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CAN SOCIAL-ECOLOGICAL SYSTEMS INHIBIT INVASIVE SPECIES CONTROL? A STUDY OF *ACACIA MEARNSII* CONTROL IN THE GOLDEN GATE HIGHLANDS NATIONAL PARK OF SOUTH AFRICA

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Abstract

Considered to be an important source of water, energy and biological diversity, mountains are a critical component of livelihoods because of the ecosystem goods and services they provide to montane communities. In South Africa, mountain ecosystems are under threat from invasion by alien species, posing considerable pressure on wildlife, native plant species and local habitats. This paper assesses the socio-economic and cultural context of the control of *Acacia mearnsii* invasion in the Golden Gate Highlands National Park, a mountain based protected area in South Africa. The paper draws from a questionnaire survey and interviews that were conducted in communities adjacent to the park to ascertain why these communities were reluctant to cooperate in government funded control programs, despite evidence showing that the communities are a springboard for bio-invasion in the park. The results indicate that social-ecological systems are the root of resistance against of *Acacia mearnsii* control.

Keywords: *Ecosystems Services; Grassland Biome; Invasive Alien Species; Poverty; Social-Ecological Systems; South Africa*

1. INTRODUCTION

Carbutt (2012) notes that South Africa has been invaded by many species of non-native plants, many of which are already well established and have a negative ecological and economic impact on the country. In South Africa, where about 10 million hectares of land have already been invaded, problems associated with plant invasions are escalating rapidly (Nel et al 2004). *Acacia mearnsii*, an Australian wattle, is considered to be one of the principal and most problematic alien plant invaders in the country (Richardson et al 2011; van Wilgen et al 2011; McConnachie et al 2012; Donaldson et al 2014), where it has invaded 2 500 000 ha of land (http://www.fao.org/docrep/005/ac846e/ac846e09.htm).

Australian wattles were introduced to South Africa during the mid-nineteenth century for purposes such as soil stabilization, supply of fuel and timber and, in the case of the black wattle, plantations were set up for the production of tanbark liquor for the leather industry (Aitken et al 2009). By the 1950s, South Africa already had the world's largest plantations of *Acacia mearnsii* and wattle forestry products formed a major portion of the national economy (Carruthers et al 2011). Witt (2005) highlighted cases where British settler farmers introduced the species for shade and for beautifying the land, as many of these settlers were used to greener tree-filled European landscapes and sought to modify the seemingly bare, treeless grasslands by planting trees that would make them feel at home. The newly introduced species were readily adopted by indigenous Africans who started planting them in their communal areas as part of colonial improvements to the land.

The involvement of local communities constitutes a key aspect of the success of alien species control programs because of the mutual role these communities play in these programs. In this mutual role local communities provide labor to the program in return for employment. Consequently, the program is viewed as a tool for restoring invaded land, on one hand, as well as a tool for poverty reduction and livelihood improvement, on the other. In the case of the Golden Gate Highlands National Park (GGHNP) of South Africa, it is the village communities from areas located to the east of the park that are expected to participate in the control works taking place in the park (Figure 1). However, despite the huge investment in IAS control the complete control of *Acacia mearnsii* is neither going to be easy nor socially attractive in the short-term due to the limited livelihood options available to local communities. Nevertheless, this study demonstrates that while the complete eradication of *Acacia mearnsii* may not be viewed as socially and environmentally desirable, due to its capacity to disrupt social-ecological systems, the control of the species is crucial for the GGHNP's ecological integrity and for the sustained flow of the park's ecosystem goods and services in future.

McConnachie et al (2012) observed that while the WfW Program that was initiated in South Africa, has records on plant cover, treatments (i.e. clearing of the species) and costs on specific sites where contracts are awarded for clearing work (places where the clearing is done), little is known about the cost-effectiveness of its clearing treatments because of the limited number of variables recorded. Consequently, as argued by McConnachie (2012), it is not possible to assess effectiveness in terms of progress towards the goal of restoring ecosystem health. Even less known is the social-ecological context of the environment where control programs are undertaken. This relates to the compatibility between socio-cultural context and the restoration programs initiated in invaded areas.

Accordingly, the central question addressed in this paper is: "Why is it difficult to eliminate *Acacia mearnsii* altogether and why are the communities living around the GGHNP reluctant to support government funded *Acacia mearnsii* control programs, even when it is evident that the areas where they live are the springboard from which invasions by this species are taking place?" By addressing this question we hope to identify the social-ecological systems prevailing in the communities abutting the GGHNP that are in conflict with the goals of acacia control programs, including their knowledge, perceptions, practices, wants and needs. Masalu et al. (2010) note that social-ecological systems encompass the cultural and traditional practices that influence the complex and dynamic interactions between people and their environment. They are systems in which social and ecological processes are coupled (Mukwada et al., 2015). Thus, there is need to investigate the social-ecological context within which *Acacia mearnsii* is being controlled. This research need has been identified by Shackleton et al (2016) who noted the importance of further research on barriers imposed by social-ecological contexts in invasive species management.

