader plants.

These Departments are therefore tasked with the administration of the Acts, which include the National Water Act (No 36 of 1998) and the Conservation of Agricultural Resources Act (No 43 of 1983). The local people (81%) also felt that some of these responsibilities could be shifted to the local Government, while 38% said that the control of the WIP should be left with the Provincial Departments (Figure 5.11). Only 30% expressed the view that the National Department should be responsible for the control of WIP (Figure 5.11).

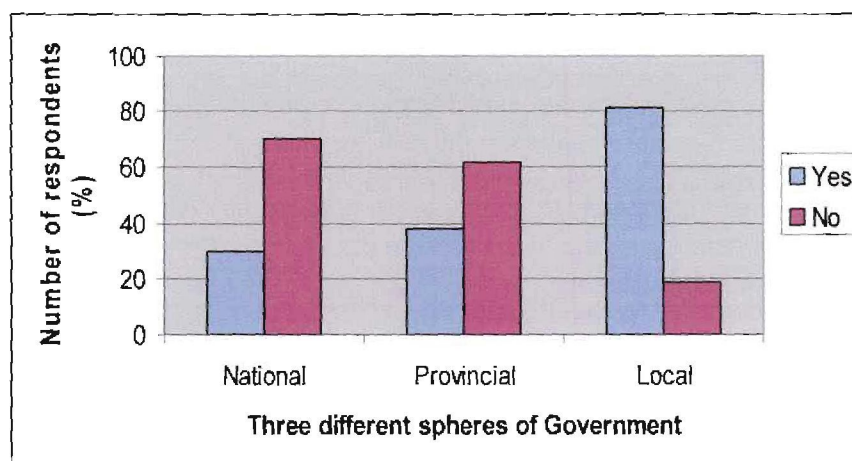


Figure 5.11: Respondents perception towards the roles of the three sphere of Government in the control of declared weeds and alien invader plants.

5.6.2 Government WIP programs

The knowledge of the members of the community of Dinokana regarding the different programs of the government, especially the Departments of Agriculture and Water Affairs and Forestry, to control declared weeds and alien invader plant species was investigated. Five programs were identified and include:

- The National Land Care program.
- The social grants.
- Prevention of mother to child treatment programs.

- The Working for Water program, as well as
- The Working for Wetlands program.

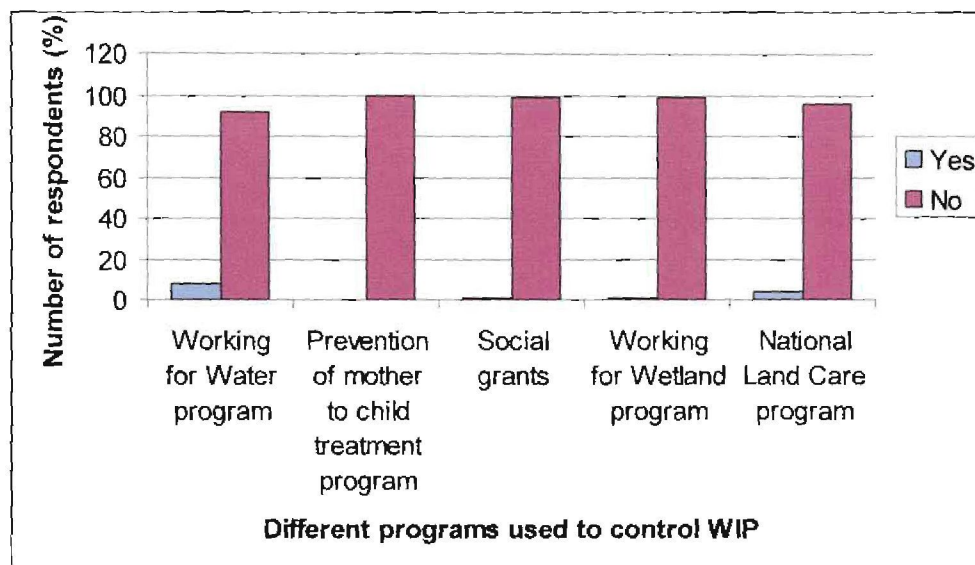


Figure 5.12: Respondents (%) knowledge with regards to the different programs used to control declared weeds and alien invader plants.

Only 11% of the respondents indicated that they were aware of all the above listed programs addressing the control of WIP, while 89% indicated that they have no idea of these programs. According to Figure 5.12, approximately 8% of the respondents indicated that they were aware of the Working for Water program, as they used to work for this program, although they were given little information about its aims. The only information given to them was that they utilise substantial quantities of underground water. According to Figure 5.12, approximately 4% of the respondents indicated that they were aware of the National Land Care program while only 1% of the respondents were aware of the Working for Wetlands (Figure 5.12). Despite the fact that the Department of Agriculture had launched the Land Care program in most parts of the Lehurutshe District no people from the community attended the launching, except the chiefs and members of the local tribal authority.

This might be attributed to poor communication between the planners of the launching of the program and/or that they did not have the knowledge that there will be launching of such a program in their district. Therefore, this poor participation resulted in poor dissemination of information that could have contributed to better understandings of what the Department mandates and strategies are all about.

The Land Care Program is meant to be a community initiative and a government supported program. Currently the Department of Agriculture is changing the focus of Land Care towards increasing the awareness of the community regarding better management of their land. Although the two programs, i.e. Working for Water and Land Care, have a common goal, i.e. to ensure the sustainable management of the natural resources through creation of jobs, capacity building and poverty alleviation, it is clear that the Working for Water program is better known to the community than the Land Care program (Figure 5.12). The Working for Water program is for example only known as "*Namola leuba*", meaning "drought relief", just because it has created jobs for the people. Some people will not even call it "*Namola leuba*" but will only show you the T-shirts of WfW they obtained at the launching of the program without any knowledge on the aims of the program.

The other two programs were only included to trick respondents to see whether they will relate them to WIP. Unfortunately 1% of the respondents indicated that the social grants have some relationship to the control of WIP. These two programs were the "Social grants" as well as "Prevention of mother to child treatment programs" (Figure 5.12).

No respondent had any knowledge regarding the aspects of policies dealing with the prevention of the proliferation of WIP species in the country. It is generally perceived by this research that many of the people are not interested in familiarising themselves with policy matters.

5.7 The densities of WIP in the study area

5.7.1 Introduction

Investigating the density of WIP in the study area was another method of research that would be employed. The density of WIP was conducted in order to determine whether there is uniform distribution of the problem in the area. However, since some of the plants were growing individually, it will be important to only count them since they were scattered throughout the area making it impossible to determine their effect in terms of how much area is affected.

5.7.2 Maramage Village

The vegetation was monitored in two sample plots in the Maramage Village (Figure 5.13). The area of sample plot one (plot 1) was 8ha in size and that of sample plot two (plot 2), 1.4ha. The density of *Populus canescens* in plot 2 was 92842.5 TE/ha. The dominant height class was between >1 and 2 metres with 29187.5 TE/ha, with only a few trees in the lower class of <0.5 metres (2227.5 TE/ha) (Figure 5.14). There were >0.5 to 1 metre with 14562.5 TE/ha, >2 to 3 metres with 15447.5 TE/ha, >3 to 4 metres with 13980 TE/ha and >4 metres with 17437 TE/ha (Figure 5.14).

