Valuation of ecosystem services at health clinic gardens in South Africa

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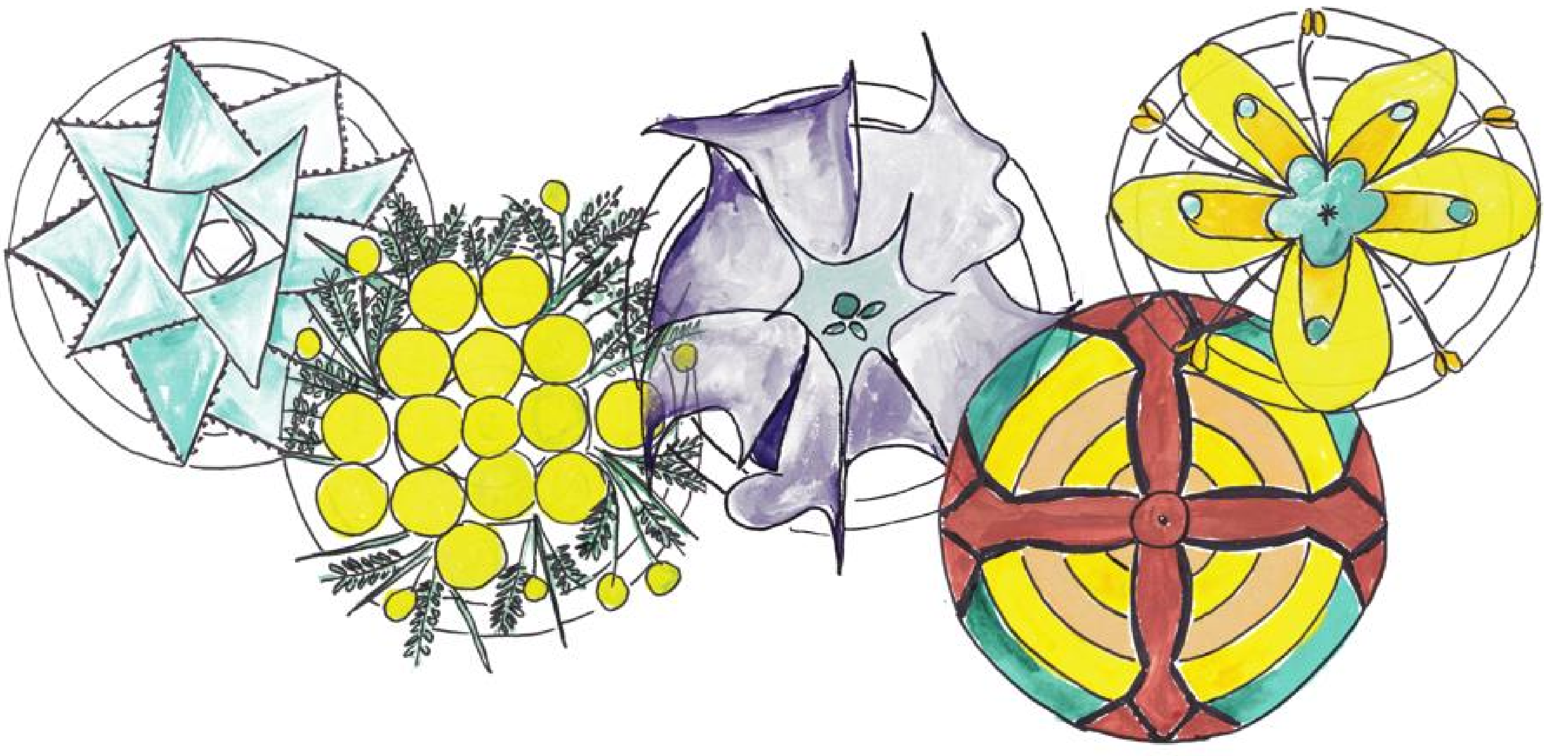

PREFACE

"The world is His garden, filled with provisions for us. It's up to us to discover them and use them wisely—and with thankful hearts"

Francine Rivers

"There lies all about us, if only we have eyes to see, a creation of such spectacular profusion, such spendthrift and extravagant richness, such intricate and absurd detail, as to make us drunk with astonished wonder."

Michael Mayne

I am very privileged to have grown up on two nature reserves as my father is a nature conservationist. On these reserves, my passion and love for nature grew and led me to pursue further studies in environmental sciences. Having this privilege has allowed me to learn many lessons I believe I would not have learned if I grew up in a different setting. South Africa is very rich regarding its fauna, flora, human races, cultures, geology and biomes. Therefore, it is such a pleasure and privilege to be part of ecological remediation and sustainable management studies in South Africa. I want to use the knowledge that I have obtained to have a positive impact on the environment and make a difference in our world.

Many people participated in this study and contributed to its success. I want to express my sincere appreciation for the involvement and support of the following people:

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- Finally, I want to give praise to our heavenly Father for giving me passion and the opportunity to study his wonderful creation.

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ABSTRACT

Health clinic gardens provide a variety of ecosystem services (ESs) that when properly valued may inform the larger community of the benefits of having a garden, especially concerning food and health security and increase sustainable gardening practices that will contribute to the building of resilience. However, there is not much research conducted on the value of ecosystem services provided by health clinic gardens. Previous research on health clinic gardens focused on the presence of natural, physical and social resource diversity as well as on different stakeholder perceptions. In order to address this gap, existing ecosystem service valuing techniques were investigated and implemented to determine the ecological, economic, social and cultural value of health clinic gardens in terms of different provisioning, regulating, cultural and supporting ecosystem services provided by health clinic gardens in the Dr Kenneth Kaunda District Municipality, North-West Province and Phokwane Local Municipality, Northern Cape Province. The perceptions of stakeholders on the presence and value of ecosystem services and presence of ecosystem disservices were obtained by interviewing 70 stakeholders (facility managers, groundskeepers, community members) at 32 clinics. A qualitative analysis was also used to obtain additional information from the interviews. The actual values of selected ecosystem services were determined by making use of market values, whereafter the perceived and actual values of the different ESs were compared and analysed. Actual values in contradiction of perceived values need to be emphasised during communication with all the stakeholders in the co-management process of the gardens as to increase the understanding of the importance of ecosystem services in maintaining human lives. The actual values were generally more than the perceived values, indicating that the stakeholders are not fully aware of the benefits the clinic gardens provide or the value of these benefits.

Key terms: cultural value, ecological value, economic value, ecosystem disservices, ecosystem services, interview schedule, qualitative analysis, social-ecological systems, social value, valuation.

OPSOMMING

Gesondheidskliniektuine voorsien 'n verskeidenheid ekosisteemdienste (ED) wat, indien waardes daarvan behoorlik bepaal word, dit die groter gemeenskap van die voordele van tuine kan inlig. Die groter gemeenskap moet veral ingelig word met betrekking tot voedsel- en gesondheidsveiligheid, en verhoging van volhoubare tuinboupraktyke wat sal bydra tot die bou van veerkragtigheid. Daar is egter nie veel navorsing gedoen oor die waardes van ekosisteemdienste wat deur gesondheidskliniektuine voorsien word nie. Vorige navorsing oor gesondheidskliniektuine fokus op die teenwoordigheid van natuurlike, fisiese en sosiale hulpbron diversiteit sowel as op die persepsie van verskillende rolspelers. Ten einde hierdie gaping aan te spreek, is bestaande ekosisteemdienswaardasie-tegnieke ondersoek en geïmplementeer om die ekologiese, ekonomiese, sosiale en kulturele waardes van gesondheidskliniektuine te bepaal. Hierdie waardes is in terme van die verskillende voorsienings-, regulerings-, kulturele- en ondersteunings-ekosisteemdienste wat deur gesondheidskliniektuine in die Dr Kenneth Kaunda Distriksmunisipaliteit (Noordwes Provinsie) en Phokwane Plaaslike Munisipaliteit (Noord-Kaap Provinsie) voorsien word. Dit is behaal deur 70 belanghebbendes (fasiliteitsbestuurders, tuinomsieners en gemeenskapslede) by 32 klinieke te ondervra om hul persepsies te verkry oor die teenwoordigheid en waardes van ekosisteemedienste en die teenwoordigheid van ekosisteem-nie-dienste. Kwalitatiewe analise is ook gebruik om bykomende inligting uit die onderhoude te verkry. Die werklike waardes van geselekteerde ekosisteemdienste is bepaal deur gebruik te maak van markwaardes, waarna die waarneembare en werklike waardes van die verskillende ED vergelyk en ontleed is. Werklike waardes, in teenstelling met waargenome waardes, moet beklemtoon word tydens kommunikasie met al die belanghebbendes in die medebestuursproses van die tuine, om die begrip van die belangrikheid van ekosisteemdienste in die handhawing van menslike lewens te verhoog. Dit moet gedoen word omdat daar bevind is dat die werklike waardes oor die algemeen hoër was as die waargenome waardes. Dit wil voorkom of die rolspelers van die kliniektuine nie ten volle bewus is van die voordele wat kliniektuine bied nie, en dat hulle ook nie bewus is van die waarde van hierdie voordele nie.

Sleutelterme: ekologiese waarde, ekonomiese waarde, ekosisteemdienste, ekosisteem-nie-dienste, kulturele waarde, kwalitatiewe analise, onderhoudskedule, sosiaal-ekologiese sisteme, sosiale waarde, waardasie.

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Chapter 1: Introduction

CHAPTER 1 - INTRODUCTION

1.1 Problem statement and research rationale

In 2014 already, it was stated that due to population growth and urbanisation, 2.5 billion people were expected to be added to the world's population by 2015, of this approximately 90% will occur in Africa and Asia (United Nations, 2014). Furthermore, Africa is projected to become 56% urban by 2050 (United Nations, 2014), as Africa had a population growth rate of 2.55% in 2010-2015, which is the highest rate of population growth among major areas (United Nations, 2015). As our global population grows, the amount of space we require increases and more pressure is put on our limited resources.

Humans live in cities and are dependent on good management to maintain a quality of life for the future; therefore, it is important to understand urban ecosystems in an ecological sense (Grimm *et al*., 2000). If natural landscapes continue to be lost due to cultivation, mining and urban expansion, no natural areas will be left by 2050 except those that are already in protected areas in the Gauteng, KwaZulu-Natal and North West Provinces of South Africa (Tibane, 2017). In the North West Province of South Africa, the Department of Health believed that gardens could provide many benefits, including combating the effects of urbanisation, as gardens often support a rich assembly of plant and animal species (Davoren, 2009; Lubbe *et al*., 2011). Consequently, gardens were developed at most of the urban and rural community health clinics in the North West Province (Cilliers *et al*., 2018). Clinic gardens in South Africa can provide many direct and indirect benefits to households and communities (Cilliers *et al*., 2013). These benefits are mostly in the form of ecosystem services (ESs), the benefits that people directly or indirectly obtain from ecosystem processes and functions (Costanza *et al*., 1997; Costanza *et al*., 2017), which aid in safeguarding human well-being and increases socio-economic development (Davids *et al*., 2016).

Gardens can however also be a source of ecosystem disservices (EDSs). EDSs refer to natural or anthropogenic-impacted ecosystem functions negatively affecting human well-being (Davids *et al*., 2016; Lyytimäki & Sipilä, 2009; Von Döhren & Haase, 2015). It is important to note that for one person a tree may be aesthetically pleasing, may increase comfort and provide shade, while for another person it may be a source of allergens, leaf litter and an obstructed view (Escobedo *et al*., 2011). It is important to study urban EDSs as they affect urban residents daily at their place of work, where they live and where they commute (Speak *et al*., 2018).

A study was done by Cornelius (2016) on health clinic gardens in the Bojanala District Municipality, North West Province, South Africa, which indicated that these gardens are important sources of ESs to the clinics and the surrounding communities. In that study, the natural resources, physical resources, social resources, stakeholder perceptions on ESs, and best practice health clinic gardens were determined. However, the value of the ESs provided by the health clinic gardens was not determined. Therefore, it was suggested by Cornelius (2016) that further research on health clinic gardens needs to be done specifically on the ecological, political and economic valuation of ESs. These values will add accurate and quantitative value to the perceptions of the stakeholders on ESs at health clinic gardens. Constanza *et al*. (2017) supported this by stating that through conducting studies on valuation in urban environments one can obtain a better understanding of the spatial interaction between human, natural, built and social capital which contributes to human well-being. By recognising the value of natural capital (i.e. ecosystems), government programmes are provided with a foundation that can play a role in reducing inequality, unemployment, and poverty (Anderson *et al*., 2017). Additionally, this can also increase stewardship, monitoring, and restoration of valuable natural capital (Anderson *et al*., 2017).

Knowledge about areas where social and environmental dynamics intersect is crucial (Cornelius, 2016). This knowledge will create perspective and understanding of how power and competing value systems are integral to the development and effectiveness of social-ecological systems (Cornelius, 2016). There is a gap in research conducted on social-ecological systems as most research on this topic have been conducted in developed countries even though urbanisation is occurring rapidly in developing countries in the Southern Hemisphere (Cornelius, 2016).

Many ES studies have focussed on only one or a few ESs provided by an ecosystem. However, Costanza *et al*. (2017) stated that the full range of ESs must be considered in order to understand the entire system and to ensure the maximum number of benefits is obtained. This study will address this by incorporating 18 different ESs as explained in TEEB (2011).

South Africa's National Strategy for Sustainable Development (NSSD) has five goals of which an increasing awareness and understanding of the value of ESs to human well-being is one (Tibane, 2017). This dissertation will address this goal by assessing the perceived value stakeholders have of ESs which will be compared to actual values of some of the ESs.

If we acquire the knowledge of techniques to value ESs, it can improve the way we see and use our natural resources by especially improving our appreciation thereof. If we realise the importance of ESs, it can motivate people to conserve green infrastructure throughout urban areas. It is therefore important to increase the intensity and relevance of urban ecological research.

1.2 Background: Research conducted at health clinic gardens

Cilliers *et al*. (2018) and Cornelius (2016) explored the idea that health clinic gardens in South Africa, specifically in the Bojanala district of the North West Province, could be considered complex social-ecological systems. Social-ecological systems refer to humans and biophysical systems being inter-connected due to the fact that they co-evolved and co-exist (Berkes *et al*., 2003; Walker & Salt, 2006; Langemeyer *et al*., 2016). The study conducted by Cornelius (2016) consisted of three main parts, namely natural resource diversity, physical resource diversity and social resource diversity, which all contribute to the social-ecological system. The results of this study were then used to determine best practice clinics in order to make recommendations to improve the potential of the health clinic gardens (Cornelius, 2016). Cornelius (2016) determined the plant species composition, floristic and functional diversity, resource diversity, and the perceptions of different stakeholders on ESs and EDSs at each health clinic garden. Cornelius (2016) also compared the health clinic gardens with peri-urban and urban domestic gardens as well as rural home gardens in the North West Province. Results of this comparison indicated that the floristic and physiognomic diversity was similar amongst the different gardens. Stakeholder perceptions on ESs and EDSs differed from person to person, therefore indicating that each person had a unique contribution to make, which is important for the garden to exist and be maintained. Cornelius (2016) concluded that a combination of natural, physical and social resources at health clinic gardens could improve sustainable gardening practices. According to Cornelius (2016), future research needs to focus on the multiple functions of health clinic gardens and the benefits they provide.

Cilliers et al. (2018) used data from the study of Cornelius (2016) and discussed how health clinic gardens can be used to address some of the challenges regarding optimising garden ESs.