Grêt-Regamey (2012) maintains that there is urgent need for protecting fragile mountain ecosystems where ecosystem services are under pressure. This urgency has been demonstrated in the GGHNP in South Africa, where despite the huge investment that has been made in an invasive alien species (IAS) control program, invasion remains unabated, as some species continue to spread from their refugia in abuting village communities. This is particularly the case with *Acacia mearnsii,* which the villagers protect or even propagate as a resource.

Therefore, the objective of this paper is to use empirical data from the case study of the GGHNP to contribute to the ongoing debates on the dilemma facing conservationists and policy makers regarding the control of IAS in South Africa and assess the nature of conflicts that arise from IAS control programs. Proximity of the communities included in this study to a national park whose goals are to preserve an endangered grassland biome and ruggedness of terrain presents unique conditions that have not yet been explored. The remaining part of this paper is organized as follows. First, we review literature on IAS, both on problems posed by IAS in general and those affecting South Africa in particular. Second, we describe the methodology that was employed in the study before finally summarizing the results of the study and the discussion on which policy recommendations can be drawn.

2. BACKGROUND

2.1 Literature review

The environmental impacts of IAS on biodiversity can be "immense, insidious and irreversible" (Caffrey et al 2015: 1). Pimentel et al (2005) maintain that invasive species even have the potential to pose a threat to the economy of a nation, while Pejchar and Mooney (2009: 497) note that alien species invasion has been "heralded as the second greatest agent of species endangerment and extinction after habitat destruction". IAS have a wide range of effects in the environment, including reduction of surface water runoff, groundwater recharge, livestock production and biodiversity in terrestrial biomes (van Wilgen et al 2007), and are therefore capable of disrupting ecosystem services derived from it (Mgidi et al 2007). Ecosystem services are the functions and products of ecosystems that benefit people or yield welfare to society (Lele et al 2013). Problems associated with invasiveness of alien tree species used in forestry are increasing rapidly worldwide, and are viewed as most severe in areas where species have been planted for a long time (Richardson et al 2015). Globally, alien species invasion is considered to be one of the most important environmental problems facing natural ecosystems (Wilcove et al 1998; Al Harun et al 2014).

Findings from recent research by Shackleton et al (2015) have revealed the need to evaluate stakeholder characteristics such as knowledge, perceptions, practices, awareness, and wants and needs relating to biological invasions. In the case of invasion by *Acacia mearnsii,* the variability of such social-ecological conditions is a complex of outcomes of historically and geographically contingent processes that integrate plant ecology, economic development, political context and culture and consequently the use of acacias is shaped by land use traditions, historical and current economic opportunities, subsistence needs, and by access to land or tree resources (Kull et al 2011). Of particular interest in this context are the conflicts related to the control of *Acacia mearnsii,* as a result of limited cooperation of local communities, and in some cases conflicts associated with control programs. Van Wilgen and Richardson (2015) indicated that the dimensions of the conflicts that arise and the options that exist for resolving these conflicts are highly taxon- and region-specific, while the drivers and human dimensions of biological invasions are

changing very rapidly, with each major group of invasive species posing particular challenges to ecologists and ecosystem managers.

This creates a dilema regarding how control programs should be designed and managed. Aitken et al (2009) note that since the 1990s, in South Africa there has been a more tolerant view showing that although wattles are regarded as invasive species that impact water resources and land use, they are beneficial to poor rural households, which rely on them to meet their subsistence needs. This view argues that acacias are a tool used to improve the livelihoods of many poor indigenous people who have had limited access to economic opportunities due to marginalization by apartheid. This view reinforces the argument that people adopt alien plant species due to the utility of these species, which many use to meet their needs for energy, shelter, medicine, food, spirituality and culture, as well as trade in plant products to generate cash income, making it necessary for environmental managers to have a better understanding of the social context in areas within which acacias are being controlled (Kull et al 2011). It is within this context that the current study is situated.

2.2 Challenges associated with bio-invasion in South Africa

In recent years opinion has been divided regarding the control of the species. For instance, Rangan et al (2010) have highlighted the conventional global perspective which views large scale tree cover as the means for preventing soil erosion, increasing water infiltration and retention in soils, and recharging streams and water tables. On the other hand these authors have also shown evidence from research by some scholars which highlights the negative effects of fast-growing forestry species which have turned into weedy invasive species and started to affect catchment hydrology and grassland biomes. The dilemma regarding the management of IAS is currently gripping South Africa. Aitken et al (2009) pointed out the severe impacts of wattles on hydrological services and reported of the 2000 results of the long-term experiments that were set up in 1935 which showed a significant decrease in surface water availability in afforested South African catchments. The impacts of plant invasions include the disruption of ecosystem services (van Wilgen et al 2011; Shackleton et al 2015) on which many rural communities depend for livelihood.