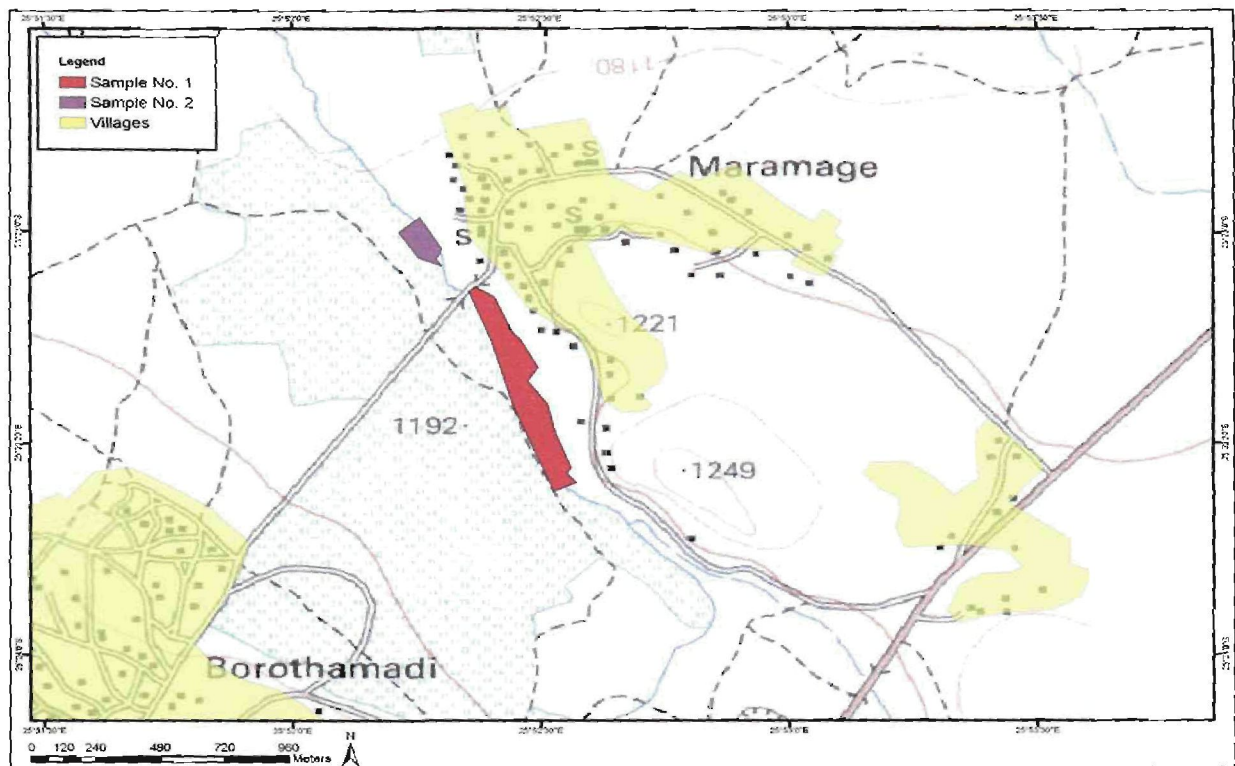


Figure 5.13: Two plots at Maramage Village where vegetation sampling of *Populus canescens* was carried out.

According to Figure 5.14, there were more *Populus canescens* than any other WIP (e.g. *Melia azedarach*) in the village. Sample No 2 was also characterized by the invasion of *Melia azedarach*. There were only three height classes of this species, i.e. >1 to 2 meters (375 TE/ha), >2 to 3 metres (626 TE/ha) as well as >4 metres with 187.5 TE/ha, with a total of 1188.5 TE/ha (Figure 5.14). Therefore, in general, *Melia azedarach* was not an important contributor towards the invasion of WIP in the village. However, should there be a plan to control these species, trees in the height class of >2 to 3 metres should be controlled first because there are more trees in this height class, followed by individuals within height classes of >1 to 2 metres (Figure 5.14).

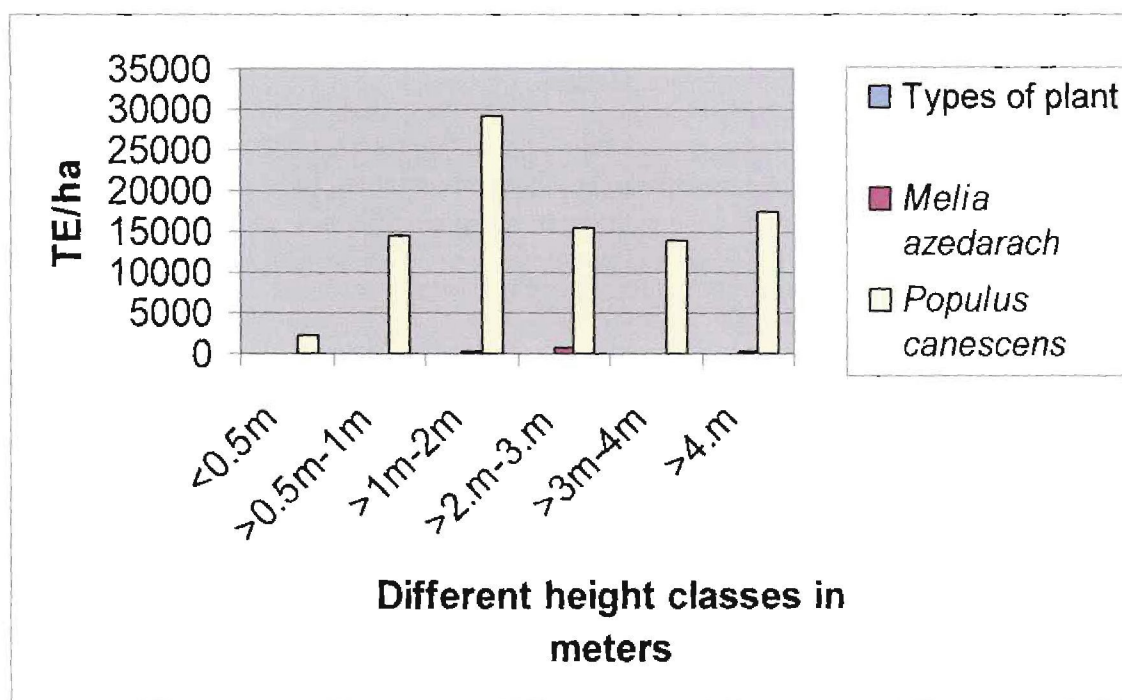


Figure 5.14: Densities (TE/ha) of *Populus canescens* and *Melia azedarach* for different height classes (m) for Sample No 2, in the Maramage Village (right hand side of the road).

Populus canescens and *Melia azedarach* were identified in Sample No 1. *Melia azedarach* trees with a maximum height class of >1-2 meters occurred at a density of 125 TE/ha while *Populus* spp. occurred at a density of 109 356 TE/ha (Figure 5.15).

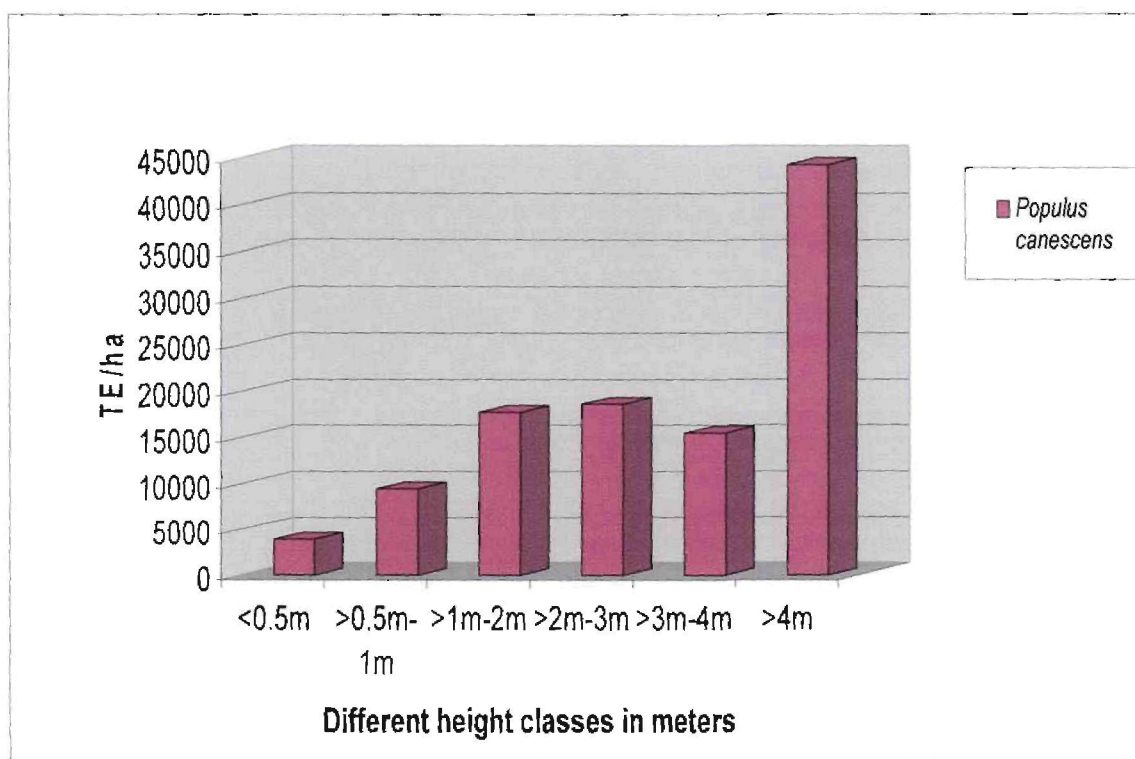


Figure 5.15: Densities (TE/ha) of *Populus canescens* for different height classes (m) for Sample No 1 at Maramage Village (left hand side of the road).

The density of *Populus canescens* trees higher than 4 meters was 44250 TE/ha, and represented the highest density of all the height classes (Figure 5.15). This was followed by trees within the >2-3 metres height class with 18625 TE/ha and then the >1-2 metres height class with 17750 TE/ha (Figure 5.15). There were fairly few trees in the height class of >3-4 metres with 15436 TE/ha. The difference between the other height classes, i.e. >0.5-1 metres as well as <0.5 metres were not contributing much to the problem of WIP invasion. Trees within the >0.5 to 1 metre height class occurred at a density of 9438 TE/ha, while trees smaller than 0.5 metres high occurred at 3857 TE/ha (Figure 5.15).

5.7.3 Dinokana Village

The WIP occurrence was also mapped in Dinokana Village. These plants were not quantified (TE/ha), but their infestation were noted and is presented in Table 5.2.