Du Toit *et al*. (2018) stated that there is a lack of in-depth ES studies in sub-Saharan Africa. Many of the studies reviewed by Du Toit *et al*. (2018) are only on the perceptions of participants with no accompanying measured values. Additionally, the studies on ESs were mainly on regulating and provisioning services with supporting services receiving the least attention (Du Toit *et al*., 2018).

1.3 Aim and objectives

The research aim is to explore the actual and stakeholdersôperceived presence and value of ecosystem services and disservices provided by health clinic gardens in the Dr Kenneth Kaunda District Municipality and Phokwane Local Municipality.

The following three objectives were identified for this study:

- Objective 1: To conduct an ecological survey to determine the social, cultural, economic and ecological value of a variety of ESs and EDSs (actual values of ES).
- Objective 2: To develop and conduct a social survey to determine the social, cultural, economic and ecological value of a variety of ESs and EDSs as perceived by different stakeholders (perceived values of ES).
- Objective 3: To compare/test relationships between the actual and perceived values of ESs.

1.4 Dissertation outline

This dissertation consists of 7 chapters. The first chapter (introduction) contains the problem statement and research rationale, the aims and objectives of this study and overall materials and methods including information on the study area. Chapter 2 (Literature Review) elaborates on recent research on urbanisation, urban gardens, gardening in South Africa, clinic gardens and Tswana tshimo, gardens as social-ecological systems, resilience thinking, sustainable development, sustainable livelihood approach, co-production of knowledge, ESs, EDSs and the valuation of ESs. The first results chapter, namely Chapter 3 depicts the presence and actual value of ESs and EDSs provided by health clinic gardens, which is in alignment with objective 1, to conduct an ecological survey to determine the social, cultural, economic and ecological value of a variety of ESs and EDSs. Chapter 4 concerns the perceived presence and values of stakeholders on ESs and EDSs provided by health clinic gardens. Chapter 5 contains the qualitative research data findings obtained from the interviews. Chapter 4 and 5 are in alignment with objective 2, to develop and conduct a social survey to determine the social, cultural, economic and ecological value of a variety of ESs and EDS as perceived by different stakeholders. The last results chapter (Chapter 6) consolidates the actual values with the values as perceived by the stakeholders on ESs and EDSs. Chapter 7 contains the conclusion and recommendations of this study.

1.5 Materials and methods

1.5.1 Study area

This study was part of a wider research project on health clinic gardens and community engagement in the North-West Province and Northern Cape Province, South Africa.

The North West Province is located in the inland of South Africa (**Figure 1-1**), bordering Botswana (STATS SA, 2018a). The North West Province consists of four district municipalities, namely Bojanala Platinum District Municipality (Rustenburg region), Dr Kenneth Kaunda District Municipality (Klerksdorp region), Dr Ruth Segomotsi Mompati District Municipality (Vryburg region) and Ngaka Modiri Molema District Municipality (Mafikeng region) (STATS SA, 2018a).

The health clinics that will be used for this particular study is located in the Dr Kenneth Kaunda District Municipality that covers approximately 14 642 km^2 and used to consist of four local municipalities, namely Ventersdorp, Tlokwe (Potchefstroom), Matlosana (Klerksdorp, Stilfontein, Orkney, Hartbeesfontein) and Wolmaransstad-Maquassie Hills (Wolmaransstad, Leeudoringstad, Makwassie and Witpoort). These local municipalities have been changed by amalgamating Ventersdorp and Tlokwe local municipalities to form the Ventersdorp/Tlokwe local municipality known as the J.B. Marks local municipality (STATS SA, 2018a). For this study, the previous four local municipalities will be used (**Figure 1-1, Table 1-1**).

The Northern Cape Province is the largest, but the least densely populated province in South Africa and consists of five district municipalities and 26 local municipalities (STATS SA, 2018b). The five districts are Z.F. Mgcawu District Municipality, Pixley Ka Seme District Municipality, Namakwa District Municipality, John Taolo Gaetsewe District Municipality and the Frances Baard District Municipality (STATS SA, 2018b). Clinics will be selected in the Phokwane Local Municipality which is one of the local municipalities of the Frances Baard District Municipality (**Figure 1-1, Table 1-1**) (Steinhobel *et al*., 2015).

The Dr Kenneth Kaunda District is situated in the Grassland Biome, with small patches of Savanna Biome throughout the district (Rutherford *et al*., 2006). The Phokwane local district is located in the Savanna Biome (Rutherford *et al*., 2006). The Grassland Biome, as well as the Savanna Biome, is in a summer-rainfall area (Rutherford *et al*., 2006).

The Dr Kenneth Kaunda district consists of three bioregions, namely Dry Highveld Grassland Bioregion (Gh), Mesic Highveld Grassland Bioregion (Gm) and the Central Bushveld Bioregion (SVcb) (Rutherford *et al*., 2006). The Phokwane local municipality consists of Eastern Kalahari Bushveld Bioregion (SVk) (Rutherford *et al*., 2006).

Table 1-1: The 32 health clinics that were investigated.

District Municipalities	Sub-districts	Health clinics
Dr Kenneth Kaunda	Tlokwe	Boiki Tlhapi
		Lesego
		Mohadin
		Promosa
		Steve Tshwete
		Top City
	Matlosana	Alabama
		Botshabelo
		Delekile Khoza
		Empilisweni
		Grace Mokhomo
		Jouberton
		Kanana

		Khuma
		Majara Sephapo
		Marcus Zenzile
		N.M. Pretorius
		Tigane
		Tsholofelo
	Ventersdorp	J.B. Marks
		Kgotso
	Wolmaransstad-Maquassie Hills	Bophelo
		Kgakala
		Leeudoringstad
		Segametsi Mogaetsho
		Tswelelang 1
		Tswelelang 2
Frances Baard	Phokwane	Jan Kempdorp
		Jerry Botha
		Nomimi Mothibi
		Pampierstad
		Valspan

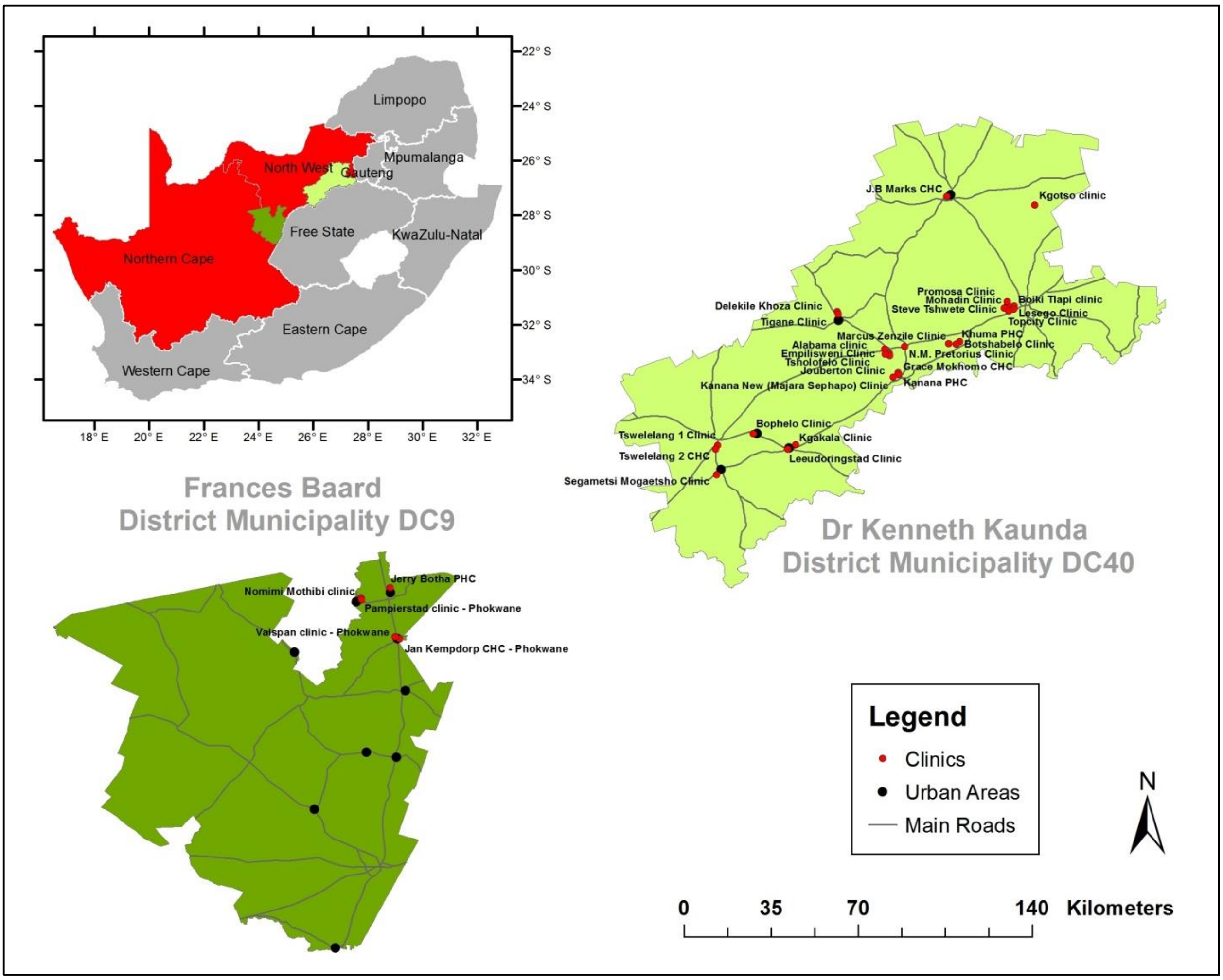


Figure 1-1: Study area: Dr Kenneth Kaunda District Municipality, North West Province and Frances Baard District Municipality, Northern Cape Province, South Africa.

1.5.2 Statistical and analytical procedures

The design of the study was a qualitative-quantitative descriptive survey. Thus, this study comprised of a multiple method (or multimethod), i.e. quantitative and qualitative approaches will be followed. The multimethod refers to research where multiple forms of qualitative and quantitative data are collected (Creswell, 2015). Qualitative data will be in the form of interviews and observations (Chapter 5), while quantitative data will be in the form of survey data (Chapter 3 and 4).

In Chapter 3 ecological surveys were used to determine the actual value of some ESs. Plant species were identified by an expert in garden plants and further aided by literature. The potential uses of the identified species were then recorded, and the actual value of some ESs determined. EDSs were also determined by making observations. SPSS Version 25 was used for hierarchical linear models where the sub-districts were used as the subject. The p-values were determined. A small p-value (< 0.05) is accepted as adequate evidence that the result is statistically significant (Ellis & Steyn, 2003). The effect size was determined between the five sub-districts, as it is independent of the sample size and is a measure of practical significance (Ellis & Steyn, 2003). Practical significance, according to Ellis and Steyn (2003) refers to a difference being large enough that it could affect practice. An effect size of 0.2 was regarded as small, an effect size of 0.5 was medium and an effect size of 0.8 was large. In this chapter contingent and direct market valuation techniques were also used to determine the economic value of the ESs in the clinic gardens. The stakeholdersô perceptions were then compared to the calculated economic value of the ESs in Chapter 6.

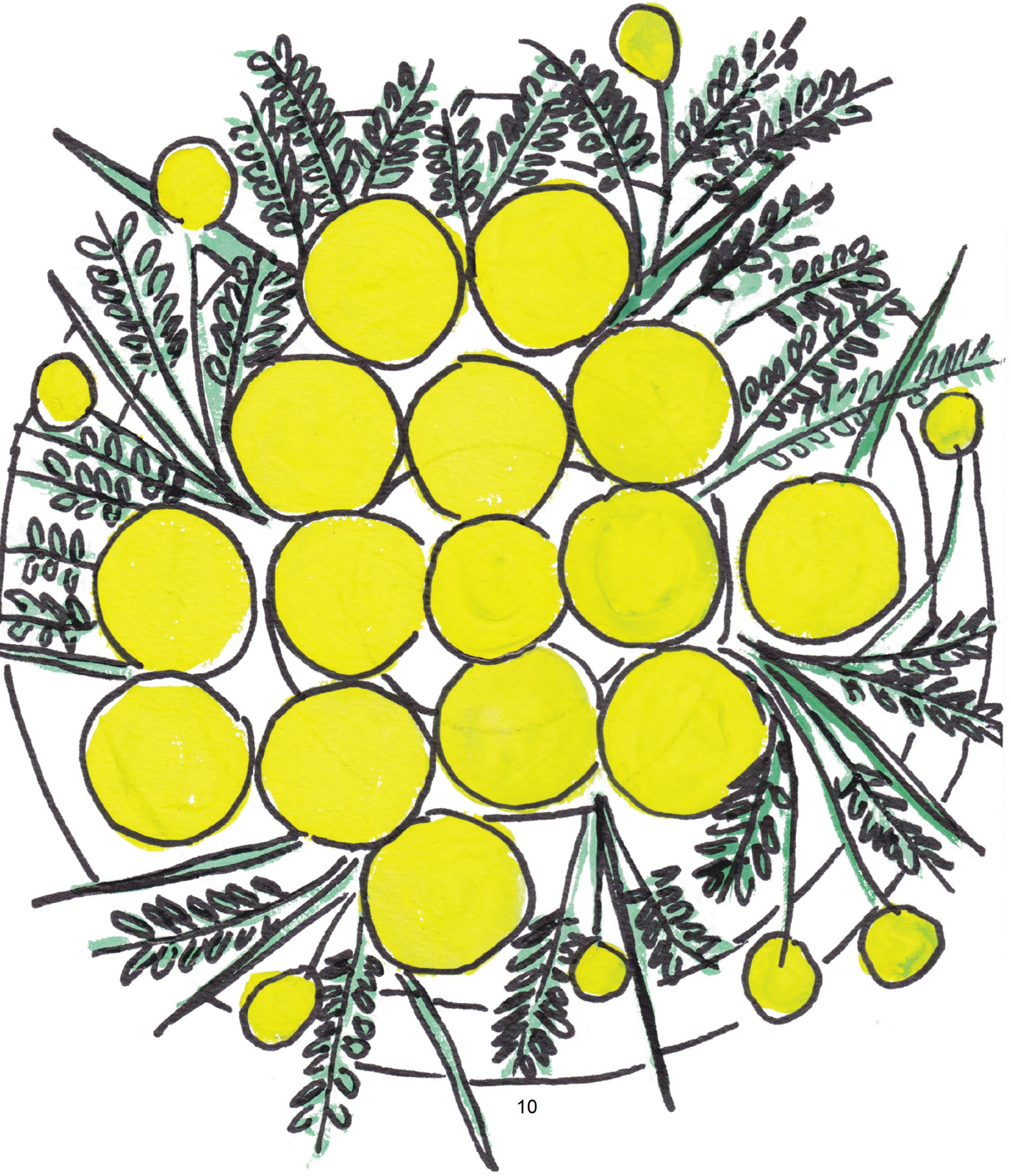
In chapter 4 the results of the interviews with 70 different stakeholders were discussed. Questions were asked on the presence of ESs and EDSs, the value of ESs and the willingness-to-pay (WTP) for ESs. In Chapter 4 Cronbachô s coefficient alpha was used, which allows one to sum all interrelated items in order to obtain an overall score for each participant (SAS, 2013). SPSS Version 25 was used for hierarchical linear models where the sub-districts were used as the subject to compare demographic groups. The p-values were determined.