Viewed this way, it can be argued that there is need to control invasive plant species, especially in fragile environments such as mountains. Despite the fact that it occupies status 2 on the Conservation of Agricultural Resources Act (CARA) 1983 (Act 43 of 1983) list of invasive species (RSA 1983), which makes the control of the species a legal obligation and a priority of landowners, the spread of bio-invasions have remained unabated. While CARA has been superseded by the National Environmental Management – Biodiversity Act (No. 10) of 2004, the control of *Acacia mearnsii* in South Africa is still based on CARA. For instance the 2013-2023 park management plan for the GGHNP notes:

SANParks has a legal obligation to control and eradicate weeds and invader plants in terms of CARA. The control and eradication strategy is therefore based in the list published in terms of the CARA and the associated regulations as well as the invasive species identified in the park. DEA is currently in the process of finalising an alien invasive species list to be published in terms of the NEM:BA. SANParks acknowledge that as soon as this list has been gazetted the park will have to comply with section 70 to 77 of the NEM:BA. SANParks will align the alien species control and eradication program accordingly (SANParks 2013: 29).

However, a more radical view has been reported by Aitken et al (2009), who have observed that since the 1990s there has been a more tolerant view showing that although wattles are regarded as invasive species that impact water negatively on resources and land use they are beneficial to poor rural households, which rely on them to meet their subsistence needs. Due to the benefits they derive from the species poor rural communities are not always

willing to support wattle control programs. While results from recent research indicate the need to strengthen park community relations, upgrade existing national legislation, and boost the technical capacity of South African national parks to identify, detect, monitor and predict IAS invasions, both within the parks and their surroundings (Mukwada and Manatsa, 2017), another recent study by Mukwada *et al.* (2016) indicated that park-community conflicts prevail in the GGHNP as a result of attempts to control livestock movements across park boundaries as a measure of curbing bio-invasion in the park. The participation of local communities in the control of IAS is important, particularly now in South Africa where climate change threatens to worsen bio-inavions (Irlich et al 2014).

In line with government's response to the problem of bio-invasion, the Working for Water (WfW) Program was founded by the Department of Environmental Affairs (DEA) (but later moved to the Department of Water Affairs and Forestry in 1995) in order to restore ecological services in the invaded areas. Besides the DEA, there are a number of other stakeholders that are involved in the WfW Program. These include other government departments such as Department of Tourism, Department of Agriculture, and Department of Trade and Industry, as well as provincial departments of conservation, environment and agriculture. Other important stakeholders include private companies, research foundations and local communities. In the case of the GGHNP the Invasive Species Control Unit (ISCU) has been responsible for coordinating *Acacia mearnsii* control works since 2003. However, by then invasion by *Acacia mearnsii* had long been declared a national problem threatening South Africa as a whole, in terms of the Conservation of Agricultural Resources Act (Act 43 of 1983).

3. DATA, METHODS AND ANALYSIS

3.1 Description of the Study Area

This study was conducted in the GGHNP and Qwaqwa, a neighbouring communal area which is located to the east of the park. The GGHNP, is a a 32,690 hectare wildlife conservation area that was founded in 1963 (SANParks, 2004) and is situated along the fringes of the Maloti-Drakensberg Mountains, between 28°27' S - 28°37' S and 28°33' E - 28°42' E (insert in Figure 1). The area is situated in the eastern part of the Free State province of South Africa, and located in the foothills of the Maluti-Drakensberg Mountains. Two types of landscapes characterize the areas abutting the GGHNP. These include farmland, referring to land that traditionally and predominantly owned by commercial farmers of European descend. However, since the 1990s government has acquired some of this land for aspiring black commercial farmers. The other main type of landscape consists of the Qwaqwa communal lands. Qwaqwa was the designated homeland for the Sotho speaking people during the apartheid era. The Qawqwa communal lands are under tribal administration and presided over by paramount chiefs. Each chief presides over a number of sub-chiefs, who in turn oversee a number of villages. Village chiefs occupy the lowest rank in the hierarchy of tribal authorities. Unlike in the commercial farmlands where land is privately owned, land under tribal authorities is communally managed by village communities. Thus, we use the term "local community" as a loose term depicting the communities living in the villages abutting the park.

The GGHNP is bisected by the R712, a trunk road which links it to Clarens in the west and Harrismith in the east. Clarens is a popular tourist town which offers many attractions to both domestic and international tourists. Some of the tourists who visit Clarens usually visit the GGHNP as well, because of the wilderness experience it offers, and its diverse

wildlife and unique landscapes. The invasion of the GGHNP by *Acacia mearnsii* is threatening ecosystem services and undermining tourism in the park.