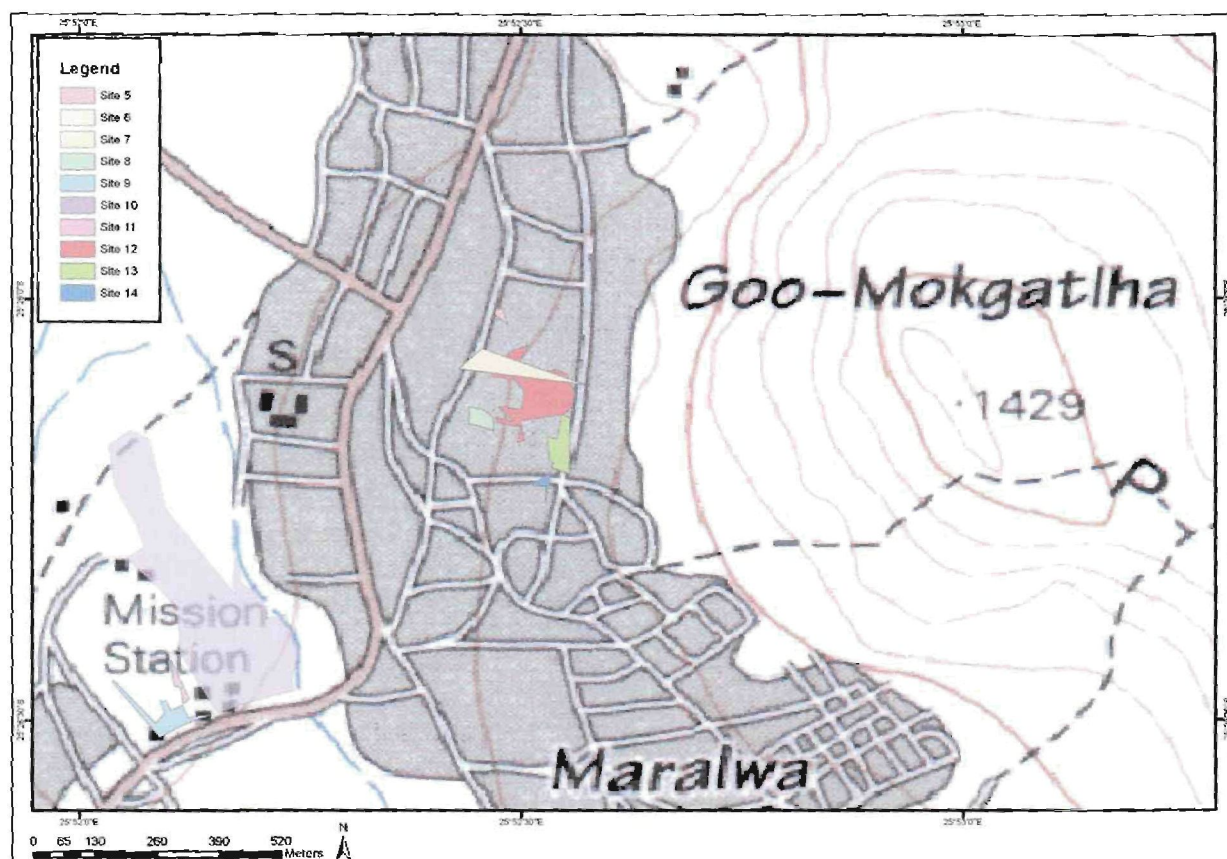


Figure 5.16: Map showing ten (10) sites where vegetation monitoring was carried out and WIP identified within the Dinokana Village.

Table 5.2: The rate of infestation of all WIP species at the different sites in Dinokana Village.

Side label	Type of WIP species	Degree of infestation	Size of the plot (ha)
Site 1	<i>Opuntia imbricata</i>	100%	0.035
Site 2	<i>Agave sisalana</i>	95%	0.083
Site 3	<i>Opuntia imbricata</i>	10%	0.005
Site 4	<i>Opuntia imbricata</i>	80%	0.276
	<i>Cereus jamacaru</i>	10%	
	<i>Eucalyptus spp</i>	30%	
Site 5	<i>Opuntia imbricata</i>	34%	0.038
Site 6	<i>Acacia elata</i>	15%	0.597
	<i>Melia azedarach</i>	1%	
Site 7	<i>Lantana camara</i>	50%	0.028
	<i>Opuntia imbricata</i>	20%	
Site 8	<i>Opuntia humifusa</i>	60%	0.169
Site 9	<i>Eucalyptus spp</i>	28%	0.416
	<i>Melia azedarach</i>	12%	
	<i>Lantana camara</i>	68%	
Site 10	<i>Jacaranda mimosifolia</i>	30%	8.139
	<i>Casuarina cunninghamiana</i>	10%	
	<i>Melia azedarach</i>	10%	
	<i>Lantana camara</i>	90%	
	<i>Cereus jamacaru</i>	5%	
Site 11	<i>Lantana camara</i>	70%	0.091
Site 12	<i>Opuntia imbricata</i>	90%	1.397
Site 13	<i>Opuntia imbricata</i>	75%	0.375
	<i>Opuntia humifusa</i>	75%	
	<i>Agave sisalana</i>	75%	
Site 14	<i>Opuntia humifusa</i>	90%	0.055

The results for survey 5 are given in Figure 5.18. *Populus* spp. was prominent at a density of 70336 TE/ha, while *Lantana camara* occurred at a density of 3 500 TE/ha. The majority of the *Populus* spp. were higher than 4 metres and occurred at 28125 TE/ha. This was followed by the height class between >3 and 4 metres with 21250 TE/ha. There were a few of these plants in the height class of <0.5 metres which only contributed 1774 TE/ha (Figure 5.18).

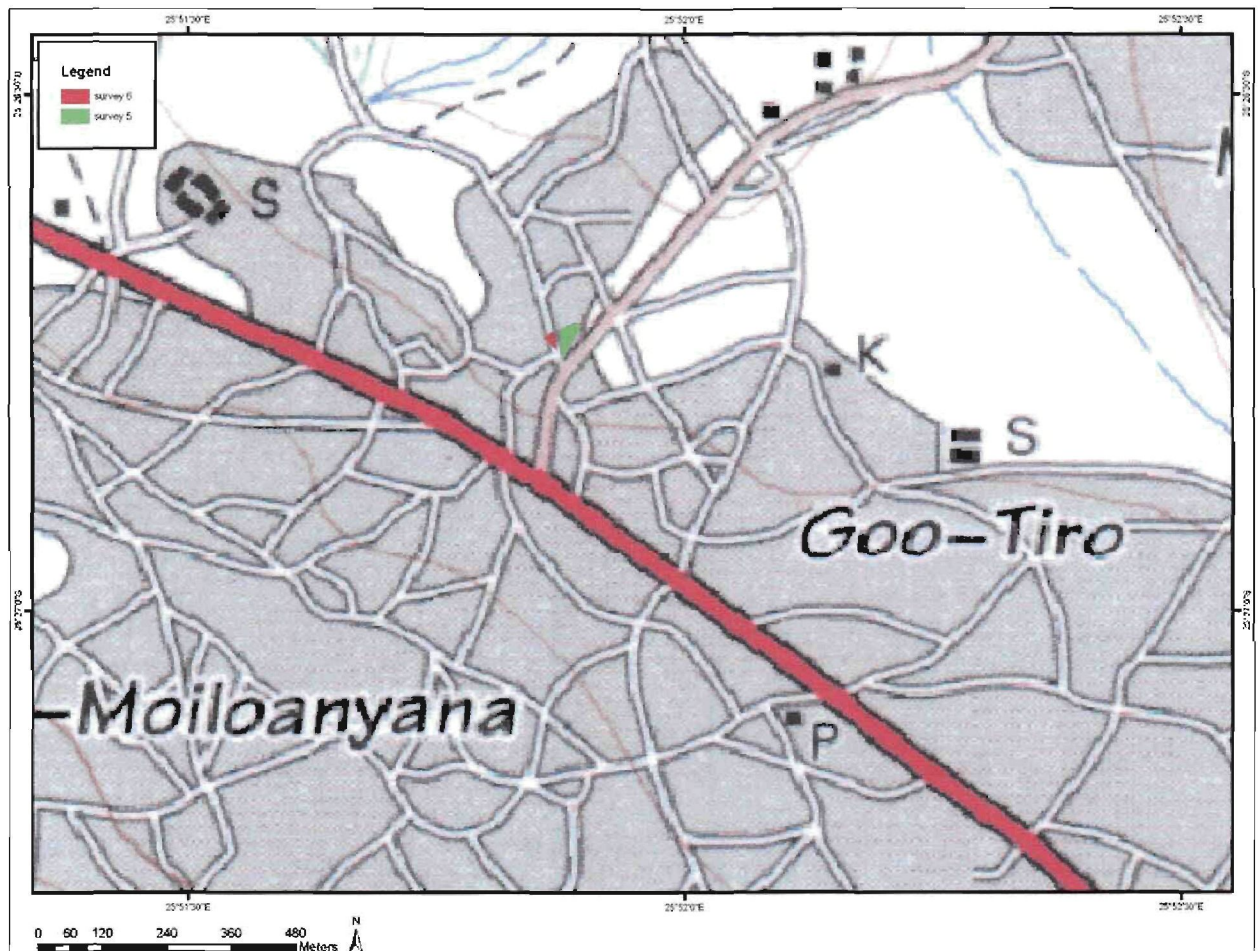


Figure 5.17: Map showing two (2) sites where the densities of only the dominant WIP species were established (surveys 5 and 6) in the Dinokana Village.