In chapter 5 the qualitative data were analysed by using the ATLAS.ti software programme (Friese, 2014). The data were coded from where categories and themes were derived which was interpreted (Creswell, 2014).

In Chapter 6 nonparametric correlations were used as this method determines monotone associations between all ordered variables without there being strict assumptions of normality (Swanepoel *et al*., 2011).

More detailed descriptions of the research design and methods used are included under materials and methods in each results chapter (Chapters 3, 4, 5 and 6).

Chapter 2: Literature review



CHAPTER 2 - LITERATURE REVIEW

2.1 Introduction

Due to human populations becoming more urbanised, human and natural environments are becoming more integrated. There is thus a need to understand these complex interactions between humans and the environments that we are dependent on. This chapter provides some background information on urbanisation, global trends of urban ecosystems as well as the benefits and types of urban gardens. Health and well-being are discussed to provide some background on health clinics in South Africa. General gardening practices in South Africa are discussed, which includes the traditional Tswana tshimo garden layout. Gardens as social-ecological systems are also discussed as clinic gardens are good examples of places where social and ecological systems in urban environments are integrated. Through studying and understanding, social-ecological systems resilience could be increased. Through this mindset of óresilience thinkingô sustainable development could increase which could link socio-economic and ecological factors known as the sustainable livelihood approach. The sustainable livelihood approach makes use of five types of capital, namely natural, human, economic or financial, physical and social capital. These capitals are used to assign values to a variety of ecosystem services (ESs). The different ESs are discussed as well as EDSs that affect human lives. Various valuation techniques are discussed that could be used to assign values to ESs.

2.2 Urbanisation

McDonnell and Pickett (1990) characterised urbanisation as ñan increase in human habitation, coupled with increased per capita energy consumption and extensive modification of the landscape, creating a system that does not depend principally on local natural resources to persistò. Better education, better health, more access to social services, and more opportunities for cultural and political participation are some of the reasons for people to prefer urban living (United Nations, 2014). Urbanisation does, however, affect disturbance regimes; biota; the structure of a landscape; cultural, economic and political factors and causes physiological stresses such as air pollution (McDonnell & Pickett, 1990). Consequently, urbanisation causes challenges in maintaining urban green spaces as well as maintaining human health and well-being (Tzoulas *et al.*, 2007).

In 2015 the world population was 7.3 billion, meaning that approximately one billion people have been added to the world population in 12 years (United Nations, 2015). In 2014, globally approximately 54% of people were living in urban areas (United Nations, 2014), while in 2016 approximately 45% (United Nations, 2016). It is expected that the worldõs rural population will decrease to approximately 40% by 2030 (United Nations, 2016). The worldôs urban population made up 30% of the global population in 1950 (746 million), was estimated to be 3.9 billion in 2014 and it is expected to be 66% by 2050 (United Nations, 2014).

Almost 90% of the worldôs rural population resided in Africa and Asia in 2014 (United Nations, 2014). By 2050 it is expected that the two fastest urbanising continents, Africa and Asia, will become 56% (Africa) and 64% (Asia) urban (United Nations, 2014). Africa had a population growth rate of 2.55% in 2010-2015, which is the highest rate of population growth among major areas (United Nations, 2015). It is expected that 2.5 billion people will be added to the worldôs population by 2050 due to population growth and urbanisation, of this approximately 90% will occur in Africa and Asia (United Nations, 2014).

According to Shackleton *et al*. (2018), the rapidly increasing population results in more attention required by environmental and socio-economic consequences of this growth. The research conducted by Miller (2005) and Stokes (2006) indicated that urbanisation is creating a ógapô between humans and the natural world because humans do not depend on local ecosystems but rather on their modern lifestyles. As people in cities lose connection with local ecosystems, they fail to realise how dependent they are of nature (Samways, 2007).

2.3 Urban Ecosystems

An ecosystem could be defined as a section of the earth of any size that comprises interacting biotic and abiotic components that also interacts with its surroundings (Grimm *et al*., 2000). Urban ecosystems, on the other hand, comprise of human-built structures that cover most of the land surface where high densities of humans live (Pickett *et al*., 2011). The unique energy signature of an urban ecosystem distinguishes it from a natural ecosystem (Collins *et al*., 2000). The processes of photosynthesis or chemosynthesis ópowersô a natural ecosystem, while external sources of energy are required to ópowerô a city (Collins *et al*., 2000).

Pickett *et al*. (2001; 2011) further stated that urban ecosystems can include the core of the city, suburban areas, exurbs, and smaller villages connected to more densely populated, built-up areas by commuting utilities, and hinterlands that are managed or affected by the energy and material from the urban core and suburban areas. Humans and their social and economic manifestations, as well as native and introduced plants, animals and microbes are included in urban ecosystems as the various organisms present (Pickett *et al*., 2011). Humans have direct control of the plant species present in the urban environment; therefore, it could be said that humans also control the habitat quality and quantity which is defined in terms of vegetation (Faeth *et al*., 2011).

Urban environments could be viewed as repositories of present and future biodiversity (Faeth *et al*., 2011) that are generally influenced by biophysical, ecological, social and economic drivers (Elmqvist *et al*., 2004). Consequently, there has to be an understanding of the socio-economic, ecological and evolutionary processes that influence the biodiversity of urban areas so that these areas can be preserved and biodiversity increased (Faeth *et al*., 2011).

Biophysical and ecological drivers potentially consist of factors such as climate change, species extinction and invasion, while social and economic drivers primarily consist of human population change, urban sprawl, real estate, and banking practices (Elmqvist *et al*., 2004). According to Grimm *et al*. (2000), the perception humans have as well as human choice and action often drive political, economic, or cultural decisions that initiate or respond to change in ecological systems.

Miller (2005) stated that in order to engage more people in natural areas, these natural areas have to have high aesthetic and conservation value as there are benefits to integrating nature into the built environment such as nurturing support for the preservation of biodiversity, creating opportunities for indigenous species, and improving the human condition. It is important to find ways to effectively communicate conservation principles in such a way that people do not feel confronted but rather feel drawn together (Miller, 2005). It is important to effectively communicate the value and relevance of nature to the public so that they can understand how dependent we are of nature and to successfully conserve biodiversity (Miller, 2005). People become increasingly disconnected with the natural world mainly because more people than ever live in cities meaning that in future more people will reside human-dominated environments where the importance of nature is not fully appreciated and the essential ecological processes are hidden from view (Miller, 2005).

Humans alter landscapes, change the composition of the atmosphere, cause some species to go extinct while introducing new species, and mobilise nutrients and pollutants (Collins *et al*., 2000). Therefore, it could be said that humans today are a ñglobal ecological force able to affect every species and ecosystem on the planetò (Collins *et al*., 2000). Cities are among the most extremely changed ecosystems on the planet, with their boundaries also containing some of the most diverse ecological conditions (Collins *et al*., 2000).

Cities consist of many different land-use types which vary in sizes, including preserved natural areas, roads, concrete areas, golf courses, industrial parks, tree-lined residential streets and managed lawns of homeowners (Faeth *et al*. 2011; Collins *et al*., 2000). Therefore, it could be said that urban ecosystems are ñpatchyò. These patches created by fragmentation lead to populations being isolated and movement being reduced (Faeth *et al*., 2011). In order to understand the effect humans, have on habitat patch composition and pattern, one has to study historical, political, cultural and economic factors in addition to traditional variables such as competition, predation and nutrient availability (Collins *et al*., 2000).

There is a lack in the means to reverse the degradation of our natural heritage in a meaningful way (Miller, 2005), which could be due to experts struggling to communicate the importance and wonder of the natural world to the general public (Nabhan, 1995). Complex biodiversity concepts can be successfully communicated to people in simple ways (Nabhan, 1995). The challenge according to Nabhan (1995) is, however, making these complex concepts a vital interest to all human cultures. Urbanisation also has a homogenizing effect on biodiversity (Miller, 2005). Homogenization occurs when indigenous species are replaced by exotic species usually human-introduced, which can lead to a reduction in spatial diversity if unique endemic species are replaced by already widespread species (McKinney & Lockwood, 1999).

An urban ecosystem, like any other ecosystem, is dynamic and continuously changing (Collins *et al*., 2000). Biologists focus on the biodiversity that is changing and the need to conserve it, rather than to consider the people who are causing the changes and if conservation will happen (Stokes, 2006). Human intervention can, however, alter the recovery of an urban ecosystem from a disturbing event such as a fire or flood that is natural and usually followed by ecological succession, which is suppressed in urban ecosystems due to human intervention (Collins *et al*., 2000). Due to the fact that the decision about conservation lies mainly with the public, the isolation of humans from biodiversity due to urbanisation causes great concern (Stokes, 2006).

2.4 Urban gardens

According to Pudup (2008) "gardening heals the spirit, expands the mind, mends the broken body, and realises a deeply felt human need for connection with the earth and other people". Pudup (2008) further states that "organised garden projects are the sites, and gardening the practical path, of individual, social and spatial transformation". There are different types of gardens, of which Lin and Egerer (2018) identified community or allotment gardens, private gardens, easement gardens, and rooftop gardens or green roofs. Cilliers *et al*. (2018) have identified additional garden types in Sub-Saharan Africa. These gardens include food gardens, botanical gardens, clinic gardens and medicinal gardens.

2.4.1 Community or allotment gardens

According to Kurtz (2001) "community gardens are tangible arenas in which urban residents can establish and sustain relationships with one another, with elements of nature, and with their neighbourhood". Through these definitions, it is quite clear that gardens play an important role in the relationship people have with nature. Community gardens in Sub-Saharan Africa are privately owned and have the main purpose of fruit and vegetable production, social interactions and providing a sense of place (Cilliers *et al.*, 2018).

2.4.2 Private gardens

There are two types of private gardens, namely home and domestic gardens. Home gardens, according to Reyes-García *et al.* (2014), are places where biological and cultural diversity meet, sometimes used for small-scale, complimentary food production. These gardens are most often located in suburban areas and are the most prevalent form of urban agriculture (Lin & Egerer, 2018). Domestic gardens are privately owned spaces next to or surrounding residences usually consisting of lawns, ornamental and vegetable plots, trees, ponds, paths, patios and temporary buildings (Gaston *et al.*, 2005; Cilliers *et al.*, 2018). Home and domestic gardens in Sub-Saharan Africa are privately owned and managed by homeowners themselves. Domestic gardens have the main purpose of providing fruit and vegetables, being aesthetically pleasing, recreation, and environmental control (Cilliers *et al.*, 2018). Home gardens have the main purpose of the provision of medicine, production of fruit and vegetables, environmental control and a feeling of a sense of place (Cilliers *et al.*, 2018). According to Molebatsi *et al.* (2010), domestic gardens are considered to be luxury spaces mainly used for relaxation, play, keeping pets, outdoor eating and the cultivation of ornamental plant species. Additionally, home gardens play a role in preserving cultural history, as useful plant species have been selected over time to be planted in gardens (Molebatsi *et al.*, 2010).

2.4.3 Easement gardens

These gardens are regulated by the government but are located on private or community grounds (Lin & Egerer, 2018).

2.4.4 Guerrilla gardens

As the word “guerrilla” suggests, this is a rebel action in conflict with a dominant power (Adams *et al.*, 2015; McKay, 2011). Guerrilla gardeners attempt to make neglected neighbourhoods more beautiful and increase biodiversity (Adams *et al.*, 2015). Guerrilla gardening is, however, illegal activity as people alter land without the knowledge or permission of the authority (Adams *et al.*, 2015; Reynolds, 2008).

2.4.5 Rooftop gardens or green roofs

Any vegetation present on the roof of a building can be seen as a rooftop garden (Lin & Egerer, 2018). These gardens offer a wide variety of benefits to people, including insulation, habitat creation, amenity benefits, and the cultivation of food (Lin & Egerer, 2018).

2.4.6 Food gardens

Food gardens are owned by the government and managed by schools, or other local authorities (Cilliers *et al*., 2018). The main purpose of food gardens is to produce fruit and vegetables and to be used for educational purposes (Cilliers *et al*., 2018).

2.4.7 Botanical gardens

Botanical gardens are owned by the government and managed by environmental organisations (Cilliers *et al*., 2018). The main purposes of botanical gardens are conservation, recreation and education (Cilliers *et al*., 2018).

2.4.8 Medicinal gardens

Medicinal gardens are owned by private owners and managed by traditional healers (Cilliers *et al*., 2018). The main purpose of medicinal gardens is to produce medicine (Cilliers *et al*., 2018).

2.4.9 Clinic gardens

Clinic gardens are owned by the government and managed by health organisations (Cilliers *et al*., 2018). The main purposes of clinic gardens are vegetable and medicine production, and education (Cilliers *et al*., 2018).

2.4.10 Benefits of urban gardens and green spaces

In a study conducted by Guitart *et al*. (2012) it was found that community gardens have certain benefits, including social development and unity, improved health, access to fresh food, saving or making money, education, environmental equity, reduced crime, increased safety, environmental sustainability, enhancing cultural heritage, life satisfaction, and increased biodiversity. Community gardens also provide humans with the following: a de-stressing environment, an environment to partake in your passion, fresh air, an area for citizens to support each other and discuss issues, connection with nature, a sense of joy watching plants grow, an area to release tension through meditation, closeness to God, a sense of achievement, an improvement to the aesthetics of the neighbourhood and an opportunity to improve physical fitness (Kingsley *et al*., 2009). Gardiner *et al*. (2013) have found that green spaces also have the potential to ŗpreserve declining species, restore ecosystem functions and support diverse ecosystem servicesò. Public green spaces provide an opportunity for most of the population to come in contact with the natural environment (Fuller *et al*., 2007).

Urban green spaces provide people with an area to cultivate food while engaging with the local food system and with other individuals of the community, with its success lying in the community demonstrating leadership and support from the city and community organisations (Corrigan, 2011). Extra food produced in these community gardens were donated to organisations such as churches and soup kitchens. However, these community gardens alone cannot address food insecurity, but they do improve access to fresh food on a local level (Corrigan, 2011).

According to Langemeyer *et al*. (2016), as the benefits and ecosystem services provided by gardens are increasingly acknowledged, a revival of urban gardening has begun to take place across Europe. Similarly, this revival can also be expected to happen in gardens in South Africa.

2.4.11 Disadvantages of urban gardens

The disadvantages or challenges of community gardens include soil contamination, lack of water, safety issues, neighbourhood complaints, managing volunteers or volunteer drop off, theft of tools and vegetables and fruit, lack of funding, cultural difference matters, and lack of knowledge (Guitart *et al*., 2012).

2.5 Gardening practices in South Africa

In 2016 it was found that households partaking in agricultural activity amounted to only 14.8% (STATS SA, 2016). Backyard gardens (private gardens) were the most used space for growing crops, with most households producing food through agricultural activities (STATS SA, 2016). Food that was produced included fruit and vegetables (50.8%), grains (45.5%), livestock (36%) and poultry (33.1%) (STATS SA, 2016).

In 2016 it was observed in North West that the percentage of households that were involved in agricultural activities amounted to 9.4% (STATS SA, 2016). The main reasons for participating in agricultural activities in North West include that it was the main source of income (9.1%); an extra source of income (24.1%); a leisure activity (6%); a main source of food for the household (6.3%); or an extra source of income (54.5%) (STATS SA, 2016).