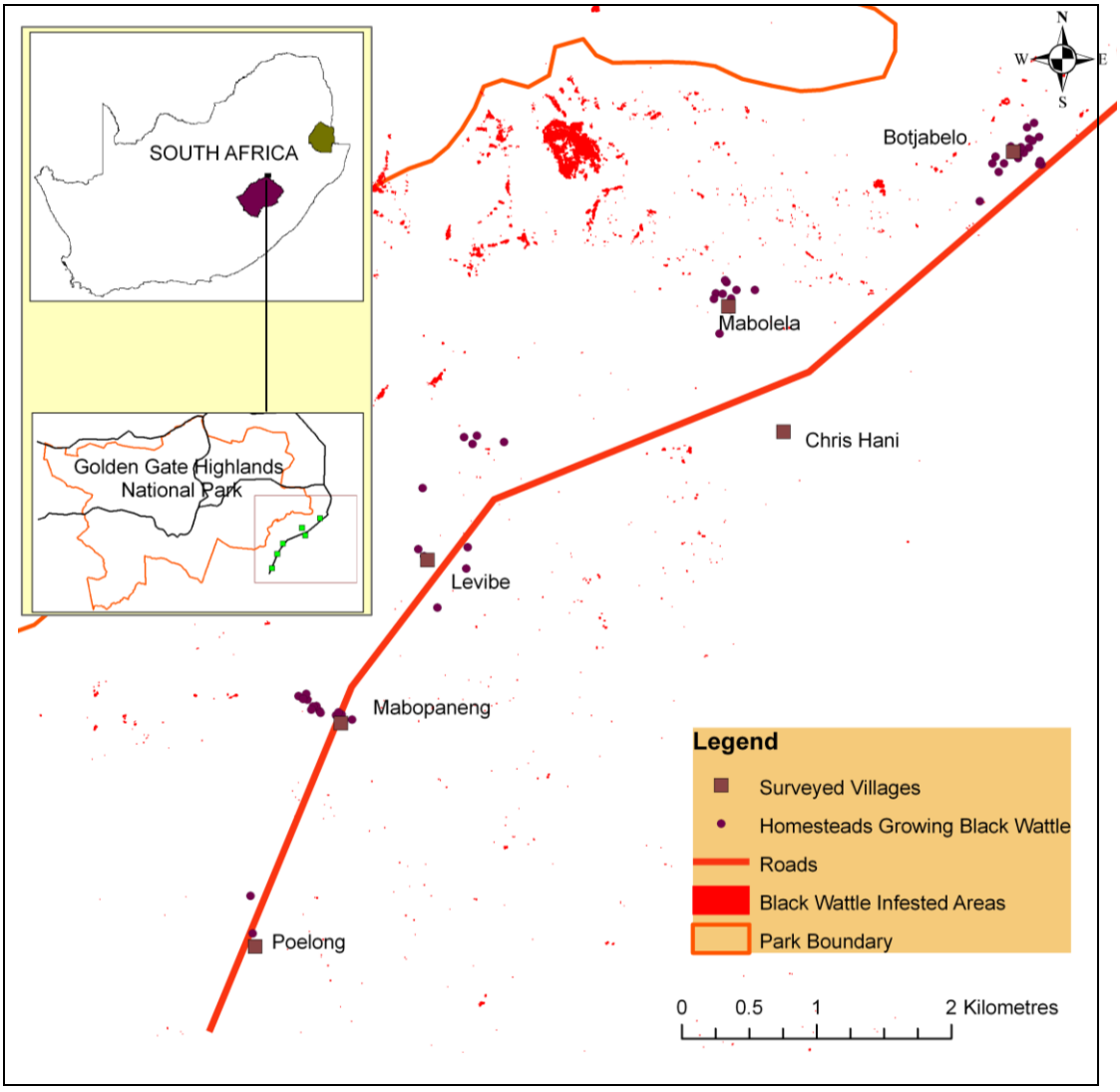

Figure 1. Location of the Golden Gate Highlands National Park and the villages where the questionnaire survey and interviews were conducted. The symbol for village represents village centres rather than village boundaries.

The types of natural vegetation found in the area include the Sandy Grassland; Basotho Montane Shrubland; Northern Drakensberg Highlands Grassland, Lesotho Highland Basalt Grasslands and Drakensberg-Amathole, as well as the Afromontane Fynbos (SANParks 2012). However, some of the plant species that are found in the park are exotic, including invasive ones such as *Eucalyptus globulus, Populus canescens, Pyracantha angustifolia Rosa rubiginose, Rubus cuneifolius, Salix babylonica* and *Acacia mearnsii*. Like in most other parts of the eastern Free State, the GGHNP is situated in a region characterized by high levels of unemployment and poverty.