There were only three height classes (>0.5-1 metres, >1-2 metres as well as >2-3 metres) for *Lantana camara* (Figure 5.18), therefore its contribution to bush encroachment was minimal compared to *Populus canescens*. The area covered by this species was 0.116 ha.

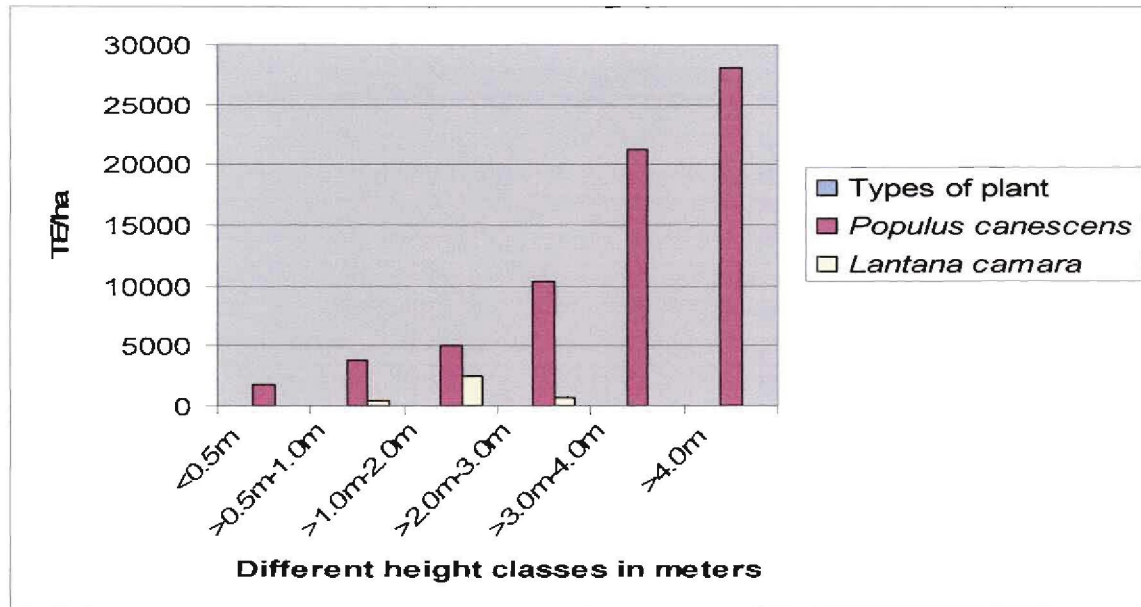


Figure 5.18: The density of *Populus canescens* and *Lantana camara* (TE/ha) for the different height classes for survey site 5 in the Dinokana Village.

The second survey site at Dinokana Village (Survey 6) as indicated in Figure 5.17 and the results are presented in Figure 5.19. The total size of this area was 0.035 ha (Table 5.2). There four different WIP species which includes *Populus* spp. *Lantana camara*, *Asparagus* spp. and *Melia azedarach*. The occurrence of *Lantana camara*, *Asparagus* spp. and *Melia azedarach* was limited. *Melia azedarach* trees with a maximum height of 4 metres occurred at a density of 375 TE/ha. *Populus* spp. with a maximum height of more than 4 metres occurred at a density of 15937 TE/ha, followed by individuals within height classes of >3-4 metres with a density of 11213 TE/ha (Figure 5.19).

Trees smaller than 0.5 metres high occurred at 1237 TE/ha, trees within >0.5-1 metres height class occurred at a density of 1125 TE/ha as well as >1-2 metres at a density of 4125 TE/ha, while trees in height class of >2-3 was 29225.

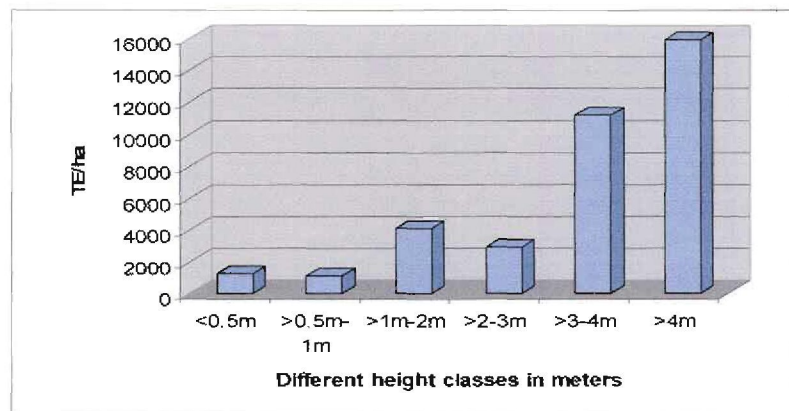


Figure 5.19: The density of *Populus canescens* for different height classes for survey site 6 in the Dinokana Village.

5.8 Comparison between qualitative and quantitative results

Through the interviews, the community of Dinokana generally indicated that there are moderate to heavy infestations of the *Opuntia imbricata* (Appendix A: B5) in the area. The quantitative vegetation assessment results, however, indicated that only 2.146 ha were infested with these plants. It is important to indicate that not all the community members interviewed during the study experienced the same problems of infestation of the area with the plants.

The other communities did not have the same problem that their villages were infested with *Opuntia* spp. invasions. The *Opuntia* stands that were identified at the Matlhase, Madutle and Khunotswana Villages were in natural veld and they were highly scattered, therefore less observed by the local community. Since the problem is mainly in the Dinokana Village, any form of control intervention mechanisms should be concentrated there. The infestation of *Eucalyptus* species is perceived to be from very light to light.

The impression by the local community is that this plant is not a serious problem in the area. They occurred mainly in stands (yards) of the houses. This means that they were planted purposefully by the land users for different reasons. There is a relationship between what the people were saying and what the vegetation survey results were, since most of the respondents rated the infestation between moderate and heavy (Figure 5.5), while vegetation survey indicated various TE/ha and this are represented in Figure 5.14, 5.15, 5.18 and 5.19.

There was a question regarding the rating of the plants and *Cereus jamacaru*, whereby the people perceived the plant causing a moderate to heavy infestation. However, through vegetation survey *Cereus jamacaru* identified was not identified. Most of the plants were noticed in homesteads. Since these plants (*Cereus jamacaru*) was not identified in the grazing land or open areas where the small stock are normally grazing, it was not regarded as an important contributor to the infestation of the area, provided that those people who are in possession of the plants takes precautionary measures to ensure that the infestation does not get out of control.

The people's perception regarding *Populus canescens* was estimated as moderate to heavy infestations. The vegetation sampling for *Populus canescens* was conducted mainly in the stream areas, at the Maramage and Dinokana Villages. About 9.4 ha of *Populus canescens* was observed in Maramage Village alone. There was also *Populus canescens* at Dinokana Village. *Populus canescens* was observed in Dinokana and Maramage alone. Dense stands of this plant were however observed with *Melia azedarach* in most instances. Both these species were used by the local community for shade, construction and fuel purposes.

5.9 Summary

- Demographic information

There majority (56%) of the respondents was female. Most local people are unemployed (69%). This implies that people concentrated on gathering resources for their daily need. Approximately 54% of the respondents have between Grade 12 to higher education qualifications.

- Indigenous knowledge

The local people possessed a fair amount of knowledge of declared weeds and alien invasive plants. There was however less information regarding the occurrences of *Nerium oleander* and *Lantana camara* as compared to other WIP species identified within the study area. They knew where the plants occur and they are also using it for different purposes. The indigenous knowledge of the respondents and their perception of WIP were determined and presented in different Figures. Obstacles during interviews included knowledge of the local language and the common names of the WIP plants that were studied, especially as these WIP species are known with different names than the common names written in various literature materials.

- Control of the declared weeds and alien invasive plants

Many people indicated that they will not participate in the control programs especially if there will be no incentives. The respondents indicated that they prefer the mechanical WIP control as it is labour intensive, and if applied with incentives, many people will be employed. The respondents indicated that the application of herbicides as the people indicated that it is more effective was suggested, but it seems expensive to purchase.

The respondents indicated that they were unwilling to subsidize the buying of herbicides. The respondents indicated that they were not aware of programs of the different Government Departments that are used the control of WIP.

- Policy awareness

There people interviewed had no knowledge of policies dealing with the control of WIP in the country.

- Vegetation sampling

The most affected villages were Maramage and Dinokana. WIP found in these areas includes *Populus canescens*, *Melia azedarach* and *Lantana camara* along the rivers. In other seven villages trees were occurring in a singular form especially in open spaces and in yards. *Opuntia* plant species was mainly observed in Dinokana Village.