The products obtained from agricultural activities in North West include livestock (55.8%), poultry (49.5%), fruit and vegetable crops (20.4%), grains and food crops (4.4%), and fodder or pasture grass for animals (1.2%) (STATS SA, 2016). Households can produce more than one of these products; therefore, the percentages do not add up to 100% (STATS SA, 2016).

According to Reuther and Dewar (2006), the potential of urban gardens in alleviating poverty and empowering people is still uncertain in South Africa. But it does, however, have significant economic and social benefits if it is managed and practised efficiently (Reuther & Dewar, 2006).

Reuther and Dewar (2006) have found that to improve gardening outcomes gardening groups have to be established who can benefit from improving their skills; efficient gardening procedures have to be implemented which included irrigation, application of fertiliser and pest control; resources have to be paid for, especially for water used in the garden to make people aware of the costs; and the gardens have to produce their own compost and seeds.

Gardens are essential components of urban and rural areas, as they provide ecosystem services to humans, and thus play an essential role in food and health security (Cilliers *et al*., 2018).

2.6 Health clinic gardens and Tswana Tshimos

The Department of Health of the North-West Province believed that gardens surrounding health clinics could provide benefits to the local community. As a result, most of the urban and rural community health clinics in the North West Province have developed gardens on their properties (Cilliers *et al*., 2018). Cornelius (2016) studied the plant diversity of and ecosystems services provided by health clinic gardens in the Bojanala District Municipality in the North West Province. These health clinic gardens often consist of different micro-gardens with different ecosystem services which represent a typical Tswana tshimo layout according to Cornelius (2016).

The Tswana tshimo (home garden) could be considered to be a model of sustainable resource management in South Africa (Molebatsi *et al*., 2010). In general home gardens in rural areas are a luxury that is mainly used to support livelihoods, for food production, medicine and spirituality as stated by Roces *et al.* (1989), Das and Das, (2005), and Nemudzudzanyi *et al*. (2010).

The Tswana tshimo according to Molebatsi *et al.*, (2010) consists of seven different micro-gardens, namely naga, lawn, vegetable garden, medicinal garden, ornamental garden, hedge and orchard. Naga consists of natural areas where indigenous species grow that are harvested and used as food or medicine or is used for grazing and can be quite large (Cornelius, 2016). The lawn contains regularly cut grass species and is more common in areas where water is available for irrigation. The vegetable garden is divided into sections in which different kinds of plants such as grains, leafy vegetables and fruit plants are cultivated. The medicinal garden contains different medicinal species planted and managed within a single area usually near the house. The ornamental garden consists of mainly flower beds that contain a large diversity of aesthetic species. Some plant species are shaped to form a hedge around the yard. The orchard consists of fruit trees which may have a medicinal value such as lemon trees. Molebatsi *et al*. (2010) also recognise the Lebala, which consists of the bare ground around the home that is kept open by sweeping and weeding as to keep snakes and other wild animals at a distance.

It has been found by Cilliers *et al*. (2018) that clinic gardens could address certain challenges that home, domestic and community gardens face concerning the optimum fulfilment of ES. One such challenge is the lack of available land for a home, domestic and community gardens. Health clinic gardens usually have adequate land available around the clinics which could provide especially provisioning services (Cilliers *et al*., 2018). Another challenge is safety and security issues such as crop theft. Health clinic gardens address this challenge by having fences around the clinic property, and some clinics have 24-hour security (Cilliers *et al*., 2018). There is generally a lack of knowledge concerning the importance of gardens in producing food, gardening practices, and use of indigenous plant species which could be addressed by involving different stakeholders that could contribute knowledge on a variety of aspects to increase the deliverance of ES (Cilliers *et al*., 2018).

According to Cilliers *et al*. (2018) all gardens, including clinic gardens, can be viewed as social-ecological systems (SES). Social-ecological systems refer to humans and biophysical systems being inter-connected due to the fact that they co-evolved and co-exist (Berkes *et al*., 2003; Walker & Salt, 2006; Langemeyer *et al*., 2016).

2.7 Health and well-being

Health, as defined by the World Health Organisation, is ña state of complete physical, mental and social well-being and not merely the absence of disease or infirmityò (Callahan, 1973; Chisholm, 1950; Larson, 1996). According to Larson (1996), this definition goes beyond having a disease by also addressing mental and social dimensions. Therefore, to fully understand health many factors, such as biological, psychological and social, need to be considered (Tzoulas *et al*., 2007). Similarly, well-being involves ña wide array of biological, sociological, economic, environmental, cultural and political factorsò (Tzoulas *et al*., 2007). Health and well-being will be further discussed focusing on the Ottawa charter for health promotion, health services in South Africa, social franchising of clinics, and food and nutrition security in South Africa.

2.7.1 The Ottawa charter for health promotion

The first International conference on health promotion was held in Ottawa, Canada on 21 November 1986 as a response to a growing expectation for a new public health movement (WHO, 1986). Health promotion, according to WHO (1986), is ñthe process of enabling people to increase control over, and to improve, their healthò. People will have to be able to recognise ambitions, ñto satisfy needs, and to change or cope with the environment in order to reach a state of complete physical, mental and social well-beingò and health is not the ñobjective of livingò but a ñresource for everyday lifeò, according to WHO (1986).

There are certain fundamental conditions and resources for health that need to be met to improve health, namely peace, shelter, education, food, income, a stable ecosystem, sustainable resources, and social justice and equity (WHO, 1986).

2.7.2 Health services in South Africa

2.7.2.1 History of health services in South Africa

South Africa transformed from a curative and hospital-centric to a primary health care (PHC) philosophy in 1994, that is based on the development and participation of the community in planning, provisioning, controlling and monitoring of services (Cullinan, 2006). A PHC philosophy is aimed to make comprehensive health services affordable, equitable, accessible and of quality. This PHC was implemented to echo Clause 27.1 of the Constitution of South Africa accepted in 1996: ñ*everyone has the right to have access to health care services; sufficient food and water; and social security, even, if they are unable to support themselves and their dependents, appropriate social support*ò (Cullinan, 2006).

As PHC takes comprehensive care into communities, local clinics and community health centres are said to be the first level of South African health services (Cullinan, 2006) and patientsô ideal first point of entry. These facilities treat ñambulatory patientsò referring to those patients that can walk to the facility and are not confined to a bed (Cullinan, 2006).

According to Cullinan (2006), a clinic refers to a facility that provides a variety of PHC services, which is usually open eight hours a day. A community health centre (CHC) provides a variety of PHC services as well as 24-hour maternity and emergency services and contains up to 30 beds where patients can be observed for up to 48 hours (Cullinan, 2006). Furthermore, it contains no operating theatre but only a procedure room, patients will only be given general anaesthetics if necessary, and patients will not be admitted as inpatients (Cullinan, 2006).

It was stated in an article published in Critical Health 1983 (Anon, 1983) that community-based services are usually staffed with two types of personnel, including community health workers who are usually trained state-employees, and voluntary health workers with limited training. These personnel were tasked with promoting improved habits and encouraging vegetable gardening, attendance at immunisation clinics, purification of water, and sanitation (Anon, 1983).

The Pholela Health Centre, located in rural KwaZulu-Natal, was an ideal PHC model that was used to inform and define the practice of PHC to other rural and urban health clinic centres and was operational from 1940 to 1970 (Kautzky & Tollman, 2008). The Pholela health centre was intended to provide comprehensive preventive and curative services and focused on holistic health care, rather than only medical care, which provided one of the first working models of community-oriented primary care (COPC) in practice (Kautzky & Tollman, 2008). COPC according to Dhlomo (2015) ñis a continuous process by which primary health care is provided to a defined community on the basis of its assessed health needs, by the planned integration of primary care practice and public healthò

Pholela health centre focused on the health of families and the community, rather than on individuals alone, by seeking to identify and addressing the social conditions and determinants that influence population health broadly (Kautzky & Tollman, 2008). Target areas included hygiene and sanitation, nutrition, water, housing conditions and occupational threats, and target groups include the most vulnerable people, such as women and children (Kautzky & Tollman, 2008). These included mandatory immunisations, school feeding schemes, the establishment of household and community food gardens, child growth monitoring, breastfeeding and baby food supplementation, communal childcare services, and family planning (Kautzky & Tollman, 2008). The vegetable gardens were used to address malnutrition (Dhlomo, 2015). Unfortunately, mainly due to politics, the progress South Africa made over 20 years of innovative community-based research, training and health systems development was lost as the supporters and practitioners of the COPC left leading to the COPC movement collapsing in 1960 (Kautzky & Tollman, 2008). Health care and systems development focused on hospitals and the private sector in the years to come (Kautzky & Tollman, 2008).

2.7.2.2 Health services today

Health and nutritional status are good indicators of development, social advancement and access to resources (Shisana *et al.*, 2013). The North-West Provincial Department of Health believed that gardens surrounding the clinics could provide benefits to society. As a result, most of the 300+ urban and rural community health clinics in the North West Province have developed gardens on their premises (Cilliers *et al.*, 2018). According to Tibane (2017) in South Africa, there are 4200 public health facilities where clinic gardens can be regarded as social-ecological systems (Cilliers *et al.*, 2018).

In 2016 it was found that approximately seven in every ten (71.4%) South African households went to public clinics and hospitals first when household members were ill or got injured (STATS SA, 2016). With most households (92.6%) going to the health care facility located the closest to their homes (STATS SA, 2016).

2.7.3 Social franchising of clinics

According to Robinson (2015) many state PHC clinics provide excellent services. Even so, there are no standards which the clinics should meet, nor are there ways to implement and maintain standards (Robinson, 2015). Robinson (2015) stated that ñinitiatives, inspiration, motivation and dedication of the facility managersò lead to the clinics being well-run, ñrather than national, provincial or district office efforts or systemsò. A shift to standardise clinics is, therefore, necessary which can be achieved by implementing the franchising concept which focuses on business principles (Robinson, 2015).

The benefits that could be obtained from following a franchising approach include:

- Replication of a system and brand that has been proven to be effective, there is thus consumer awareness and consumers know what quality to expect;
- the products and/or services are standardised;
- ñeconomies of scaleò and ñrapid expansion to scaleò; and
- ñcentralised systems and controls meaning all facilities are measured, monitored and controlled in the same way, easing comparative performance based on established standards and operating proceduresò (Robinson, 2015).

By using a social franchise model instead of a commercial franchising model, one would obtain social benefits ñby using the franchising model to replicate and distribute products and services of the organisationò, according to Robinson (2015).

In order to determine the best practice clinics in the North-West Province, field trips were made to the best-performing and worst performing clinics (Robinson, 2015). At each of these clinics, a survey was done on the clinical care, support services, health information, monitoring and evaluation and community engagement to determine their inclusion into the operation manual (Robinson, 2015). The establishment and maintenance of the clinic garden were also included as a factor that could enhance community nutrition (Robinson, 2015). Thus, by obtaining information on the value of ecosystem services provided by the health clinic gardens it could contribute to the selection of a best practice garden that could be incorporated into the social franchising model.

2.7.4 Food and nutrition security

Food security refers to circumstances when all people at all times have physical and economic access to enough, safe and nutritious food to meet their dietary needs in order to live a healthy life (FAO, 1996). This definition encompasses four aspects, namely food availability, food access, food utilisation, and stability of availability and access (Tsegay *et al*., 2014). When a household fails one or all of these dimensions, it is considered to be food-insecure (Tsegay *et al*., 2014). Food insecurity is also known as hunger, while the absence of hunger is considered as an indication of food security (Shisana *et al*., 2013). The availability of food in South Africa is not always sufficient and can lead to nutrition deficiency (Vorster *et al.,* 2011). Furthermore, the nutrient content of the food consumed by most South Africans is not sufficient and can be described as a “hidden hunger” (Tsegay *et al*., 2014). By realising the value of the clinic gardens, these nutrient deficiencies can be addressed by creating, expanding and improving vegetable gardens at more clinics.

Every human on earth has a right to obtain safe and nutritious food and thus be free from hunger (FAO, 1996). Unfortunately, not all people have access to food due to a lack of income to purchase food, instability of supply and demand, and/or natural and anthropogenic disasters (FAO, 1996). Urgent action has to be taken to prevent the problems of hunger and food insecurity to persist or increase, especially as the human population is increasing and thus putting more strain on natural resources (FAO, 1996). Food insecurity is mainly caused by poverty; therefore, sustainable progress in the alleviation of poverty is necessary to increase access to food (FAO, 1996). Those that live in poverty have little or no access to land, water, seeds and or plants, suitable technologies and farm credit (FAO, 1996). Other factors that contribute to food insecurity include conflict, terrorism, corruption and environmental degradation (FAO, 1996). A peaceful and stable environment is thus necessary to reach sustainable food security.

Hunger negatively affects the population socially and physically (Shisana *et al*., 2013). Hunger was described by the interviewees of Tsegay *et al*. (2014) as something that degrades them as social beings by inducing feelings of hopelessness and despair. These feelings prevent people from reaching their full potential, which could lead to inequality (Tsegay *et al*., 2014). Hunger not only leads to malnutrition but also negatively influences their ability to do physical or mental work, to learn, to recover from illness and to grow (Tsegay *et al*., 2014).

Tsegay *et al*. (2014) stated that in 2014 one in four South Africans suffered from hunger on a regular basis, while half of the population were at risk of going hungry. In 2016 it was found that 22.3% of South African households experienced inadequate or severely inadequate access to food, in comparison with 23.9% in 2010 (STATS SA, 2016). In 14 years (from 2002 to 2016) there was a decrease from 23.8% to 11.8% in households and a decrease from 29.3% to 13.4% in individuals who experienced hunger (STATS SA, 2016). In 2016 it was found that households in the North West Province experienced the most food access problems, with 36.6% of households experiencing inadequate or severely inadequate food access (STATS SA, 2016). In 2013 it was found that most people that experienced food insecurity lived in urban informal (32.4%) and rural formal (37%) areas (Shisana *et al*., 2013). Most rural and urban households in South Africa buy their food from shops and markets, with only 1.74% of households growing their own food as the main source of food (Tsegay *et al*., 2014). In tribal and rural areas 42% of the households grow their own produce to supplement what they buy from shops (Tsegay *et al*., 2014).

The revitalisation of rural areas is important in order to improve social stability and also to address the excessive rate of migration from rural to urban areas due to poverty, hunger and malnutrition (FAO, 1996).

Local governments are primarily responsible for reaching food security. These governments have to create and implement policies that ensure peace, social, political and economic stability, equity and gender equality (FAO, 1996). These policies are important so that no governing body can use food as an instrument for political and economic pressure (FAO, 1996).

It is generally accepted that people who are more educated, have more knowledge concerning health as schooling increases your education which influences your knowledge on health, which may also influence your income (Shisana *et al*., 2013). So, people with higher income are also better off in terms of knowledge of health because they have more access to the information (Shisana *et al*., 2013). However, in South Africa, this is not always the case as the majority of South Africans have limited knowledge concerning health, regardless of their education level and financial status, according to Shisana *et al*. (2013).

Food security also includes the availability of nutritious food. In order to ingest a sufficient amount of important nutrients, a variety of foods is needed in the diet, because no single food contains all the nutrients needed to maintain optimum health (Shisana *et al*., 2013). Diets that consist mainly of starches such as maize, rice and bread, have been linked to food insecurity (Shisana *et al*., 2013).