3.2 Methods

A questionnaire survey was conducted in six villages that border the GGHNP (Figure 1), to determine the extent to which the communities in these villages regard the species as a resource or an environmental problem, what the communities use the species for, the impact that the species (or its control) has on the environment, as well as the extent to which the

control of the species is viewed as beneficial to them. Due to the nonexistence of census records at the village level and unavailability of village population registers it was not possible to determine the total number of people or households living in the surveyed villages. A total of 125 household heads responded to the questionnaire. The household heads who were included in the survey are those who were present when the survey was conducted. Accordingly, a census type of survey was conducted. Thus, one of the limitations of this study is that it was based on nonprobability sampling and the sample of household heads that were selected is not necessarily proportional to the total number of the households living in the study area. It is for this reason that inferential statistics were not employed when determining the nature of the relationship between prevalence of *Acacia mearnsii* in the park and the socio-economic and cultural characteristics of the surveyed households. In order to address this limitation, interviews were held with key informants from the villages, including village chiefs, local councilors and park officials from the ISCU, as a way of validating the information that was collected through the survey. This provided a mechanism for triangulation, as well as a way of compensating for the sampling limitations of the survey. Data on the operations of the WfW Program, including the number and sizes of the plots that were cleared and costs of clearing, were obtained from the ISCU. The cost of clearing per unit area was calculated by dividing the total cost for clearing a plot by the size of the plot. The data that were collected through the questionnaire survey were analyzed statistically using Microsoft Excel and SPSS to compute frequencies of respondents and to plot graphs, while content analysis was employed to extract meaning from interview recordings.

4. RESULTS ND DISCUSSION

Results from this study show that the prevalence of *Acacia mearnsii* in the GGHNP and its surroundings is a function of a number of economic and socio-cultural challenges, as discussed below. The major economic challenges related to *Acacia mearnsii* control are those associated with the eradication of the species.

4.1 Economic challenges of *Acacia mearnsii* control

Data from the ISCU reveals that the control of alien species is a generally difficult and expensive venture. As shown by the high deviation from the norm (Figure 2), the costs of clearing some small plots is disproportionately high and not commensurate with plot size. Whereas this can be explained in terms of low tree densities in some large plots, the effects of repeated treatments due to invasions cannot be ruled out. In the GGHNP, between 2003 and 2015, the cost of clearing *Acacia mearnsii* exceeded R3 million (approximately US$190 000) and accounted for more than 30% of the expenses incurred by the WfW Program in clearing all alien species combined. Similarly, the number of years taken to clear plots is negatively related to plot size (with a correlation coefficient of -0.35), signifying the difficulties experienced in the control of the species from some plots.

The results of this study indicate that though the government has made a huge investment in *Acacia mearnsii* control the process has been hampered by many obstacles. In the GGHNP the WfW Program has devoted more financial resources to the control of *Acacia mearnsii* than any other species. This reality mirrors findings from earlier research conducted elsewhere in South Africa. For instance, van Wilgen et al (2012) noted that of the 561.9 million rand (approximately US$35 million) that was spent on the control of alien plant species between 1995 and 2008, the largest portion of the money was spent on *Acacia mearnsii* control.