CHAPTER 6

CONCLUSION AND RECOMMENDATION

6.1 Introduction

The aims of the study were:

- a) To assess perception and attitudes of the indigenous knowledge of the local community towards the declared weeds and alien invasive plants (WIP).
- b) To carry out a vegetation survey to quantify the abundance of the different WIP species and compare the perception and attitudes of the indigenous knowledge by the community of Dinokana area.
- c) To formulate recommendations for the existing programs of WIP control.

6.2 Perception and attitudes of the indigenous knowledge.

Land degradation especially in the communal land is “multifaceted”, i.e. the cause is not attributed to one factor alone. The approach to deal with it need to include considering the history of the country, which lead to overcrowding of people in certain areas, putting more pressure on the natural resources. The knowledge of the people regarding WIP in the study area indicated that some plants are known, therefore this make it difficult for people to know whether they are planting a WIP species or indigenous species. This limited knowledge resulted in more WIP being planted than the indigenous species.

The use of the local language is important in assisting the community to understand the nature of the particular study being undertaken. It was clear that elderly people could not read and easily understand different names of WIP.

Although younger people could read, this did not assist them as their knowledge regarding WIP was limited. There is limited knowledge regarding the impacts of WIP to the environment. This problem is one of the major obstacles for the understanding and giving value to reasons why they need to control these declared weeds and alien invasive plants.

The problem of invasion by declared weeds and alien invasive plants (WIP) was found to be mainly near the households. As many WIP plants are also used by the local community for their livelihoods, these plants are not controlled and not seen as invaders. For example, some WIP are used for firewood, medicinal purposes, shade or for the construction of roofs. The local people therefore, do not remove trees such as *Populus canescens*, as it would force them to start buying building materials which they are now able to access from the natural veld. The perception and attitude of the people is that “someone else” introduced most of the WIP species in these areas and therefore “those people” are responsible to control them. They therefore indicated that they will not participate in the control of these plants, and not contribute to the purchasing of herbicide even through the subsidy scheme of the Department of Agriculture. The community members also felt that the Local and National government in general are not doing anything for them, which contributes to the reason why they do not allow the National initiatives such as the Working for Water program to work in their area without giving them the first priority, in terms of employment opportunities.

Some WIP plants are still being planted, mainly for shade or construction purposes, which indicates that in order to deal with the eradication of these plants is often not achievable. The attitude of the local community regarding the control of WIP often leads to a serious miscommunication between themselves and the Government Departments. These Departments are implementing policies and legislation to regulate proliferation of WIP, which are not known or understood by the local community members.

The Department often used these instruments (such as policies and legislation), more than other acceptable approaches, in addressing the problems caused by WIP, which leads to making the people angry and negative towards Government initiatives. The local people believed that since unemployment and poverty level was high, Government Departments need to use the environmental problems to assist them in the alleviation of poverty through some forms of incentives.

If herbicides were used, the community needs to purchase it through the Department of Agriculture's subsidy scheme. Most people are unwilling to pay, especially if they still have to volunteer to spray the plants with herbicides without any compensation. The biological methods to control WIP is unknown by the local community. This is a major setback which is not understood by the community. The promotions of the use of biological control methods are cheaper while contributing to a safer environment. These biological agents are often not readily available and are often not adapted to a particular area, especially in most parts of the North West Province due to its dry weather conditions. The areas currently invaded with WIP were previously used for agriculture, mainly for the cultivation of crops and grazing for livestock. Since these areas are no longer used for cultivation, they became open niches for WIP invasions.

The researcher investigated what factors contribute to a lack of commitment towards controlling WIP. These include economic, political, and social factors as well as combination of these factors. It was clear that social and economic factors are prevailing factors which contribute to the lack of commitment of the people to address the WIP problem. These factors also contribute to the lack in understanding of the impacts by WIP on the environment and the high rate of unemployment and poverty of the members of the community.

Other programs implemented by the National Government, include the weed subsidy scheme, which is mainly used to control *Opuntia* species. Other programs include Land Care which is the responsibility of Department of Agriculture as well as Working for Water and Working for Wetlands program, which are both falls within the implementation mandate of the Department of Water Affairs and Forestry.

6.3 Comparison of vegetation survey with perception and attitudes of the indigenous knowledge.

Following the discussion, it was clear that the two main villages infested with WIP were Maramage and Dinokana. At Maramage, the density of *Populus canescens* was the most prominent species in these villages. The density of *Populus canescens* trees higher than 4 meters was 44250 TE/ha. This was followed by individuals within height classes of 1 to 2 meters with 29187 TE/ha. At Dinokana, there was 70336 TE/ha of *Populus canescens* trees (Figure 5.18: Survey 5) and the density for *Lantana camara* within the class height of 1 to 2 was 2500 TE/ha (Figure 5.18). The most important height class was trees higher than 4 meters. The degree of infestation and height classes are discussed in chapter 5. The classification of plants into three different categories according to Conservation of Agricultural Resources Act (No 43 of 1983), e.g. category one up to category three plants (Chapter 2), is still a problem for the community.

6.4 Recommendations

After the results for this study have been analysed, the following recommendations to improve the perception and attitudes of the local community of the Dinokana Area are proposed:

- Capacity building must be improved. The emphasis should be more on awareness raising, training and support programs. The awareness of WIP in schools and through other means of programs to reach the youth, such as the Land Care should be encouraged. All Government Departments and not only the Department of Agriculture must be involved in the awareness and initiation of control actions, using programs applicable to a specific problem. The Department of Agriculture must therefore continuously seek partnerships with other Government Departments.
- Tribal chief's responsibilities on all aspects in controlling WIP, even if the land is not registered in his/her name, should be emphasised.
- Comprehensive information should be obtained regarding the conditions on which communal land was given to communities and/or tribal chiefs to ensure more power and liabilities or responsibilities. This might help to let everyone having a better understanding of the problems regarding WIP occurring in these areas.
- There is a need to carry out research to investigate how the land could be used more productively to let everyone benefit from it and to what extent is the agricultural land infested with WIP, and not only around the living area.
- Based on a lack of commitment from the community to control WIP, it is necessary for institutions to take into account other challenges facing the community. Sometimes WIP control may not be a priority for the local people as they do not address issues, such as poverty, unemployment and health. Institutions should therefore also invest in these latter issues before addressing the WIP problems.
- WIP control programs, such as Working for Water, should be expanded to other places and not only concentrate on the catchment areas.
- Government programs should be better co-ordinated which should lead to increased communication between Government programs and initiatives on provincial, local and national level.

- If the livelihood and poverty issues are addressed by e.g. employment through Government initiatives such as Land Care and Working for Water, the people would have more money to purchase herbicide through the Department of Agriculture's WIP subsidy scheme.
- Better the understanding of the problems caused by WIP, to discourage the local people to plant these plants in their homesteads for other uses, and to propose alternative indigenous species.
- The Municipal Integrated Development Plans (MIDP), should include mechanisms to conserve biodiversity, since some municipal development takes place in areas which are environmentally sensitive, thereby ignoring their Spatial Development Framework (SDF).

It was surprising to find during the study that most of the local community are planting the different WIP species and that they are using them for various functions. Also that there are lot of perception that leads to failure of the locals to control the plants, such as that the person who introduced the plants should be the one to get rid of them.

CHAPTER 7

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APPENDIX A

QUESTIONNAIRE FOR THE INDIGENOUS KNOWLEDGE OF THE LOCAL COMMUNITY TOWARDS WEEDS AND ALIEN INVASIVE PLANTS IN THE DINOKANA AREA, NORTH-WEST PROVINCE, SOUTH AFRICA.

By:

Kebalepile Benedict Itholeng

(12671533)

To the community of Dinokana Area

2008

INSTRUCTION

- Please read the instructions or introductory note carefully before attempting to answer the question.
- Please answer the questionnaire carefully and legibly.
- Make sure you answer all question, unless otherwise indicated.
- Assurance is given to respondents that all information will be treated as confidential and as objectively as possible.
- The responses will be used for research only
- All relevant representatives of the community organization will be informed about the survey in the village, and this message will be communicated to the respondents to assure them that nothing is done against the will of the villagers.
- The purpose of the survey is to investigate the perception and attitude towards declared weeds and alien invasive plants of the people of Dinokana.
- Please mark with a tick in the applicable box where appropriate.
- Please ensure that numerical rating or scaling questionnaires are answered appropriately, e.g. where ratings are from 1 till 4,5 or 6.

SECTION A

Demographic Information.

1. What is the gender of the respondent?

Male	1	
Female	2	

2. What is your age at your last birthday?

Less than 25	1	
Between 26 and 36	2	
Between 37 and 47	3	
Between 48 and 58	4	
Between 59 and 69	5	
70+	6	

3. What is your level of education?

Never attended school but able to read and write	1	
From Grade 1 to 7	2	
From Grade 8-12	3	
High education (Certificate, Diploma, degree)	4	

4. What are you doing for a living?

Working for government Department	1	
Working for local Municipality	2	
Unemployed	3	
Self employed, including farmers	4	
A student	5	
Working for private companies	6	

SECTION B

KNOWLEDGE OF THE DECLARED WEEDS AND ALIEN INVASIVE PLANTS.