Unfortunately, nutrition transition is a reality in Africa and is described as “the changes in dietary patterns and nutrient intakes when populations adopt modern lifestyles during economic and social development, urbanisation and acculturation” (Vorster *et al*., 2011). The nutrition transition in Africa has been observed in that people use fewer staple foods rich in starch and dietary fibre, and fewer plant proteins such as legumes (Vorster *et al*., 2011). There are also increases in animal origin foods rich in total fat and saturated fatty acids, energy-dense snack foods, carbonated sweetened beverages, alcoholic beverages, and sugar, and in the number of fats and oils used in the preparation of food (Vorster *et al*., 2011). Even so, it has been noted that in the North West Province there has been an increase in fruit consumption, which is ascribed to increased availability and affordability in the urban areas (Vorster *et al*., 2011).

By growing food in the community or at home increases the community's or household's food security and saves money as food does not have to be bought, and the nutritional value could be improved through growing it locally (Reuther & Dewar, 2006).

2.8 Gardens as social-ecological systems (SES)

The concept of socio-ecological-systems widens our perception of ecosystem services (ESs) from being only ecological towards it being social and cultural as well (Langemeyer *et al*., 2016). Barthel *et al*. (2010) and Reyes-García *et al*. (2014) referred to gardens as pockets of social-ecological memory describing places that have “captured, stored, and transmitted” knowledge and experience concerning the management of local ecosystems and ESs, and continuously maintaining them despite severe changes in surrounding environments. In gardens, the transmission of social-ecological memory could be in the form of gardening skills, cultural traditions, or the physical exchange of plants, seeds and recipes (Cilliers *et al*., 2018). Community gardens may, therefore, be centres where communities of practice are formed for different stakeholders to share ideas, skills and understanding which could lead to different social practices (Cilliers *et al*., 2018; Cornelius, 2016).

According to Cote and Nightingale (2012), one of the ways used to study social-ecological systems is through resilience thinking. While Walker and Salt (2006) stated that by enhancing the resilience of the social-ecological system, one will obtain sustainability.

Social-ecological systems do not change predictably; instead, they are complex adaptive systems (Walker & Salt, 2006). Walker and Salt (2006) further stated that SES can “exist in more than one kind of regime in which their function, structure, and feedbacks are different”. When an SES experiences a disturbance such as fire, floods or market changes, the system can cross a threshold into a different regime (Walker & Salt, 2006). A resilient SES however, has a greater capability to avoid unwelcome regime shifts as result of disturbances to continue to provide humans with ecosystem goods and services that support quality of life (Walker & Salt, 2006). Resilience thinking is about realising that the social-ecological system that all humans are part of is an interlinked system (Walker & Salt, 2006).

2.9 Resilience thinking

Walker and Salt (2006) described resilience as the ñcapacity of a system to absorb disturbances and still retain its basic function and structureò. Resilience thinking allows one to manage complex natural systems by adapting through cycles of change (Walker & Salt, 2006).

Spash and Aslaksen (2015) stated that ñwhen ecosystemsô processes are subject to disturbance or shocks, greater biodiversity improves stability (resistance) and the ability for recovery (resilience)ò. Resistance and resilience are used to measure the tendency toward stability within ecological systems, where resistance is a measure of how ñunyielding a system is to a disturbanceò while resilience is a measure of ñhow quickly a disturbed system returns to its equilibriumò (Limburg *et al*., 2002).

In a biologically diverse ecosystem, there are species with similar functions that improves redundancy so that if one species declines or is lost another species providing similar functions can replace it with minimal disturbance to ecosystem functioning (Spash & Aslaksen, 2015; Colding & Barthel, 2013). Thus, ecosystem resilience will be promoted if many species within a single functional group is managed; this reduces the risk of one ecosystem function being lost from the whole ecosystem (Elmqvist *et al*., 2003). Hooper *et al*. (2005) state that a functional type is a collection of species that have similar effects an ecosystem process or responds similarly to environmental conditions. Knowledge obtained through biodiversity research suggests that the perseverance of functional groups of species increases the performance of ecosystems and ES (Hooper *et al*., 2005; Carpenter & Folke, 2006). Functional groups are found to be sources of renewal and reorganisation for ecosystem resilience when facing changes (Peterson *et al*., 1998; Hooper *et al*., 2005; Chapin *et al*., 1997; Carpenter & Folke, 2006).

Greater diversity also increases ôresponse diversityõ, which refers to the fact that different organisms respond differently to different types and frequencies of environmental change which increases the redundancy of the system (Colding & Barthel, 2013; Elmqvist *et al*., 2003). The response diversity concept does not necessarily imply that high species diversity leads to ecosystem resilience or vice versa, areas rich in species could still be highly susceptible to environmental change (Elmqvist *et al*., 2003).

Walker and Salt (2006) state that ñresilience thinking presents an approach to managing natural resources that embraces human and natural systems as complex systems continually adapting through cycles of changeò. Resilience thinking thus concerns an understanding and engagement with our changing world (Walker & Salt, 2006). ñResilience thinking is systems thinkingò, according to Walker and Salt (2006). All people depend directly or indirectly on ecosystems to survive, and because our existence is inextricably linked with ecological systems, we exist within social-ecological systems (Walker & Salt, 2006). If one domain, social or ecological, experiences change the other domain will also be affected (Walker & Salt, 2006). Therefore, to fully understand the systems in which we live we have to understand the dynamics of both domains, and not study the domains separately (Walker & Salt, 2006).

An increase in diversity leads to an increase in social-ecological resilience, as there is an increase in the redundancy (Barthel & Isendahl, 2013). The resilience of a system depends on three main factors according to Barthel and Isendahl (2013). Firstly, it is dependent on the diversity and number of persisting memory carriers found in the disturbed area, for example, large trees that remain alive after a fire or seeds that endure in the soil. Secondly, it is important that there is a diversity of vectors (e.g. insects, birds, humans) that transport in new memory carriers (e.g. seeds, eggs, pollen). The third-factor resilience depends on is the often-human influenced form and structure of the surrounding landscape, this includes migration routes and diverse refugia through which memory carriers can enter the disturbed area, thus forming a mnemonic infrastructure for resilience.

People have to be educated on the relationship they have with their life-support systems, in order to achieve urban resilience (Barthel & Isendahl, 2013). New knowledge could be developed, and new balance could be established when the human-environment relation is altered due to major social or environmental perturbations (Reyes-Garcõa *et al*., 2014). Therefore, Reyes-Garcõa *et al*. (2014) stated that the resilience of an SES mainly depends on the capacity to absorb new information.

The maintenance of home gardens based on agricultural knowledge provides a good circumstance to study the resilience of traditional agricultural knowledge, because it presents an explicit example of ñknowledge developed through historical and intergenerational continuity in resource use managementò, and it is rooted in an SES undergoing rapid change (Reyes-Garcõa *et al*., 2014).

When concerning integrated systems of humans and nature, resilience has three interconnected characteristics, namely the amount of change a system can undergo while still retaining its basic structure and function; the degree to which a system can self-organise; and the ability to increase the capacity to learn and adapt (Colding & Barthel, 2013). Cognitive resilience building is described as the ñmental processes of human perception, memory and reasoningò that humans obtain from frequently interacting with nature, which shapes the experiences; worldviews and values people have of local ecosystems and ultimately of the planet (Colding & Barthel, 2013).

Dynamic systems such as ecosystems, societies, corporations, economies, nations and SES pass through four characteristic phases, namely rapid growth and exploitation (r), conservation (K), collapse or release (q), and renewal or reorganisation (Ŭ) (Carpenter *et al*., 2001). Major changes occur in the q and Ŭ phases, which is usually brief (Carpenter *et al*., 2001). The q phase is a period where some components and attributes of the system may be lost due to a major perturbation (Carpenter *et al*., 2001). After this phase comes the Ŭ phase during which reorganisation occurs and novelty can arise (new species, new ideas, etc.) (Carpenter *et al*., 2001). Thereafter the r phase allows the system to settle into a new trajectory in a well-defined basin of attraction (Carpenter *et al*., 2001). Within the r phase, there is rapid colonisation that occurs in a recently disturbed area (Gunderson, 2000). This phase is also characterised by high ecological resilience, meaning that the system can absorb many disturbances (Gunderson, 2000). The K phase allows material and energy to be accumulated and stored (Gunderson, 2000).

It is important to note, as stated by Carpenter and Cottingham (1997), that a specific ecosystem serviceôs contribution towards achieving and maintaining ecosystem resilience is often context specific and might vary over time and space.

Resilience and sustainability differ in the sense that resilience can be desirable or undesirable (Carpenter *et al*., 2001). For example, Carpenter *et al*., (2001) stated that polluted water or dictatorships that decrease social welfare can be highly resilient.

2.10 Sustainable development

There are said to be three pillars of sustainable development, namely environmental protection, social development and economic development (United Nations, 2014; Murphy, 2014; Morse & McNamara, 2013; Kates *et al*., 2005). Thus, continued urbanisation could lead to sustainability challenges, especially in lower-middle- income areas where urbanisation is occurring fastest (United Nations, 2014). These sustainability challenges can occur when the infrastructure is not up to standard or when policies are not implemented to ensure that city life benefits are equally shared (United Nations, 2014). It has been noted that in some cities when an unplanned or inadequately managed urban expansion is allowed to take place, it could lead to rapid sprawl, pollution, degradation of the environmental, as well as unsustainable production and consumption patterns (United Nations, 2014). Therefore, there have to be integrated policies with the aim of improving the lives of urban as well as rural inhabitants (United Nations, 2014). Urban agriculture (horticultural, agricultural, and farming activities carried out in and around urban areas) as a practice touches on all three pillars of sustainability (Ackerman *et al*., 2014).

2.10.1 Environmental benefits

Plants in urban areas can improve urban environmental conditions such as air quality, thermal conditions, reduce stormwater runoff and sequester carbon (Lembani, 2015). Urban agriculture can also lessen the amount of energy used to transport food by reducing the distance food has to travel to reach our tables (Ackerman *et al*., 2014).

It was found in a study conducted by Stewart *et al*. (2001) that trees have the potential to reduce, by 25%, the concentration of small particles and thus improve air quality (Lembani, 2015). It has also been found that an increase in trees in urban areas decreases the temperature by 2-3°C (Stewart *et al*., 2001; Lembani, 2015). Urban plants also play a role in reducing surface water runoff by slowing the flow of precipitated water, storing and/or evaporating the water and facilitating the infiltration of the water into the soil (Lembani, 2015). The environment has many other benefits as can be seen under ecosystem services (section 2.13).

2.10.2 Economic benefits

Community development, food security and economic security are the most common reasons why people participate in urban agriculture projects (Ackerman *et al*., 2014). Urban agriculture projects can increase a householdôs income, offset food expenses and create job opportunities (Ackerman *et al*., 2014).

2.10.3 Social benefits

Vegetation in urban areas can have an impact on social factors which includes ñhealth, education, crime and safety, economic development, and social disenfranchisementò (Westphal, 2003). Community gardens are places where a variety of different people come together for a mutual benefit (Ackerman *et al*., 2014). These gardens can also be used to host community enrichment programmes such as skills development and job training (Ackerman *et al*., 2014).

2.11 Sustainable livelihood approach

According to Krantz (2001), the sustainable livelihood concept was introduced by the Brundtland Commission on Environment and Development. This concept was meant to link socio-economic and ecological factors in a structure that is cohesive and policy-relevant (Krantz, 2001). The grouping of resources into different capitals indicates the diverse variety of resources that people rely on to make a living (Krantz, 2001).

The sustainable livelihood approach uses five types of capital, namely natural capital, human capital, economic or financial capital, physical capital and social capital (Morse & McNamara, 2013; Fabricius & Collins, 2007). Natural capital includes natural resource stocks such as soil, water, air and biological resources such as trees, pasture, and biodiversity as well as environmental services such as the hydrological cycle and pollution sinks (Morse & McNamara, 2013; Krantz, 2001; Elasha *et al*., 2005), in other words the ecosystem goods and services (Fabricius & Collins, 2007). Human capital concerns skills, knowledge and labour, while also including good health and physical capability (Morse & McNamara, 2013; Krantz, 2001; Fabricius & Collins, 2007). Economic or financial capital is the capital base which includes cash, credit and debt, savings, and other economic assets (Morse & McNamara, 2013; Krantz, 2001; Fabricius & Collins, 2007). Physical capital includes infrastructure such as buildings and roads, production equipment and technologies (Morse & McNamara, 2013; Fabricius & Collins, 2007) created by economic production (Elasha *et al*., 2005). Social capital comprises social resources such as networks, social claims, social relations, affiliations and associations (Morse & McNamara, 2013; Krantz, 2001; Fabricius & Collins, 2007).

Costanza *et al*. (2017) stated that a balance is required between natural capital, built or manufactured capital, human capital and social or cultural capital to sustain and enhance human well-being.

2.12 Co-production of knowledge

Human lives are enriched by interacting with ecosystems that contribute to economies and human well-being in many ways (Tengö *et al*., 2014). In order to sustainably manage these ecosystem processes, we need to maintain all knowledge originating from multiple systems (Tengö *et al*., 2014). Existing systems have to be recognised and strengthened for learning and responding to change and new conditions to build resilience (Berkes & Folke, 2002; Tengö *et al*., 2014). This resilience is especially important for clinic gardens.

Exchange of knowledge between a diversity of knowledge systems can lead to the generating of new knowledge, which could improve the capacity to react to conditions, change, responses, and in some cases fundamental relationships in the dynamics of SES and it can be used to determine or predict future trajectories or pathways (Tengö *et al*., 2014). Health clinic gardens can thus be seen as sources of social-ecological innovation (Cilliers *et al*., 2018). There are many cases where shared knowledge across different knowledge systems have improved the understanding and management of ecosystems, threatened natural resources, and biodiversity (Tengö *et al*., 2014).

Co-production of knowledge occurs when knowledge is jointly generated at all stages of an assessment or study (Tengö *et al*., 2014). Knowledge can be co-produced in co-management, community-based management, and participatory natural resource monitoring to name a few (Tengö *et al*., 2014). When knowledge is combined from a variety of knowledge systems, one usually obtains an enriched picture of the case study or investigation (Tengö *et al*., 2014). When this enriched picture is processed, it is important to include conflicting or contradicting knowledge. This knowledge should be accepted since some knowledge will remain incompatible (Tengö *et al*., 2014). Such incompatible knowledge may benefit the generation of more knowledge and may also be used in decision making (Tengö *et al*., 2014). If representatives from different knowledge systems accept that each knowledge system contributes unique inputs and understands the world differently, space is created for collaboration between the systems (Tengö *et al*., 2014).

Tengö *et al*. (2014) stated that there is a need for the science-policy community to embrace many different knowledge systems, and they must not merely use aspects that can easily be fitted into existing models and frameworks. Experts from diverse knowledge systems need to be acknowledged respected and involved in assessments and other processes, and also in the development of the procedures for designing such processes (Tengö *et al*., 2014).

It is essential to obtain a community perspective as communities are often neglected even though they form an important part of ecosystem management (Fabricius *et al*., 2007). Furthermore, the roles of communities which includes knowledge, experience, institutions, and organisational capabilities, should be recognised and incorporated into governance systems so that ecosystems can be managed sustainably so that human well-being can be increased (Fabricius *et al*., 2007). Therefore, one way to better understand the complex link between ES and human well-being is by conducting a community-based ecosystem assessment, according to Fabricius *et al*. (2007).

Social groups form their own images of the world based on “agreed upon versions of the past versions constructed through negotiation”, and not by their individual remembrance (Barthel *et al*., 2010). A community’s social memory is shaped by past experiences that determine behaviour and is used to deal with a complex world by creating shared mental maps (Barthel *et al*., 2010). In Africa, most cultural information, including information on traditional medicine, is contained in oral tradition (Van der Merwe *et al*., 2001).