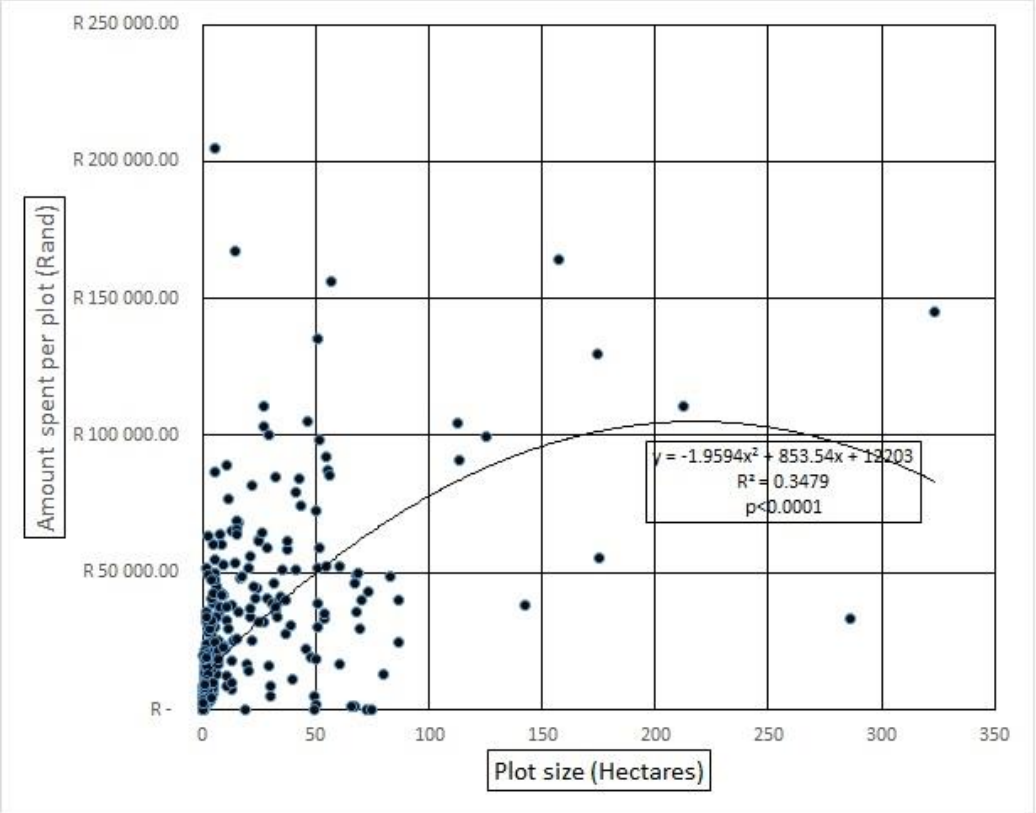

Figure 2. Costs of *Acacia mearnsii* control in the GGHNP between 2003 and 2015.

The problem of excessive costs of *Acacia mearnsii* control has been compounded by the repeated reinvasion of cleared areas, which has necessitated repeated treatments of the plots. In some plots there were as many as twelve clearing treatments between 2003 and 2015. Reluctance by local communities to cooperate with control programs has contributed to repeated invasions of some plots. This reluctance is rooted in the prevailing social-ecological systems, as noted below.

4.2 Social-ecological systems influencing the control of *Acacia mearnsii*

There are a number of socio-cultural factors that militate against the control of *Acacia mearnsii* in communities surrounding the GGHNP. An analysis of the characteristics of the households indicated that 93 (74%) of the households were headed by females, 79 (63%) were aged forty and above and 35 (28%) comprised five or more members, while 93 (74%) earned less than R2 000 (US$150.49) per month. Communities around the GGHNP regard *Acacia mearnsii* as a resource rather than an environmental nuisance. The species has a number of domestic, environmental, cultural and medicinal uses within these communities.

Therefore, while there are numerous factors that impede the control of the species, including the state of the biophysical environment and the high costs associated with control programs, the role that the species plays in the livelihoods of local communities is the biggest factor. As demonstrated in the preceding sections, *Acacia mearnsii* is a “keystone species” in rural communities because of the vital role that it plays in meeting the needs of these communities. This reality is shown by the reluctance of these communities to destroy the tree, as well as their eagerness to grow it around their homes (Figure 1). Even though the utility of invasive species has been noted as a crucial aspect in determining the choices that rural communities make when using the species to meet various needs such as energy, shelter, medicine, food, spirituality and culture and income (Kull et al 2011), the results of this study

illustrate how these needs vary according to uniqueness of social-ecological context, which is elucidated below.

4.2.1 Domestic and Environmental Uses of Acacia mearnsii

Whereas the WfW Program was founded as far back as 1995 it was not until 2003 that the program was adopted as the ISCU's strategy for invasive species control in the GGHNP. Though there is a dearth of information about when the species has been regarded as a serious problem in the park, the need to control *Acacia mearnsii* within the GGHNP is enunciated in the park's management plan, which depicts invasion by the species as a national problem in terms of CARA (Act 43 of 1983). However, despite concerted efforts to manage the species, *Acacia mearnsii* remains an important species in the communities living around the GGHNP because of the role it plays in the livelihoods of these communities. Figure 3, illustrates the percentage of households that rely on *Acacia mearnsii* for different purposes. *Acacia mearnsii* is a source of a number of products that are required by the local communities on a daily basis. These include charcoal, aromas, cosmetics, handicrafts and furniture, most of which are sold locally or produced for domestic use. The tree also has a number of environmental uses, including provision of shade, windbreaks, as well as protection of homesteads from lightning and erosion. This explains why about 51.2% of the households had stands of the species at their homesteads. Thus, the species is grown and protected due to the value that local communities attach to it, in terms of its contribution to their welfare. Much less known to these communities are the insidious environmental impacts of protecting the species and the long term damage it causes to the sustainability of ecosystem services. Due to their limited understanding of the impact that *Acacia mearnsii* has on the environment, 64% of the household heads who were included in the survey either disagreed or strongly disagreed that the species is a source of environmental problems.

Nature of knowledge held and poverty also shaped the perceptions that local communities hold regarding the environmental impacts of the species. For instance, only 36.8% acknowledged that the species contributed to the drying of streams. Thus, the majority of the household heads could not link the prevalence of the species to the hydrological cycle of the environment in which they live. However, environmental awareness did not seem to be wholly influenced by level of education attained by the respondents. Of the majority of the 46 household heads who demonstrated some knowledge about the link between the species and stream discharge, 29 had not acquired any formal education beyond primary level. With the correlation coefficient of 0.15 ($p>0.05$), it can be argued that level of education had no significant influence on level of environmental awareness. Consequently, though limited understanding of broader issues related to the environmental impacts of *Acacia mearnsii* invasion was evident in the survey responses from all six village communities, lack of formal education among community members did not seem to directly contribute to lack of environmental knowledge, or attitudes and practices that promote the spread of the species.