1. Do you know that some plants are weeds and alien invasive?

Yes	1	
No	2	

2. Does some of it occur in your area?

Yes	1	
No	2	

3. Some of the plants listed below occur in your area, please select those that you have seen in Dinokana?

		Yes	No
3.1.	Seringa (Mogolagodimo)- <i>Melia azedarach</i>	1	2
3.2.	Imbricate cactus (setoroko)- <i>Opuntia imbricata</i>	1	2
3.3.	Blue gums (bluekom)- <i>Eucalyptus species</i>	1	2
3.4.	Lantana- <i>Lantana camara</i>	1	2
3.5.	Queen of the night (setoroko)- <i>Cereus jamacura</i>	1	2
3.6.	Poplartree (popoliri)- <i>Populus conescens</i>	1	2
3.7.	Jacaranda- <i>Jacaranda mimosifolia</i>	1	2
3.8.	Oleander (Selonsroos)- <i>Nerium oleander</i>	1	2
3.9.	Pepper tree wattle (pepperboom)- <i>Acacia elata</i>	1	2
3.10.	Garingboom- <i>Agave sisalana</i>	1	2

4. Do you regard these plants as a problem in the area?

Yes	1	
No	2	

5. If the answer above is YES, could you please rate the problem of declared weeds and alien plants in your area on the scale of 1-4 (whereby 1 refers to not much problem and 4 refer to serious problem).

No	Types of WIP in the area	Scores as from 1-4			
5.1	Imbricate cactus (setoroko)- <i>Opuntia imbricata</i>	1	2	3	4
5.2	Blue gums (bluekom)- <i>Eucalyptus species</i>	1	2	3	4
5.3	Lantana- <i>Lantana camara</i>	1	2	3	4
5.4	Queen of the night (setoroko)- <i>Cereus jamacura</i>	1	2	3	4
5.5	Poplartree (popoliri)- <i>Populus conescens</i>	1	2	3	4
5.6	Seringa (Mogolagodimo)- <i>Melia azedarach</i>	1	2	3	4
5.7	Jacaranda- <i>Jacaranda mimosifolia</i>	1	2	3	4
5.8	Oleander (Selonsroos)- <i>Nerium oleander</i>	1	2	3	4
5.9	Pepper tree wattle (pepperboom)- <i>Acacia elata</i>	1	2	3	4
5.10	Garingboom- <i>Agave sisalana</i>	1	2	3	4

6. Please indicate the extent of the problem of infestations in your area by ticking in the most appropriate box.

Light infestations	1
Medium infestations	2
Heavy infestations	3

7. Indicate the area where most of these plants are likely to be found by ticking the most applicable answer with a *mark (x)* from the possible answers given below (Mark only one answer).

Along the stream	1
Near to the living stands	2
Where livestock are normally concentrated	3
Along the streets and main roads	4

8. Indicate the conditions of the natural resources where this plant occurs by ticking the most applicable answer with a *mark (x)* from the possible answers given below.

		Yes	No
8.1.	Bare soil	1	2
8.2.	Signs of erosion	1	2
8.3.	Good grass cover	1	2

9. From the list given, please indicate the area where you think that this plant normally occurs, please indicate with a *mark (x)* from the possible answers given below, and give only one answer.

Yes	No
-----	----

9.1.	Land left bare or unused	1	2
9.2.	Well protected land	1	2
9.3.	Badly overgrazed and heavily eroded piece of land	1	2
9.4.	Abandoned. Previously land used for cultivations	1	2

10. Are these plants useful to the local people?

Yes	1	
No	2	

11. What do they use these plants for?

- 12.1. Can this land be useful to the local community after the control of WIP?

Yes	1	
No	2	

- 12.2. For what purpose do you think the land can be used for?

13. What was the land initially used for before being invaded by weeds and alien invasive plants?

14. Do you know any factors influencing the invasions process of WIP?

Yes	1	
No	2	

15. If you have answered YES in 14 above, from the list below, please indicate factor/s that influences the invasion process of WIP, you can choose more than one.

		Yes	No
15.1.	Good temperature and humidity for the growth of these plants.	1	2
15.2.	Changes in habitats caused by human land use	1	2
15.3.	Fragmentation of the landscape	1	2
15.4.	Changes in the availability of the limiting factors, such as rainfall.	1	2
15.5.	Planting of grass in the street	1	2
15.6.	Judicious burning of the veld	1	2

16. Why do you think we need a strategy to manage the declared weeds and alien invasive plants?

		Yes	No
16.1.	They increases the fire frequencies	1	2
16.2.	They make land to be beautiful and safe	1	2
16.3.	They increase sediments accumulations, and restrict the natural water flow pattern.	1	2
16.4.	They have greater nutrients and water uptake	1	2
16.5.	It decreases species diversity and causes the extinctions of local native species	1	2
16.6.	It threatens rare and endangered species	1	2

17. How do you think these plants could be managed?

		Yes	No
17.1.	We need to minimize the disturbance of soil	1	2
17.2.	We need to limit the dispersals of the seeds of weeds and alien invasive plants.	1	2
17.3.	We have to stop planting all those plants that are prohibited by all the environmental legislations of this country.	1	2
17.4.	We need to really start taking that responsibility and stop putting lot of pressure on our natural resources, which include soil, vegetations and water.	1	2

SECTION C

CONTROL OF DECLARED WEEDS AND ALIEN INVASIVE PLANTS.

1. Do you think that the control of weeds and alien invasive plant species is a priority to the local people?

Yes	1	
No	2	

2. Which one of the factors given below, do you attribute mostly to a lack of commitment to the control of weeds and alien invasive by the local people?

	Yes	No
2.1. Social factors	1	2
2.2. Economic factors	1	2
2.3. Political factors	1	2
2.4. All of the above	1	2

- 2.1.1. Please give a reason for your answer above

3. From the list below, which one of the control measures indicated do you regard as the most appropriate control method for the WIP in your area, please mark with an (x) in the appropriate box (Please mark only one answer).

3.1.	The use of herbicides	1
3.2.	The use of biological control materials	2
3.3.	The use of mechanical means	3
3.4.	The integrated control method of all the existing methods	4

4. The government policy allows us to use the herbicides (chemicals), do you support this policy in using to control these plants

Yes	1	
No	2	

5. Please give a reason for your answer under 4.

6. For the community to obtain the herbicides through the government subsidy scheme they have to pay. Tell me how much you think the community can afford to pay for the herbicides (Please mark only one answer).

6.1.	R1-R2.50	1
6.2.	R2.51-R3.50	2
6.3.	R3.51-R5.00	3
6.4.	R5.01-R6.50	4
6.5.	R6.51-R8.00	5
6.6.	R8.01-R10.50	6
6.7.	R10.51-R12.00	7
6.8.	R12.01 and more	8
6.9.	Nothing	9

7. If you were asked to volunteer to come and spray these plants without any compensation, would you agree or not

Agree	1	
Disagree	2	

8. To ensure the control of these plants, which spheres of government do you think need to play a vital role from the list given below.

Yes	No
-----	----

8.1.	National Government	1	2
8.2.	Provincial Government	1	2
8.3.	Local Government	1	2

9. Apart from the Government subsidy scheme from the Department of Agriculture, do you know of any other program/s available which can help us in dealing with the problem under discussion?

Yes	1	
No	2	

10. If the answer above is YES, please indicate the program/s that you know from the list given below.

		Yes	No
10.1.	The Working for Water program of the Department of Water Affairs and Forestry.	1	2
10.2.	Prevention of mother to child treatment program	1	2
10.3.	The social grant	1	2
10.4.	The Working for Wetland program of the Department of Water Affairs and Forestry	1	2
10.5.	The National Land Care program of the Department of Agriculture	1	2

SECTION D

KNOWLEDGE ABOUT THE POLICY

1. Do you have any knowledge about the policy dealing with the control of the declared weeds and alien invasive plants?

Yes	1	
No	2	

2. What specifically do you know about the policy, please elaborate?

3. Do you know of legislations that govern the control of WIP in RSA?

Yes	1	
No	2	

NB, if the answer in question 3 above is No, please ignore the questions that follows.

4. If yes, what do you know about that legislation, briefly elaborate?

5. Which of the given legislation are you referring to; please select one or more from the options given to you?

Yes	No
-----	----

5.1.	The National Water Act, Act 36 of 1998	1	2
5.2.	Conservation of the Agricultural Resource Act, Act 43 of 1983, (CARA).	1	2
5.3.	Fencing Act, Act 70 of 1970	1	2
5.4.	Environmental Conservation Act, Act 73 of 1989	1	2
5.5.	The National Environmental Management Act, Act 107 of 1998	1	2

6. What do you know specifically about the CARA legislation, please elaborate?

7. What do you think is the provision of the law, from the given alternatives, you can choose more than one?

Yes	No
-----	----

7.1.	It allows the people to keep dagga in their homes.	1	2
7.2.	It prohibits the exhibition or any movement whatsoever of any plant species declared under section 15 of the CARA legislation.	1	2
7.3.	It indicates that the people must stay away from the grass in front of the house.	1	2
7.4.	The law allows the planting of certain plants only in a specific demarcated area.	1	2
7.5.	You can only have plants declared as weeds or alien invasive species if you have been authorized by the executive officer.	1	2
7.6.	No forestations within the 30 to 40 meters of the wetland areas.	1	2

8. Do you think this laws is applicable, especially in the rural areas

Yes	1	
No	2	

9. If the answer above is yes, why you think so, please give a reason.

10. If the answer above is no, why do you think so, please give a reason.

11. Any other input you may want to add.

Thank You: Ke a leboga ka nako ya ganyo!!