2.12.1 Local and indigenous knowledge

Local communities who live in and manage ecosystems are usually the first to notice ecosystem change and are most directly affected by this change (Fabricius *et al*., 2007). The knowledge local people have of human-ecosystem interactions affects how sustainable ecosystem services are used (Fabricius *et al*., 2007). Local knowledge can be used to increase an ecosystem's capacity to generate services by creating adaptive societies that share knowledge amongst themselves (Fabricius *et al*., 2007).

Olsson and Folke (2001) stated that local ecological knowledge is the knowledge of a specific group of people have of their local ecosystems, thus concerning the relationships among organisms and between organisms and the environment. Local ecological knowledge may consist of scientific and practical knowledge which is specific to a particular area and often involves a belief component (Olsson & Folke, 2001). Local ecological knowledge is different from traditional ecological knowledge in terms of historical and cultural continuity of resource use (Olsson & Folke, 2001). Indigenous knowledge refers to knowledge systems that are unique to a specific community or ethnic group (Houde, 2007). In many rural communities, indigenous knowledge is used as the basis for making local decisions (Finn *et al*., 2017).

Local and indigenous knowledge systems develop through experimentation, adaption, and co-evolution over extended time periods. These knowledge systems can promote sustainable ecosystem management by providing valid and useful knowledge, in addition to methods, theory and practices (Tengö *et al*., 2014). According to Fabricius *et al*. (2007), local knowledge can, however, be destructive if it undermines ecosystem resilience, for example, when local experts use their knowledge to exploit the last remnants of declining fauna and flora populations. Indigenous knowledge systems in Africa have allowed people to become aware of the useful indigenous plant species, such as African leafy vegetables, that require minimum production input to cultivate (Molebatsi *et al*., 2010).

2.12.2 Traditional knowledge

Traditional knowledge is obtained over generations through observations and is used for scientific, social, or economic reasons by conservation biologists, ecological anthropologists, other scholars, and the pharmaceutical industry (Berkes *et al*., 2000). Berkes *et al*. (2000)

further stated that traditional knowledge is thought to be “holistic in outlook and adaptive by nature”.

Traditional knowledge systems change due to factors such as the learning and experimentation of individuals, implementation of new technologies, adapting to new social or ecological conditions which leads to the production of new knowledge, interacting with other knowledge systems (e.g. scientific knowledge) to co-produce knowledge (Reyes-García *et al*., 2014).

Field experiments conducted by Reyes-García *et al*. (2014) indicate that gardeners experiment with new varieties or technologies while continuing to make use of the familiar traditional technologies. The research conducted by Reyes-García *et al*. (2014) insinuates that traditional knowledge systems can adopt new knowledge into the existing body of knowledge in the process of continuity and change in response to change and socio-economic conditions. These changes to traditional knowledge are considered to form part of the self-organising process of this knowledge system (Reyes-García *et al*., 2014).

According to Gómez-Baggethun *et al*. (2012), if we allow traditional knowledge to vanish, it will lead to a reduction in adaption options for the future.

Knowledge, especially knowledge obtained from change, is considered by Reyes-García *et al*. (2014) to be very important to obtain a resilient SES. Therefore, traditional knowledge systems should be explored so that changes can be absorbed and the system can continue to exist. When information from a variety of knowledge systems is incorporated, the resilience of the system will increase by expanding the range of available responses to disturbances or limiting factors (Reyes-García *et al*., 2014). For example, when scientists and resources users combine their knowledge it can lead to an increase in social and ecological resilience, this is because the more knowledge one obtains from different sources the more complicated it becomes and is, therefore, better suited to address old and new problems by generating innovative answers (Reyes-García *et al*., 2014).

Berkes *et al*. (2000) coined a working definition for traditional ecological knowledge (TEK), where it is described as an evolving body of knowledge, practices, and beliefs that develops by adaptive processes and transmitted through cultural transmission through generations. This knowledge includes the relationships of living organisms, including humans, with one another and with the environment. Houde (2007) defined TEK as all types of environmental knowledge gained through experience and traditions by a particular group of people. Furthermore, Berkes *et al*. (2000) and Finn *et al*. (2017) have found that TEK has also been defined as “representing the generation, accumulation, and transmission of knowledge and the adaptive management of local ecological resourcesò

TEK is mainly passed from one generation to the next through storytelling, song, arts, crafts, ceremonies and preparing traditional foods together (Finn *et al*., 2017). Thus, TEK allows one to understand the changes that have occurred in a specific area over time, for example, the changes in temperature that have occurred at times (Finn *et al*., 2017). TEK can potentially address important topics such as environmental, reproductive, and mental health as well as ecosystem imbalance and climate change (Finn *et al*., 2017).

It has been noted that historical knowledge of a specific area can contribute to the conservation of biodiversity, the creation of protected areas, conservation of ecological processes, and the sustainable use of resources of that specific area (Finn *et al*., 2017).

TEK is seen as a form of citizen science which refers to the involvement of volunteers in a scientific process (Bela *et al*., 2016; Finn *et al*., 2017). In this way, new knowledge can be generated by the collaboration of scientists and volunteers (Bela *et al*., 2016). The benefits for the volunteer citizens include empowerment and enhancement of their scientific literacy (Bela *et al*., 2016). TEK is very important in understanding the relationships between organisms that contribute to a healthy ecosystem. Therefore, it allows community members to identify and address the environmental factors affecting human health (Finn *et al*., 2017).

There are a variety of stakeholders identified at health clinic gardens in the North West Province that play different roles regarding the clinic gardens. These stakeholders include clinic personnel, patients, rest of community, caregivers, Community Works Program (CWP), NGOõs, Traditional Health Practitioners (THP), private companies, and experts (Cilliers *et al*., 2018; Cornelius, 2016).

Clinic personnel include facility managers, other medical staff, nutrition specialists and groundskeepers (Cilliers *et al*., 2018; Cornelius, 2016). The contribution of these stakeholders to the garden is leadership and facilitation in gardening as well as transferring knowledge in the broader knowledge network (Cilliers *et al*., 2018).

Patients in the North West Province are mainly from the Batswana ethnic group and include those who are chronically ill (Cilliers *et al*., 2018). The rest of the community consists of municipal or tribal councillors, private gardeners, schools and churches (Cilliers *et al*., 2018). The contribution of these stakeholders to the garden is their indigenous knowledge or traditional ecological knowledge especially on the Tswana tshimo garden layout and the use of traditional African leafy vegetables (Cilliers *et al*., 2018; Cornelius, 2016).

Caregivers receive a stipend from the Department of Health (Cilliers *et al*., 2018). The contribution of these stakeholders is provisioning of home-based care, including providing fruit and vegetables from the clinic gardens and transferring knowledge to the chronically ill and the elderly (Cilliers *et al*., 2018).

The Community Works Program (CWP) workers receive a stipend from the Department of Cooperative Governance (Cilliers *et al*., 2018). Their contribution to the garden is physical work in creating or maintaining food gardens as well as other community projects (Cilliers *et al*., 2018; Cornelius, 2016).

Non-governmental organisations (NGOs) contribute to the gardens by providing mainly technical knowledge, support and funding, and education through skills development and training courses (Cilliers *et al*., 2018).

Traditional Health Practitioners (THP) contribute to the clinic gardens with their indigenous knowledge or traditional ecological knowledge; they maintain social order while preserving cultural heritage; they contribute to collaborative health care systems; and communicate their knowledge on plants (Cilliers *et al*., 2018; Cornelius, 2016).

Private companies such as mines are often in partnership with NGO's (Cilliers *et al*., 2018). These stakeholders contribute to clinic gardens through financial and physical capital (Cilliers *et al*., 2018). This capital includes finance for boreholes, pumps, greenhouses, tools as well as courses to develop skills (Cilliers *et al*., 2018; Cornelius, 2016).

Experts include agricultural extension officers and scientists (Cilliers *et al*., 2018). These stakeholders contribute to clinic gardens by providing technical knowledge on agricultural practices and commercial crop varieties as well as scientific knowledge on ecology, conservation, agriculture, horticulture, soil science, nutrition and sociology (Cilliers *et al*., 2018).

2.13 Ecosystem services (ESs)

An ecosystem, at the most basic level, can be described as a natural unit of the biotic and their physical environment (DEFRA, 2007). The biotic and abiotic components form an interdependent system as they function together, meaning if one part is negatively affected, the whole system may be impacted (DEFRA, 2007). *Homo sapiens* are a biological species and an integral part of the biosphere, they use resources in the environment to survive and thrive (Costanza *et al*., 2017). There exists interdependence between humans and the rest of nature. If we do not realise this interdependence, we may be negatively affecting the well-being of other species and endangering global ecosystems (Costanza *et al*., 2017).

Ecosystem functions are described as “the habitat, biological, or systems properties or processes of ecosystems” (Costanza *et al*., 1997). According to Costanza *et al*. (2017) ecosystem processes and functions refer to existing biophysical relationships that occur regardless of it benefiting humans. Ecosystem goods (e.g. food) and ESs (e.g. local climate and air quality regulation) are the benefits that people directly or indirectly, consciously or un-consciously obtain from ecosystem processes and functions (Costanza *et al*., 1997; Costanza *et al*., 2017). Here ESs are referred to as a combination of ecosystem goods and services.

According to the Millennium Ecosystem Assessment (MEA) (2003), ESs refer to the benefits people derive from the functions of ecosystems. Swaffield and McWilliam (2013) describe ESs as benefits received by humans from sensory experiences of ecosystems, namely through sight, hearing, taste, smell and touch. According to Le Maitre *et al*. (2007), the term ‘ecosystem service’ includes the ecosystems that deliver the services as well as people who benefit from them. According to Demir (2013), a healthy environment stems from complex biodiversity that also provides “life-support required for the welfare of people through the various goods and services”.

There are different classification systems of ESs (Langemeyer, 2015; Gómez-Baggethun *et al*. 2013). For this study, the ES classification by MEA (Langemeyer, 2015) was used, which divides ESs into supporting, provisioning, regulating, and cultural services.

According to Le Maitre *et al*. (2007), the different ESs are linked and often dependent on one another. As an example, they refer to regenerating services such as soil formation and maintenance of soil fertility that is needed to create food and medicines. The MEA (2005) also found that on a global scale 15 of the 24 investigated ESs are declining, which could have a negative impact on human welfare. According to Carpenter and Folke (2006), the only ES that is increasing is production from crops, livestock and aquaculture, and carbon sequestration.

Here follow descriptions of the different ESs.

2.13.1 Provisioning ecosystem services

Provisioning services are an ecosystem’s material outputs (Langemeyer, 2015) also known as goods (Costanza *et al*., 1997). Valuing the provisioning services of an ecosystem involves the “quantification of the flow of goods harvested in the ecosystem, in a physical unit” (Hein *et al*., 2006). Provisioning services are the combination of ES, built capital, human capital and social capital to produce food, timber, fibre, etc. (Costanza *et al*., 2017). For example, to gather fish as a source of food requires having access to fishing boats (built capital), fishermen or -women (human capital) and fishing communities (social capital) (Costanza *et al*., 2017).

2.13.1.1 Food

Food is an essential ES that is mainly produced in managed agro-ecosystems but is also produced in marine and freshwater systems, forests and urban horticulture to a smaller extent (TEEB, 2011). Urban food production typically takes place in peri-urban farm fields, on rooftops, in backyards, and in community gardens (Gómez-Baggethun *et al*. 2013). According to Langemeyer *et al*. (2016), the most important benefits of producing food in urban gardens are food security and diet improvement.

Some food types such as beans and potatoes need a large area and are not specifically well suited to produce on small-scale (Ackerman *et al*., 2014). Other foods such as leafy greens and tomatoes are better suited to be grown on large quantities in smaller urban areas (Ackerman *et al*., 2014).

A study conducted by McClintock *et al*. (2016) found that eating healthy and fresh food were essential considerations and motivations for producing vegetables in household gardens. Other essential considerations include living environmentally sustainable, relaxing or unwinding, and being more self-sufficient.

2.13.1.2 Raw materials

A variety of raw materials, including wood, biofuels and plant oils, are provided by ecosystems that are used as construction material and/or fuel (TEEB, 2011).

2.13.1.3 Freshwater

Ecosystems maintain the flow, storage and purification of water, and therefore play a vital role in providing freshwater to urban environments (Gómez-Baggethun *et al*. 2013; TEEB, 2011). Water is an essential resource that allows humans and other organisms to sustain healthy lives (Brouwer & Hassan, 2013; Obi *et al*., 2006). Water is also essential in the world's economy as it is essential for all human activities (Obi *et al*., 2006). Therefore, clean water is vital for socio-economic development (Obi *et al*., 2006).

It has been found that rural areas, in comparison with urban areas, have lower levels of access to safe drinkable water (Ashton & Ramasar, 2002; Obi *et al*., 2006). Furthermore, South Africa is considered to be a "water-stressed" country with 1000-1666 m^3/person/year (Ashton & Ramasar, 2002). Water-stressed means the existence of "frequent seasonal water supply and quality problems, accentuated by occasional droughts" (Ashton & Ramasar, 2002).

2.13.1.4 Medicinal resources

Since ancient times the use of plants to treat many diseases has been part of the human culture (Van der Merwe *et al*., 2001). A diverse ecosystem contains a variety of plant species that are used as traditional medicines, and they can provide raw materials for the pharmaceutical industry (TEEB, 2011).

2.13.2 Regulating ecosystem services

The biosphere, consisting of species, soil, air and water, fulfils the role of regulator of the human environment and maintains ideal conditions required to sustain human life (Langemeyer, 2015). Ecosystems have an important function in the regulation and maintenance of ecological processes and life support systems (De Groot *et al*. 2002). The integrity of these systems has to be maintained in order for humans to continue to benefit from the functions the systems provide (De Groot *et al*. 2002). Furthermore, the benefits humans obtain are usually indirect and are therefore not always recognised until it is lost or disturbed, but they remain essential for human existence. Even though urban gardens are small in comparison to the global biosphere, they can influence the local area (Langemeyer *et al*., 2016).

Regulating services combined with built or manufactured capital, human capital and social and cultural capital produce local climate and air quality regulation, carbon sequestration and storage, moderation of extreme events, wastewater treatment, erosion prevention and maintenance of soil fertility, pollination and biological control (Costanza *et al*., 2017).

Quantification of regulating services according to Hein *et al*. (2006) requires a spatially clear study of the biophysical effect of the ñservice on the environment in or surrounding the ecosystemò. Regulating services are also more complicated to value than provisioning and cultural services, as their values are most often not direct and are linked to larger scale processes (Turpie *et al*., 2017). Only the carbon sequestration service of the regulating services is well understood in South Africa, and additional work is needed on the other services (Turpie *et al*., 2017).

2.13.2.1 Local climate and air quality regulation

Urban environments tend to be a few degrees warmer than the surrounding rural areas, this is known as the ñurban heat island effectò (Bowler *et al*., 2010). Ecological infrastructure in urban areas play a role in regulating local temperatures, and it also buffers the effects of urban heat islands (Gómez-Baggethun *et al*. 2013). Vegetation is important in lowering the temperature in cities by shading and through absorbing heat from the air by evapotranspiration (Gómez-

Baggethun *et al*. 2013; TEEB, 2011; Bowler *et al*., 2010). Human activities such as traffic and construction cause noise pollution in urban areas, and thereby affecting health through stress, which could be reduced by urban soil and. Furthermore, urban soil and plants (Gómez-Baggethun *et al*. 2013).