Instead, environmental awareness was more linked to one's means of livelihood, such as requirements for energy, shelter and safety than to issues that are remotely connected to their welfare, such as tourism and wildlife conservation. For instance, the majority of the 44% of the household heads who noted that *Acacia mearnsii* suppressed the growth of grass relied on livestock holding as a means of livelihood. It was easy for them to notice the diminution of pastures in invaded areas because it was directly linked to their livelihoods. Similarly, proneness of invaded areas to fire was more readily observed by most household heads. Not much importance was attached to the impact of *Acacia mearnsii* on wildlife habitats, as only 13.6% reported that the species had an effect on

these habitats. This can easily be explained in terms of lack of direct access to wildlife related benefits in the GGHNP by these communities. However, another explanation for this scenario could be that local communities were more concerned about the impacts that lead to noticeable drastic environmental changes than to the more insidious ones. For example, about 67.2% of the household heads reported that areas that have been invaded by *Acacia mearnsii* were susceptible to veldt fires, compared to other areas. Similarly, 82.6% of the household heads indicated that the destruction of the species promoted erosion.

It can therefore be argued that programs meant to control the species must be planned in such a way that they simultaneously meet the development needs of local communities, including poverty reduction. Poverty reduction does not only enhance the purchasing power of the communities but it also augments the access of these communities to better energy sources such as electricity or to resources such as fencing materials, thus reducing the need to depend on natural products from IAS.

However, poverty seems to be the driving force responsible for shaping the perceptions of local communities regarding the value of *Acacia mearnsii*. A total of 87.9% of the household heads either agreed or strongly agreed that the species is an important resource to their villages. Thus, there is amble evidence showing that the tree is central to their livelihoods. Their low purchasing power explains the high percentage of people who use the species as noted in Figure 3. Consequently, 75% of the household heads would like the species to be conserved, while 76.4% noted that they would not want to see the tree destroyed. This therefore explains why the WfW Program is receiving low support from local communities, despite the employment opportunities created by the program.

As shown by the results of this study, high levels of poverty and unemployment force many households to depend on woodland products for a wide range of purposes. As a result of low income levels, most households in the surveyed villages cannot afford electricity. Consequently, they rely on wood fuel for heating and cooking. High unemployment rates can be explained in terms of lack of formal education and skills among the villagers. This limits their access to the job market. About 72% of the households who were included in the survey were headed by individuals who had only received secondary education or less. Approximately 47.2% of these households had either received primary education only or not received any formal education at all. However, what is required the most is education that promotes sustainable behavior, rather than mere formal education. Jahn et al. (2011) argue that one of the most important keys to more sustainable behavior in our society may be a reorientation of the education towards more sustainable development.

Environmental awareness campaigns could complement poverty reduction programs because of their potential to provide a better information base that is necessary for maintaining the sustainability of ecosystems of goods and services within the communities affected by IAS. The argument by Shackleton and Gambiza (2007) that the clearing of alien species may benefit from a better understanding of the social needs, perceptions of degradation by the various stakeholders and ecological dynamics of the area is therefore valid in this context. Resistance against control programs stems from the proclamation of a buffer zone in spaces where communities have different land use goals. Local communities therefore have legitimate grounds for not cooperating since they regard this initiative as a way of depriving them of their livelihood needs.

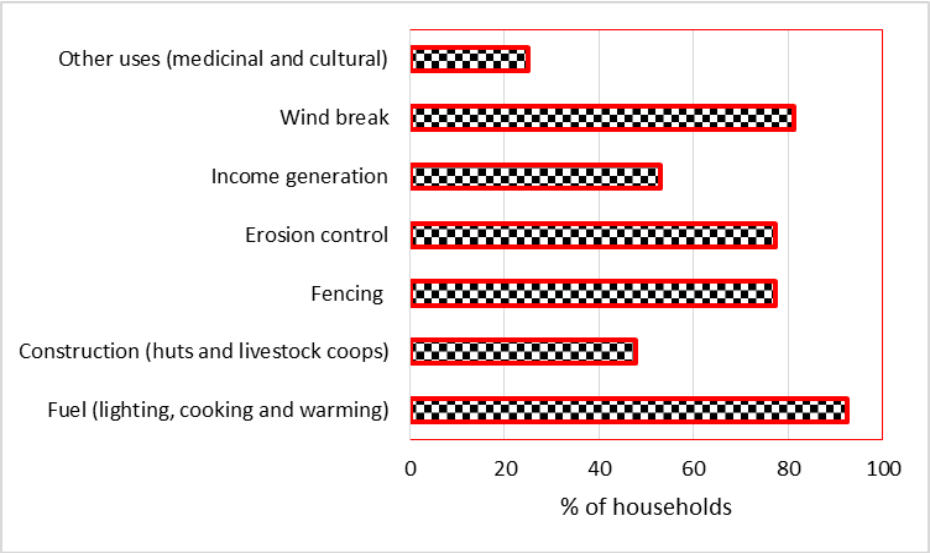

Figure 3. Percentage of households relying on *Acacia mearnsii* for different purposes

Responses from some members of these communities manifest the extent to which the species is a valued asset to these communities.