APPENDIX B

SAMPLES OF THE PICTURES OF SOME OF THE DECLARED WEEDS AND ALIEN INVASIVE PLANTS (WIP) IDENTIFIED IN THE STUDY AREA

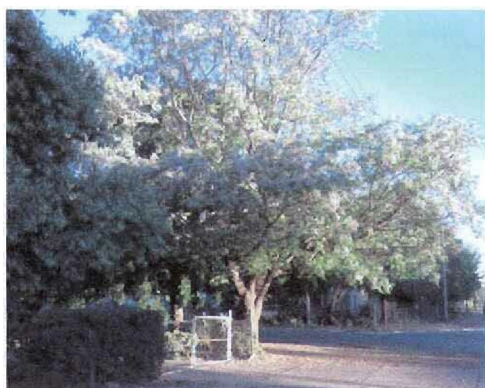


Photo 1: *Melia azedarach* (Seringa)



Photo 2: *Opuntia imbricata* (Imbricate cactus)



Photo 3: *Eucalyptus* species (gum)



Photo 4: *Lantana camara* (Lantana) underneath the *Eucalyptus* tree species



Photo 5: *Cereus jamacaru*
(Queen of the night)



Photo 6: *Populus canescens* (Poplar tree)



Photo 7: *Jacaranda mimosifolia*
(Jacaranda)



Photo 8: *Nerium oleander*
(Oleander)



Photo 9: *Acacia elata* (Pepper tree wattle)



Photo 10: *Agave sisalana* (Garingboom/Sisal)

APPENDIX C

NAMES OF DECLARED WEEDS AND ALIEN INVADERS WITH THEIR CATEGORIES, Henderson (2001)

(For category description of the plants, refer to Chapter 2).

Botanical name	Common name	Type	Category
* <i>Nerium oleander</i> (excluding sterile double flowered cultivars)	Selonsroos oleander	Weed	1
<i>Opuntia auriantica</i>	Jointed cactus	Weed	1
<i>Opuntia exaltata</i>	Long spine cactus	Weed	1
* <i>Opuntia ficus-indica</i>	Sweet prickly pear.	Weed	1
<i>Opuntia fulgida</i>	Rosea cactus	Weed	1
<i>Opuntia humifusa</i>	Creeping prickly pear.	Weed	1
* <i>Opuntia imbricata</i>	Imbricate prickly pear	Weed	1
<i>Opuntia lindheimeri</i>	Small round leave prickly pear	Weed	1
<i>Opuntia spinulifera</i>	Large round leaved prickly pear	Weed	1
* <i>Opuntia stricta</i>	Australian pest pear	Weed	1
* <i>Pinus halepensis</i>	Aleppo pine	Invader	2
<i>Populus alba</i>	White poplar	Invader	2
* <i>Populus canescens</i>	Grey poplar [matchwood poplar]	Invader	2
<i>Prosopis glandulosa</i>	Honey mesquite	Invader	2
<i>Prosopis velutina</i>	Velvet mesquite	Invader	2
<i>Robinia pseudoacacia</i>	Black locust	Invader	2
<i>Salix babylonica</i>	Weeping willow	Invader	2
<i>Sesbania punicea</i>	Red sesbania	Weed	1
<i>Solanum elaeagnifolium</i>	Satanbos	Weed	1
<i>Solanum mauritianum</i>	Bugweed	Weed	1

Botanical name	Common name	Type	Category
<i>Schinus terebinthifolius</i>	Brazilian pepper tree	Weed Invader	1 KZN 3 The rest of SA
<i>Senna bicapsularis</i>	Rambling cassia	Invader	3
<i>Senna didymobotrya</i>	Peanut butter cassia	Invader	3
<i>Senna pendula</i>		Invader	3
<i>Solanum seaforthianum</i>	Potato creeper	Weed	1
<i>Solanum sisymbriifolium</i>	Wild tomato	Weed	1
<i>Sorghum halepense</i>	Johnson's grass	Invader	2
<i>Spartium junceum</i>	Spanish broom	Weed	1
<i>Syzygium cumini</i>	Jambolan	Invader	3
<i>Syzygium jambose</i>	Rose apple	Invader	3
<i>Tamarix chinensis</i>	Chinese tamarisk	Weed Invader	1 Northwest & Eastern Cape 3 The rest of SA
<i>Tamarix ramosissima</i>	Pink tamarisk	Weed Invader	1 Northwest & Eastern Cape 3 Rest of SA
<i>*Tecoma stans</i>	Yellow bells	Weed	1
<i>Thelechitonia trilobata</i>	Singapore daisy	Weed Invader	1 KZN 3 The rest of SA
<i>Thevetia peruviana</i>	Yellow oleander	Weed	1
<i>Tipuana tipu</i>	Tiputree	Invader	3
<i>Tithonia rotundifolia</i>	Red sunflower	Weed	1
<i>Toona ciliata</i>	Toon tree	Invader	3
<i>Triplaris americana</i>	Ant tree	Weed	1
<i>Ulex europaeus</i>	European gorse	Weed	1
<i>Xanthium spinosum</i>	Spiny cocklebur	Weed	1
<i>Xanthium stramonium</i>	Large cocklebur	Weed	1

Botanical name	Common name	Type	Category
<i>Orobanche minor</i>	Lesser broomrape, clover broomrape	Weed	1
<i>Paraserianthes lophantha</i>	Australian Albizia, Stink bean	Weed	1
<i>Parthenium hysterophorus</i>	Parthenium	Weed	1
<i>Passiflora caerulea</i>	Blue passion flower	Weed	1
<i>Passiflora mollissima</i>	Banana poka, Bananadilla	Weed	1
<i>Passiflora suberosa</i>	Indigo berry	Weed	1
<i>Passiflora subpeltata</i>	Granadina	Weed	1
<i>Pittosporum undulatum</i>	Australian cheesewood, Sweet pittosporum	Weed	1
<i>Plectranthus comosus</i>	Abyssinian coleus, Woolly plectranthus	Invader	3
<i>Pontederia cordata</i>	Pickrel weed	Invader	3
<i>Psidium cattleianum</i>	Strawberry guava	Invader	3
<i>Psidium guajava</i>	Guava	Invader	2
<i>Psidium guineense</i>	Brazilian guava	Invader	3
<i>Psidium X durbanensis</i>	Durban guava	Weed	1
<i>Pueraria lobata</i>	Kudzu vine	Weed	1
<i>Pyracantha angustifolia</i>	Yellow firethorn	Invader	3
<i>Pyracantha crenulata</i>	Himalayan firethorn	Invader	3
<i>Rhus succedanea</i>	Wax tree	Weed	1
<i>Rivina humilis</i>	Bloodberry	Weed	1
<i>Rorippa nasturtium-aquaticum</i>	Watercress	Invader	2
<i>Rosa rubiginosa</i>	Sweetbriar, Eglantine	Weed	1
<i>Rubus fruticosus</i>	European blackberry	Invader	2
<i>Salix fragilis</i>	Crack of brittle willow	Invader	2
<i>Salvinia molesta</i>	Kariba weed	Weed	1

Botanical name	Common name	Type	Category
<i>Acacia baileyana</i>	Bailey's wattle	Invader	3
<i>Acacia cyclops</i>	Red eye	Invader	2
<i>Acacia dealbata</i>	Silver wattle	Weed Invader	1 Western Cape 2 The rest of SA
<i>Acacia decurrens</i>	Green wattle	Invader	2
<i>*Acacia elata</i>	Pepper tree wattle	Invader	3
<i>Acacia implexa</i>	Screw-pod wattle	Weed	1
<i>Acacia longifolia</i>	Long leaved wattle	Weed	1
<i>Acacia mearnsii</i>	Black wattle	Invader	2
<i>Acacia melanoxylon</i>	Australian blackwood	Invader	2
<i>Acacia paradoxa</i>	Kangaroo wattle	Weed	1
<i>Acacia podalyriifolia</i>	Pearl acacia	Invader	3
<i>Acacia pycnantha</i>	Golden wattle	Weed	1
<i>Acacia saligna</i>	Port Jackson willow	Invader	2
<i>Achyranthes aspera</i>	Burweed	Weed	1
<i>*Agave sisalana</i>	Sisal hemp, Sisal	Invader	2
<i>Ageratina adenophora</i>	Crofton weed	Weed	1
<i>Ageratina riparia</i>	Mistflower	Weed	1
<i>Ageratum conyzoides</i>	Invading ageratum	Weed	1
<i>Ageratum houstonianum</i>	Mexican ageratum	Weed	1
<i>Ailanthus altissima</i>	Tree-of-heaven	Invader	3
<i>Albizia lebbeck</i>	Lebbeck tree	Weed	1
<i>Albizia procera</i>	False lebbeck	Weed	1
<i>Anredera cordifolia</i>	Bridal wreath	Weed	1
<i>Araujia sericifera</i>	Moth catcher	Weed	1
<i>Ardisia crenata</i>	Coral bush	Weed	1
<i>Argemone mexicana</i>	Yellow-flowered Mexican poppy	Weed	1
<i>Pennisetum setaceum</i>	Fountain grass	Weed	1
<i>Ricinus communis</i>	Castor-oil plant	Invader	2