Trees especially affect the local climate by "transpiring water, blocking winds, shading surfaces, and modifying the storage and exchanges of heat among urban surfaces", which then affects "energy use in buildings, human thermal comfort, and air quality" by shading buildings in the summer and blocking winds in the winter (Nowak *et al*., 1994). The opposite could also occur, where buildings are shaded in the winter and trees block summer breezes (Nowak *et al*., 1994).

2.13.2.2 Carbon sequestration and storage

South Africa was in the top 15 of the most energy-intensive communities in the world due to emitting approximately 400 million tonnes of carbon dioxide every year (Glazewski *et al*., 2012). Urban areas are mainly responsible as they produce 78% of greenhouse gasses that contributes to climate change, even though urban areas only account for 2% of the Earth's land surface (Grimm *et al*., 2000).

Vegetation in urban areas can regulate air quality by removing pollutants such as greenhouse gases from the atmosphere (Gómez-Baggethun *et al*. 2013; TEEB, 2011). The particles that vegetation remove from the air include ozone (O_3), sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO) and carbon dioxide (CO_2) (Gómez-Baggethun *et al*. 2013). These particles cause air pollution which affects human health by causing coughing, headaches, lung, throat and eye irritation, respiratory and heart disease, and cancer (Nowak, 1994a). Ozone is formed when the principal precursors of nitrogen oxides and volatile organic compounds react, CO is mainly emitted by vehicles, and nitrogen oxides (NO_x) are mainly emitted by vehicles and stationary combustion sources (Nowak, 1994a).

As trees and plants grow, they remove CO_2 from the atmosphere through transpiring water (Nowak, 1994a) and successfully store it away in their tissues; thus, acting as sinks to store CO_2 (Gómez-Baggethun *et al*. 2013; TEEB, 2011; Sarajevs, 2011). It is said that about half of the biomass of a plant comprises of carbon (Turpie *et al*., 2017). By increasing the number of trees in an urban area, one can potentially slow the urban accumulation of atmospheric carbon while also helping to protect soils and support biodiversity (Gómez-Baggethun *et al*. 2013; Sarajevs, 2011). Trees provide two benefits in sequestering CO_2, firstly they store atmospheric carbon and secondly trees can conserve energy if they are located correctly, which results in fossil fuel power plants emitting less CO_2 (Nowak, 1994b).

The death of trees, as well as the burning of wood, will, however, release the sequestered carbon (Nowak, 1994b). Individual large trees can store 1000 times more carbon than an individual small tree, while healthy large trees have a sequestration rate 90 times greater than that of healthy small trees (Nowak, 1994b). Therefore, to sequester and store a maximum amount of carbon, trees have to survive to become large healthy trees, while small trees have to be continuously established in properly chosen planting spaces (Nowak, 1994b).

Through using allometric equations, the biomass of trees may be determined which is an indication of the carbon sequestration potential (Stoffberg *et al*., 2010). There are however very few allometric biomass equations that exist for southern African trees (Stoffberg *et al*., 2010). As it is not possible to cut down and harvest the trees to determine the biomass, general allometric equations are generally used (Stoffberg *et al*., 2010).

2.13.2.3 Moderation of extreme events

Ecosystems and living organisms create buffers against natural disasters (TEEB, 2011). These buffers thereby prevent or reduce damage from extreme weather events or natural hazards such as floods, storms, tsunamis, avalanches and landslides. Examples include coral reefs and mangroves that play a role in protecting coastlines from storm damage (TEEB, 2011).

2.13.2.4 Wastewater treatment

Wetlands, other aquatic systems, and plant communities in urban soils filter and decompose organic wastes to contribute to waste treatment (Gómez-Baggethun *et al*. 2013; TEEB, 2011). The biological activity of soil microorganisms ensures that most waste is broken down; removing pathogens, and most of the nutrients and pollutants (TEEB, 2011).

2.13.2.5 Erosion prevention and maintenance of soil fertility

Soil erosion could lead to land degradation and desertification (TEEB, 2011). Vegetation has a reducing effect on surface runoff after precipitation by intercepting water through the leaves and stems, thus limiting soil erosion (Gómez-Baggethun *et al*. 2013; TEEB, 2011). Ground cover and root systems of plants also stabilise soil which reduces rainwater runoff which could cause floods and landslides (Langemeyer *et al*., 2016). Fertile soil is vital for plant growth as it contains the necessary nutrients required (TEEB, 2011).

2.13.2.6 Pollination

All green spaces within an urban area are considered to be important source areas for pollination, pest regulation and the dispersal of seeds (Gómez-Baggethun *et al*. 2013).

Pollination is essential for the development of fruits, vegetables and seeds (TEEB, 2011). Pollination is related to the availability of habitats, especially for birds and insects (Langemeyer *et al*., 2016). It has been estimated by Jansson and Polasky (2010) that more than 75% of all crop plants worldwide rely on animal pollination.

2.13.2.7 Biological control

Ecosystems provide services that regulate pests and vector-borne diseases that pose a risk to plants, animals and people (TEEB, 2011). The activities of predators and parasites are the main regulators of pest and diseases within ecosystems. Furthermore, TEEB (2011) states that birds, bats, flies, wasps, frogs and fungi can all act as biological controls.

2.13.3 Supporting ecosystem services

Supporting services support provisioning, regulating and cultural ESs (Lembani, 2015; DEFRA, 2007). Services that are included are biogeochemical processes such as the water cycle, the carbon cycle, nutrient cycling, soil formation, and primary productivity (photosynthesis) (Lembani, 2015). The contribution of supporting services to human wellbeing is indirect by maintaining the other ESs (DEFRA, 2007; Costanza *et al*., 2017).

2.13.3.1 Habitats for species

Due to the fact that supporting ESs maintain other services, directly and indirectly, it is important to maintain healthy habitats (De Groot *et al*., 2002). The habitat function can be divided into two sub-functions, namely refugium function and nursery function (De Groot *et al*., 2002). Natural ecosystems provide a place of refuge for many species of birds, amphibians, insects and plant species because it provides food, water, and shelter (De Groot *et al*. 2002; Gómez-Baggethun *et al*. 2013; TEEB, 2011). Every ecosystem consists of a variety of habitats that can be vital for a speciesôlifecycle, for example, migratory species all depend upon different ecosystems during their migration (TEEB, 2011).

It has been found that the human population size and age of a city correlates with the number of plant species in urban areas, i.e. the number of species increases with log number of human living in the area and the older a city is, the more species it contains (Pickett *et al*., 2001).

Birds are attracted to plants that produce significant quantities of nectar and red flowers (Johnson & Johnson, 1993). As a result, almost all bird-pollinated flowers have the same design, even though they are not related (Johnson & Johnson, 1993). Birds also seem to prefer eating red fruits, but some have been found to like shiny black fruit (Johnson & Johnson, 1993).

In order to increase bird diversity, a variety of fruiting trees that fruit at different times of the year should be present in the garden (Johnson & Johnson, 1993).

Birds are very particular about choosing their nesting sites (Johnson & Johnson, 1993). An average garden may be used by about 50 bird species, but usually, there are only two or three that will nest in the garden (Johnson & Johnson, 1993). The most popular nesting sites are the ground, dense thickets, spiny trees and tree holes (Johnson & Johnson, 1993). Ground-nesting birds prefer longer tufty grass and lots of space, while hole-nesters make their nests in soft-wooded easily excavated species, especially at damaged places (Johnson & Johnson, 1993). Dead trees should not be removed as they provide nesting sites for many different animals and its rotting wood releases food for many years (Johnson & Johnson, 1993).

2.13.3.2 Genetic diversity

Genetic diversity refers to the variety of genes between, and within, species populations (TEEB, 2011). Genetic diversity on earth is maintained by providing living space to resident and migratory species (De Groot *et al*., 2002). Genetic diversity distinguishes between different breeds or races, providing the basis for local cultivars and a gene pool for developing commercial crops and livestock (TEEB, 2011). Breeding or nursery areas provide habitat for species that are later, as adults, harvested for either subsistence or commercial purposes (De Groot *et al*., 2002). Genetic diversity may be lost if the habitat is destroyed by a planning decision such as to build a supermarket, hospital, or farm (Pearson, 2016).

ôBiodiversity hotspotsôrefers to areas that contain a very high number of species which makes them more genetically diverse (TEEB, 2011). Biodiversity itself is not considered to be an ES, but rather a characteristic of the natural world, which supports the supply of the other ESs (WBCSD, 2011). An increase in biodiversity usually leads to an increase of ESs supported (WBCSD, 2011). Greater biodiversity also increases the productivity and resilience of ESs, and, sometimes, the presence of biodiversity enables or stimulates certain ESs such cultural values (WBCSD, 2011). By conserving biodiversity ecosystems and ESs will be sustained (Bishop & Timberlake, 2007). All economies and businesses depend directly or indirectly on ESs through the conservation of biodiversity; therefore, a loss in biodiversity will affect most people (Bishop & Timberlake, 2007). Therefore, it could be said that to ensure prosperity, conserving ecosystems and ES is a necessity (Bishop & Timberlake, 2007).

In order for people to have respect and a sense of ownership for biodiversity, people have to come in contact with nature (Nakanshi *et al*., 2012). For example, many poorer and socially disadvantaged people in South Africa do not come in contact with our countries vast mammal biodiversity (Nakanshi *et al*., 2012).

2.13.4 Cultural ecosystem services

The non-material benefits that ESs provide are classified as cultural services (Lembani, 2015). These services include cultural heritage and identity, sources of education, recreation and aesthetic beauty or appreciation, sense of place for spiritual enrichment, mental development, leisure physical exercise, reduction of ultraviolet radiation and air pollution, and helps the relief of stress ï benefitting physical and mental health (Lembani, 2015; Costanza *et al*., 2017; De Groot *et al*., 2002; Gómez-Baggethun *et al*., 2013; Sarajevs, 2011). These cultural ESs will vary across different types of urban gardens which are influenced by social, ecological, and geographical factors (Langemeyer *et al*., 2016).

Humans have lived the longest period of human evolution in an undomesticated habitat, and are therefore tied to natural landscapes and species diversity (De Groot *et al*., 2002). Therefore, nature is an important source of science, culture and art, education and research (De Groot *et al*., 2002). Recreation is considered to be among the highest valued ESs in cities due to the alleviation of stress, and thereby enhancing human health and well-being (Gómez-Baggethun *et al*., 2013).

Tourism is a source of significant economic benefits and is for many countries an important source of income (TEEB, 2011). Cultural tourism and eco-tourism also create a platform for environmental education (TEEB, 2011). According to TEEB (2011) throughout human history language, knowledge and the natural environment have been closely related. Therefore biodiversity, ecosystems and natural landscapes have inspired many of our art, culture and science (TEEB, 2011).

Natural features such as forests, caves or mountains are considered to be sacred or have religious meaning in many cultures around the world (TEEB, 2011). Nature is linked to all major religions and traditional knowledge, ñand associated customs are important for creating a sense of belongingò (TEEB, 2011). The planting of vegetation could also play a role in the emotional and spiritual recovery after a traumatic event (Goodness *et al*., 2016).

Cultural services are determined by a human understanding of the ESs, or of specific features of the ecosystem (Hein *et al*., 2006). In order to assess the cultural services provided by a specific ecosystem, one requires the number of people who benefit from the service as well as the type of benefit they obtain (Hein *et al*., 2006).

Urban green areas contribute to cultural diversity and social cohesion in the city, through acting as communication points between urban residents and nature, and as meeting points for various social groups, elderly, immigrants, children, teenagers (Elmqvist *et al*., 2004).

2.13.5 Services to ecosystems

It has been found by Comberti *et al*. (2015) that humans play a role in developing, and maintaining ecosystems so that they can continue providing ESs. This is known as services to ecosystems and includes all human activities that have an effect on ecosystems and leads to the enhancement of the quality and quantity of the services they provide (Comberti *et al*., 2015). Even though humans have an impact on the ecosystem, the general health of the ecosystem remains the same over time (Comberti *et al*., 2015). This is supported by the view of Langemeyer *et al*. (2016) that ESs are the result of ña co-production of ecological processes and human activities, such as gardening.ò

Comberti *et al*. (2015) suggest that the human impact is recognised when studying ecosystems as excluding humans may devalue the role human cultures, especially indigenous and traditional cultures, have in creating and preserving the social-ecological systems they live in (Comberti *et al*., 2015). It is necessary to include the opinions and roles of indigenous and local societies, as leaving them out threatens the communities that are frequently the most closely linked with these ecosystems (Comberti *et al*., 2015). Humans and ecosystems thus have a ógive-and-takeô relationship which has to be acknowledged when studying the environment (Comberti *et al*., 2015). If affected human communities are not included in environmental management and conservation decision-making could harm these communities and their cultural diversity (UNESCO, 2008; Comberti *et al*., 2015).

Costanza *et al*. (2014) stated that ecosystems cannot provide humans with any benefits unless there are people (human capital); human communities (social capital) and built environments (built capital). This is because ESs are not necessarily directly obtained from natural capital, but through interactions with social, built and human capital it benefits human well-being (Costanza *et al*., 2014).

Even though there is a clear link between ESs and human well-being, it has been a challenge to translate this importance into tangible and reliable estimates of the value of these services (Jansson & Polasky, 2010).

2.14 Ecosystem disservices (EDSs)

It is important to note that for one person a tree may be aesthetically pleasing, may increase comfort and provide shade, while for another person it may be a source of allergens, leaf litter and an obstructed view (Escobedo *et al*., 2011). It is important to study urban EDSs as they affect urban residents daily at their place of work, where they live and where they commute (Speak *et al*., 2018).

Ecosystem disservices (EDSs) refer to natural or anthropogenic-impacted ecosystem functions negatively affecting human well-being (Davids *et al*., 2016; Lyytimäki & Sipilä, 2009; Von Döhren & Haase, 2015). A working definition was coined by Shackleton *et al*. (2016) which state that “*EDSs are the ecosystem generated functions, processes and attributes that result in perceived or actual negative impacts on human well-being*”. Some examples of EDSs include biological hazards, invasive species, floods, nutrient runoff, erosion, storms, heat waves and pests (Davids *et al*., 2016; Lyytimäki & Sipilä, 2009; Von Döhren & Haase, 2015).

EDSs can be viewed in three ways according to Shackleton *et al*. (2016), namely through the impact it can have directly on human wellbeing (e.g. allergic reaction, snake bite), reduced flow of ESs caused by EDSs (e.g. crop pests), and loss or damage of supporting or regulating ESs caused by EDSs (e.g. a wildfire causing primary production loss). Langemeyer and Gómez-Baggethun (2018) divided EDSs into three groups, namely physical, psychological and societal disservices. Physical disservices included allergic reactions, animal bites, the need for foliage removal, and destruction of infrastructure by plants or animals (Langemeyer & Gómez-Baggethun, 2018). Psychological disservices include fear, disgust, phobias, and feelings of unsafety towards animals or plants (Langemeyer & Gómez-Baggethun, 2018). Societal disservices are indirect disservices such as increased crime, and social exclusion (Langemeyer & Gómez-Baggethun, 2018).