One villager remarked:

"We live here in the mountains. This tree helps us because it provides windbreaks and reduces erosion, which are prevalent here."

A considerable number of households grow the species as a way of reducing soil erosion around their homesteads. Due to shortage of land many households live on steeply inclined land. *Acacia mearnsii* is one of the most widely grown trees because of its extensive root network which binds the soil together, as well as its ability to grow quickly. This is one of the reasons why local communities are at loggerheads with park authorities, whose quest is to eradicate the species completely and maintain an *Acacia mearnsii* free buffer zone between the park and the villages. In line with the policies of the Department of Environmental Affairs, buffer zones are areas that are adjacent to a national park, within which land use changes could affect the national park.

Acacia mearnsii is one of the most reliable and readily accessible sources of energy. Its high quality wood is used for heating, lighting and cooking by most households.

"This tree must be conserved because it is very important to us. We use it for cooking and for warming ourselves on cold days, especially in winter," Remarked one villager.

The species is also widely grown as a fence and as a protection barrier for some homesteads. One villager quipped:

"These trees provide a barrier against cars that stray from the road. Thus, they prevent motorists from killing people or damaging our houses."

Acacia mearnsii is protected by local communities and the majority of the community members grow it around their homes. When asked why they grow the tree some community members cited reasons such as protection against lightning and use of *Acacia mearnsii* stands as windbreaks. At most homesteads the black wattle trees form a hedge around dwellings and livestock coops.

4.2.2. Cultural Factors Inhibiting Control of Acacia mearnsii

Even though *Acacia mearnsii* was introduced from Australia, it has now acquired some cultural significance among communities living around the GGHNP. There are cultural

practices that protect *Acacia mearnsii* and provide refugia for the species, for example the prohibition of clearing of trees in areas where initiation ceremonies are conducted. Another type of refugium are graveyards, many of which end up overgrown and infested with *Acacia mearnsii*, as shown in Figure 4, due to poor maintenance. Digging or weeding places near graves which do not belong to one's relatives is considered as a taboo. Once outgrown by trees mechanical methods involving digging out roots without damaging the graves become difficult to apply. This worsens infestation by the species. Both types of refugia, together with patches of the species that occur around homesteads are the springboard from which the species invades the GGHNP and its surroundings.

4.2.3 Medicinal Use of Acacia mearnsii

Qwaqwa communities use *Acacia mearnsii* for a wide range of medicinal purposes. Interviews held with community leaders and traditional healers (locally known as *ngaka-ya-setso* in Sesotho, the local language) revealed that the species is used for treating heart related problems, rash, tooth ache, respiratory infections and common cold, among other ailments. The practice of traditional medicine is closely intertwined with both the local culture and poverty. For instance, one traditional healer who was interviewed claimed that he knows how to use the species to make lucky charms for dispelling evil spirits. However, herbal medicines are popular with community members who are too poor to afford primary health care services. Nearly 70% percent of the households who were included in the questionnaire survey were unemployed and 96% of the households had monthly incomes that were less than R5 000 (approximately US$380). Thus, socially and culturally the species resonates well with the needs of local communities.

Figure 4. *Acacia mearnsii* infested graveyard in Botjhabelo village

4. CONCLUSIONS

There are many factors that impede the control of *Acacia mearnsii* in the GGHNP and abutting communities. However, the dependence of these communities on *Acacia mearnsii* for livelihood is the main reason why these communities protect the species and show reluctance in supporting government funded control programs. This makes the species an

integral component of local social-ecological systems. Without alternative sources of energy, raw materials and income, or better access to health and employment epportunities these communities will continue to rely on the species for many years to come. The protection of the species has created refugia that act as a springboard from which the species is spreading and undermining the ecological integrity of the whole region, including wildlife conservation areas such as the GGHNP. Whereas environmental education and awareness campaigns are useful in containing the spreading of the species, without addressing the local social-ecological context such measures on their own will yield little positive results. Accordingly we recommend the integration of the needs of the communities into rural development programs that enhance the affluence and resilience of these communities while limiting their dependence on IAS for livelihood. Without meaningful improvement to access to employment and their livelihood requirements, such as energy, primary health care, shelter and disposable income, the efforts of conservationists, planners and policy makers will remain futile, as the species contunues to gain ground and spread into new teritories from refugia provided by local communities. With increased investment in poverty reduction and rural development programs, introduction of alternative livelihoods that lead to improved access to alternative sources of energy, the need to protect *Acacia mearnsii* by local communities will eventually fall away, as local communities become more affluent and less dependent on the species. That way, the ground lost may be regained.

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