Botanical name	Common name	Type	Category
<i>Argemone ochroleuca</i>	White-flowered Mexican poppy	Weed	1
<i>Arundo donax</i>	Giant reed, Spanish reed	Weed	1
<i>Atriplex lindleyi</i>	Sponge-fruit saltbush	Invader	3
<i>Alhagi maurorum</i>	Camel thorn bush	Weed	1
<i>Atriplex nummularia</i>	Old man saltbush	Invader	2
<i>Azolla filiculoides</i>	Azolla, Red water fern	Weed	1
<i>Bauhinia purpurea</i>	Butterfly orchid tree	Invader	3
<i>Bryophyllum delagoense</i>	Chandelier plant	Weed	1
<i>Caesalpinia decapetala</i>	Mauritius thorn	Weed	1
<i>Campuloclinium macrocephalum</i>	Pom pom weed	Weed	1
<i>Canna indica</i>	Indian shot	Weed	1
<i>Bauhinia variegata</i>	Orchid tree	Invader	3
<i>Cardiospermum grandiflorum</i>	Balloon vine	Weed	1
<i>Casuarina cunninghamiana</i>	Beefwood	Invader	2
<i>Casuarina equisetifolia</i>	Horsetail tree	Invader	2
<i>*Cereus jamacaru</i>	Queen of the night	Weed	1
<i>Cestrum aurantiacum</i>	Yellow or Orange cestrum	Weed	1
<i>Cestrum elegans</i>	Crimson cestrum	Weed	1
<i>Cestrum laevigatum</i>	Inkberry	Weed	1
<i>Cestrum parqui</i>	Chilean cestrum	Weed	1
<i>Chromolaena odorata</i>	Triffid weed, Chromolaena	Weed	1
<i>Cinnamomum camphora</i>	Camphor tree	Weed	1 N Province, KZN & Mpumalanga

Botanical name	Common name	Type	Category
<i>Cuscuta suaveolens</i>	Lucerne dodder	Weed	1
<i>Cirsium vulgare</i>	Spear thistle	Weed	1
<i>Convolvulus arvensis</i>	Wild morning glory, Field binding weed	Weed	1
<i>Cortaderia jubata</i>	Pampas grass	Weed	1
<i>Cortaderia selloana</i>	Pampas grass	Weed	1
<i>Cotoneaster franchetii</i>	Orange cotoneaster	Invader	3
<i>Cotoneaster pannosus</i>	Silver-leaf cotoneaster	Invader	3
<i>Cuscuta campestris</i>	Common dodder	Weed	1
<i>Cytisus monspessulanus</i>	Montpellier broom	Weed	1
<i>Cytisus scoparius</i>	Scotch broom	Weed	1
<i>Datura ferox</i>	Large thorn apple	Weed	1
<i>Datura innoxia</i>	Downy thorn apple	Weed	1
<i>Datura stramonium</i>	Common thorn apple	Weed	1
<i>Echinopsis spachiana</i>	Torch cactus	Weed	1
<i>Echium plantagineum</i>	Pattern's curse	Weed	1
<i>Echium vulgare</i>	Blue echium	Weed	1
<i>Egeria densa</i>	Dense water weed	Weed	1
<i>Eichhornia crassipes</i>	Water hyacinth	Weed	1
<i>Elodea Canadensis</i>	Canadian water weed	Weed	1
<i>Eriobotrya japonica</i>	Loquat	Invader	3
<i>*Eucalyptus camaldulensis</i>	Red river gum	Invader	2
<i>*Eucalyptus cladocalyx</i>	Sugar gum	Invader	2
<i>*Eucalyptus diversicolor</i>	Karri	Invader	2
<i>*Eucalyptus grandis</i>	Saligna gum	Invader	2
<i>Grevillea robusta</i>	Australian silky oak	Invader	3
<i>Hakea drupacea</i>	Sweet hakea	Weed	1
<i>Hakea gibbosa</i>	Rock hakea	Weed	1
<i>Hakea sericea</i>	Silky hakea	Weed	1

Botanical name	Common name	Type	Category
All seeds producing species or seed producing hybrids of <i>Lantana</i> that are non indigenous to Africa	Lantana Cherry pie Tickberry	Weed	1
<i>*Eucalyptus lehmnnii</i>	Spider gum	Weed Invader	1 Western Cape 2 the rest of SA
<i>*Eucalyptus paniculata</i>	Grey ironbark	Invader	2
<i>*Eucalyptus sideroxylon</i>	Black ironbark, Red ironbark	Invader	2
<i>Eugenia uniflora</i>	Surinam cherry	Weed Invader	1 N Province, KZN & Mpumalanga 3 the rest of SA
<i>Gleditsia triacanthos</i>	Honey locust	Invader	2
<i>Ipomoea alba</i>	Moonflower	Weed Invader	1 N. Province, KZN & Mpumalanga 3 The rest of SA
<i>*Jacaranda mimosifolia</i>	Jacaranda	Invader	3
<i>Lepidium draba</i>	White top	Weed	1
<i>Leptospermum laevigatum</i>	Australian myrtle	Weed	1
<i>Leucaena leucocephala</i>	Reuse wattle Leucaena	Weed Invader	1 Western Cape 2 The rest of SA
<i>Ligustrum japonicum</i>	Japanese wax- leaved privet	Invader	3
<i>Ligustrum lucidum</i>	Chinese wax- leaved privet	Invader	3

Botanical name	Common name	Type	Category
<i>Harrisia martini</i>	Harrisia cactus	Weed	1
<i>Hedychium coccineum</i>	Red ginger lily	Weed	1
<i>Hedychium coronarium</i>	White ginger lily	Weed	1
<i>Hedychium flavescens</i>	Yellow ginger lily	Weed	1
<i>Hedychium gardnerianum</i>	Kahilli ginger lily	Weed	1
<i>Hypericum perforatum</i>	St. John's wort, Tipton weed	Invader	2
<i>Ipomoea indica</i>	Morning glory	Weed Invader	1 N. Province, KZN & Mpumalanga 3 The rest of SA
<i>Ipomoea purpurea</i>	Morning glory	Invader	3
<i>Ligustrum ovalifolium</i>	California privet	Invader	3
<i>Ligustrum sinense</i>	Chinese privet	Invader	3
<i>Ligustrum vulgare</i>	Common privet	Invader	3
<i>Lilium formosanum</i>	St. Joseph's lily, Trumpet lily, Formosa lily	Invader	3
<i>Litsea glutinosa</i>	Indian laurel	Weed	1
<i>Lythrum salicaria</i>	Purple loosestrife	Weed	1
<i>Macfadyena unguis-cati</i>	Cat's claw creeper	Weed	1
<i>*Melia azedarach</i>	Syringe, Persian lilac	Invader	3
<i>Metrosideros excelsa</i>	New Zealand Christmas tree	Invader	3
<i>Mimosa pigra</i>	Giant sensitive plant	Invader	3
<i>Montanoa hibiscifolia</i>	Tree daisy	Weed	1
<i>Morus alba</i>	White mulberry, Common mulberry	Invader	3
<i>Myoporum tenuifolium</i>	Manatoka	Invader	3
<i>Myriophyllum aquaticum</i>	Parrot's feather	Weed	1
<i>Myriophyllum spicatum</i>	Spiked water- milfoil	Weed	1
<i>Nassella tenuissima</i>	White tussock	Weed	1
<i>Nassella trichotoma</i>	Nassella tussock	Weed	1

Botanical name	Common name	Type	Category
<i>Nephrolepis exaltata</i>	Sword fern	Invader	3
<i>Pennisetum villosum</i>	Feathertop	Weed	1
<i>Pereskia aculeate</i>	Barbados gooseberry	Weed	1
<i>Phytolacca dioica</i>	Belhambra	Invader	3
<i>Pinus patula</i>	Patula pine	Invader	2
<i>Pinus pinaster</i>	Cluster pine	Invader	2
<i>Pinus radiata</i>	Radiata pine, Monterey pine	Invader	2
<i>Pinus roxburghii</i>	Chir pine, Longifolia pine	Invader	2
<i>Pinus taeda</i>	Loblolly pine	Invader	2
<i>Pistia stratiotes</i>	Water lettuce	Weed	1

* indicate species that occurred in the study area.