Some processes or components can provide ESs and EDSs (Shackleton *et al*., 2016). For example, a tree may provide ESs by sequestering carbon and by providing fruit, while also producing allergens, an EDS (Shackleton *et al*., 2016). Another example is that carbon may be sequestered and stored and then released again over time (Schaubroeck, 2017). The perceptions humans have, based on context, knowledge and values, of an ecosystem function, will also determine whether the function is an ES or EDS (Lyytimäki, 2014).

EDSs in urban areas include damage to buildings or other man-made structures, unwanted species negatively influencing important species which could lead to economic losses, tall trees may be perceived as being cover for burglars, there are economic costs attached to the removal of unwanted species, property values may decrease as a result of specific EDS, people may be allergic to some species, traffic accidents may be caused by plants obstructing visibility, unmanaged areas may be regarded as being ugly even though it houses high biodiversity, green areas can be perceived to be unsafe, people may become irritated or frightened by the sounds, smells and behaviour of plants and animals, and urban animals may cause fear, anxiety or inconvenience by littering and spreading diseases (Lyytimäki & Sipilä, 2009).

Shackleton *et al*. (2016) stated that the following are viewed as typical EDSs, namely allergic reactions due to pollen, leaves blocking stormwater drains, roots damaging pavement, fear of increased crime, diseases such as bilharzia or malaria, pests, weeds and increased leaching of soil nutrients. It has also been observed by Shackleton *et al*. (2016) that people tend to first acknowledge the EDSs before recognising the ESs something can provide. For example, people immediately view snakes as being dangerous instead of realising the potential snakes have of controlling pests. The same could be said about floods; people view it as being destructive while it is important to deposit nutrient-rich sediment (Shackleton *et al*., 2016).

The costs of EDSs are divided into monetary costs, social nuisances, and environmental pollution by Escobedo *et al*. (2011) as seen in **Table 2-1**.

Table 2-1: Summary of the costs that are associated with EDSs (adapted from Escobedo *et al*., 2011).

Monetary costs	Å	Costs of pruning, planting, replacement, removal, transplants, pest-disease control, and irrigation.
	Å	Vegetation damage to homes and property, cables, sidewalks, and roads.
	Å	Increased humidity which results in decreased human comfort.
	Å	Foregone land use opportunities.
	Å	Blocked sunlight which results in increased energy use.
	Å	Green waste including debris, falling tree, branches, and litter.
	Å	Human injuries due to illness, wildlife or insect bites, and allergies.
Social nuisances	Å	Allergenic pollen.
	Å	Refugia for vector-spread diseases such as rabies.
	Å	Wild animals are attracted which can cause damage to structures and ornamental plants, leave droppings, attack pets, be an annoyance to humans, bite people.
	Å	Obscured views which lead to decreased aesthetics.
	Å	Fear of crime.
	Å	Safety hazards from tree fall
Environmental pollution	Å	Water quantity and quality is affected by fertiliser use and pesticide runoff.
	Å	Soil nutrient inputs lead to altered nutrient cycles.
	Å	Increased energy consumption from management.
	Å	Air pollution emissions from maintenance activities and carbon and methane from decomposition.
	Å	Volatile organic compound and secondary aerosol emissions.
	Å	Displacement of native species and the introduction of invasive species.

2.14.1 Misconceptions of ecosystem disservices

Litter in a natural area is not considered to be an EDS because the litter is not a result of an ecosystem process (Shackleton *et al*., 2016). A reduction in the supply of ESs is not considered to be an EDS (Shackleton *et al*., 2016). For example, some ESs may be harvested by humans for firewood or medicinal purposes, but these human actions are not EDSs, they are negative impacts on ES supply (Shackleton *et al*., 2016). If an event or phenomena does not have an ecosystem origin, it is not an EDS (Shackleton *et al*., 2016). For example, an earthquake is not an EDS but rather a natural hazard or geo-physical disservice (Shackleton *et al*., 2016). The responses of people to or within ecosystems that are either natural or transformed are not EDSs (Shackleton *et al*., 2016). For example, dropping litter is human behaviour (Shackleton *et al*., 2016). Land management choices made by humans that affect biodiversity or change ecosystems are not EDSs (Shackleton *et al*., 2016). Humans have a large impact on landscapes by influencing ecosystem structure, function, process and composition (Shackleton *et al*., 2016).

2.14.2 Characteristics of EDSs

Some species or process result in ESs and EDSs being provided at different times (Shackleton *et al*., 2016). For example, large animals such as elephants and lions have existence and cultural values in ecotourism, but when these animals attack someone, they are considered to be an EDS (Shackleton *et al*., 2016). Similarly, wildfires are an ES in that they stimulate new plant growth, reduce harmful parasites and poisonous plants, but are seen as an EDS when it damages infrastructure, crops, animals and humans (Shackleton *et al*., 2016).

Shackleton *et al*. (2016) state that the perspectives and experiences of the viewer, which are embedded in local cultures, values, norms and perceptions, will determine how EDSs are identified or viewed.

EDSs do not always occur in isolation but may interact with one another (Shackleton *et al*., 2016). For example, alien invasive species may have an impact on biodiversity, water, nutrients and aesthetics, while also increasing the fuel load for fires (Shackleton *et al*., 2016).

Some people are more at risk concerning EDSs than others due to socio-economic factors (Shackleton *et al*., 2016). People, such as farmers or fishers, who depend more directly on the productivity of the natural environment, are more affected by EDSs than people living in urban areas (Shackleton *et al*., 2016). The living area of people also have an influence, for example, people living in floodplains, steep slopes or in marginal areas are more at risk (Shackleton *et al*., 2016). The ability to cope with EDSs will differ between poorer households and more affluent households (Shackleton *et al*., 2016).

The perceptions people have of EDSs are context specific (Shackleton *et al*., 2016). Young and fit people are not as likely as elderly or new-borns to obtain environmental diseases or sickness (Shackleton *et al*., 2016). Some people may find a tree aesthetically pleasing, while others may be allergic to the tree (Shackleton *et al*., 2016).

2.15 Valuing ecosystem services

The research paper by Westman (1977), titled: ñHow much are natureõs services worth?ò raised the awareness of the value of conserving ecosystems for their services. Westman (1977) stated that Western societies especially wanted to quantify the value of items formerly thought as being priceless, which is still present today. Westman (1977) further stated that valuating ecosystem functionôs contribution to human well-being is complex, as it ñis a task of weighing human social values and is the quintessential task of politics.ò

Costanza *et al*. (2017) stated the following about valuation: ñThere is not one right way to assess and value ESs. There is, however, a wrong way, that is, not to do it at allò. Just by listing the services provided by a specific ecosystem can increase awareness and recognition in public policy (Costanza *et al*., 2017). Valuation is, however, useful, as many decisions involve making trade-offs between things that impact human well-being (Costanza *et al*., 2017). ôValuationô is defined by the Oxford Dictionary as an ñestimate of the worth of somethingò. There are different units in which the value of ESs can be expressed, including monetary, time, or labour units or in relative terms through making use of multiple indicators (Fioramonti, 2014; Costanza *et al*., 2017).

Valuation could be defined as a process that humans go through to express a value for a specific object or action (Farber *et al*., 2002). Therefore, ecosystem valuation could be described as the process of expressing a value for ESs, thereby creating a chance to make use of scientific observation and measurement (Farber *et al*., 2002). According to Zhongmin *et al*. (2003), ñthe valuation process reduces multidimensional information to a single numberò, which simplifies the result so that it could be better understood by decision makers (Zhongmin *et al*., 2003). When concerning ESs, humans have to make choices and compromises which imply that valuation is used, because the choice between competing alternatives implies that the one chosen has a higher value (Costanza, 2000). Ecological sustainability, social fairness and efficiency are important to consider when doing ES valuation (Costanza, 2000). The ôdifferenceô something makes is primarily determined through valuation (Limburg *et al*., 2002). The basic aim of valuation is to determine the value people attach to ecosystems and species by especially determining how much they are willing to pay for ESs, and how changes in supply would impact them (Environment Management Group & Ecosystem Economics LLC, 2009).

Cornelius (2016) suggested that research needs to be done on the ecological, political and economic valuation of ESs and EDSs, as this will add accurate and quantitative value to the perceptions of the stakeholders on ESs at health clinic gardens. These values are based on those identified by De Groot *et al*. (2002), namely ecological, socio-cultural and economic value. The ecological value of a system is determined by the integrity of the regulation and habitat functions of the ecosystem and by ecosystem parameters such as complexity, diversity, and rarity (De Groot, *et al*., 2002). Human perceptions play an important role in determining the socio-cultural value of an ecosystem. Social reasons play an important role in identifying important environmental functions (De Groot, *et al*., 2002). The concept of ecological economics focuses on creating markets for ESs and payments for ecosystem services (PESs) programmes in order to value the environment (Sutherland *et al*., 2016).

A green area's value is mostly dependent on how useful it is and if there are any areas that can substitute it (Tyrväinen, 2001). Use value can be determined by time or money as a standard of measure; thus, asking the question of how much time or money will a person willingly spend to obtain a specific commodity (Farber *et al*., 2002). Monetary measures of value are not the only way to determine value, but it is however very convenient since money is involved in many choices (Farber *et al*., 2002). People's tastes and preferences are expressed through value, as well as the limited means with which objects can be obtained (Farber *et al*., 2002). As a result, the more uncommon the desired object is, the greater its value will be (Farber *et al*., 2002).

Carpenter *et al*. (2006) stated that in 2006 most ESs were not marketed, even though ecosystems create economically important services (Environment Management Group & Ecosystem Economics LLC, 2009). Especially regulating services are not often priced even though they have strong effects on the ecosystem (Carpenter *et al*., 2006), which results in individuals, households, firms and governments neglecting ecosystems, especially when making economic choices (Environment Management Group & Ecosystem Economics LLC, 2009). There are three possible solutions for this, namely to create a new market (e.g. in carbon credits such as a licence to pollute); use a contingent valuation method, where one pretends there is a market and then ask people how they would value ESs in a hypothetical situation; and/or use a revealed preference method, where one uses a surrogate to value ESs (e.g. travel cost to recreational area) (Silvertown, 2015). When there are no markets for the ESs, people often exploit or damage the ESs with low or no cost to the individual (Environment Management Group & Ecosystem Economics LLC, 2009). Unfortunately, in some cases, it is less costly to deplete, pollute or over-use ESs than conserving them (Environment Management Group & Ecosystem Economics LLC, 2009). Another disadvantage of the absence of markets is that there are minimal opportunities for individuals or firms to gain something physical from their environmentally responsible behaviour (Environment Management Group & Ecosystem Economics LLC, 2009).

Valuation of ESs can be divided into four steps (Hein *et al*., 2006). First, the boundaries of the ecosystem to be valued must be specified; thereafter an assessment has to be done of the ESs supplied by the specific system (Hein *et al*., 2006). Thirdly the ESs have to be valued and fourth aggregation or comparison of the obtained values of the services (Hein *et al*., 2006).

A single ecosystem can provide many different ESs which could be valued as a collective bundle to obtain a single value, or each ES can be individually valued (Miller & Lloyd-Smith, 2012). If provisioning, regulating, habitat and cultural ESs were valued separately and added together; some of the services will be double counted since the final services include the intermediate services (Fisher *et al*., 2008). Therefore Fisher *et al*. (2008) made a distinction between ñintermediate servicesò and ñfinal servicesò. For example, nutrient cycling could be seen as the intermediate service, clean water provision the final service and drinking water the benefit. Therefore, the importance of intermediate ESs is included in the value of the final ESs (Escobedo *et al*., 2011).

There are two main types of valuation methods, namely economic and non-economic (DEFRA, 2007). It is important to remember that no valuation technique is perfect; uncertainty will always be an issue (Costanza *et al*., 2017). One has to ensure that the analysis requirements are balanced with the available data and resources (Costanza *et al*., 2017).

2.15.1 Economic valuation

Turpie *et al*. (2017) estimated that the ESs in South Africa are worth R 275 billion per year to South Africans. Economic valuation thus portrays a monetary value of the perceptions people have of the changing state of the environment, making it possible to incorporate it in a cost-benefit analysis (Miller & Lloyd-Smith, 2012; DEFRA, 2007). Because people derive value from ecosystems whether directly or indirectly, ecosystems and their services have economic value (DEFRA, 2007). A person or a societyõs income and preferences, which reflect their knowledge, tastes, and customs, will influence the economic value they attach to ESs (Miller & Lloyd-Smith, 2012). Monetary valuation makes it possible to combine, compare and communicate the value of different ESs (WBCSD, 2011). Monetary values are assigned to non-priced ESs through the process of economic valuation (Tyrväinen, 2001). Through economic valuation, one could determine the ñdifference something makes to well-beingò (Limburg *et al*., 2002); this is because most people understand monetary values (Costanza *et al*., 2014).

It is often assumed that market prices reflect the economic value, but according to Miller and Lloyd-Smith (2012) this is untrue, because ñmarket prices only express a minimum of economic value that satisfies buyers and sellers, based on the preferences and constraints that each facedò. Thus, to understand the full economic value of market-priced ESs one has to estimate the value that consumers and producers enjoyed beyond the transaction price (Miller & Lloyd-Smith, 2012). Economic values are an identification of what people prefer and what their actions will be in response to maximising their own well-being (Brown *et al*., 2006).

Due to the fact that ESs provide scarce benefits to humans, ESs are economically valuable (Miller & Lloyd-Smith, 2012). These scarce benefits have become even scarcer, which affects the well-being of humans and economies (Miller & Lloyd-Smith, 2012). Only those benefits bought and sold and a marketplace have a price, while most other benefits are unpriced even though they are economically valuable (Miller & Lloyd-Smith, 2012). Economic productivity, as well as human well-being, will be negatively impacted by unregulated competitive markets that use up the unpriced benefits (Miller & Lloyd-Smith, 2012). An economy's productivity can be negatively affected by an increase in unpriced ESs because it could increase production costs (Miller & Lloyd, 2012).

All economic valuation techniques, according to Miller and Lloyd-Smith (2012), reflect human understanding on some level about the benefits obtained from ESs. This understanding could be within the surveyed population, or with experts who made the connection between the marketplace behaviour of people and its relationship to the benefits obtained from nature, or if there is a possibility that a natural benefit can be replaced by an anthropogenic substitute. In order to economically valuate ESs, one has to know nature (Miller & Lloyd-Smith, 2012).

ESs can be divided into four categories of economic value, namely direct use values; indirect use values; option values; and non-use values (WBCSD, 2011). ESs have direct use value when people make actual use of an ES (DEFRA, 2007). These ESs are either extracted from an ecosystem such as food and timber or used within an ecosystem without extracting any elements such as recreation (DEFRA, 2007). Some of the ESs with direct use value have a market where they can be traded such as timber, while other ESs do not have markets, for example, there is no market for obtaining inspiration directly from nature (DEFRA, 2007). ESs have indirect use value when people obtain a benefit from an ES without directly using it, such as air quality, climate and water regulation; pollution filtering; erosion prevention and maintenance of soil fertility; nutrient cycling; waste decomposition; and pollination (DEFRA, 2007). Even though these ESs are very important, people often don't notice them until they come under threat or are lost (DEFRA, 2007). People like to have the option to make use of a resource in future, even if they are not currently using it, this is known as the option value (DEFRA, 2007). For example, people may contribute money to a national park where they would like the option to visit in future. The future use of a resource may be direct or indirect (DEFRA, 2007). Option value is also thought to be a form of insurance, for example, when there are many different species found in a specific habitat; the chances are greater that the species will be able to fulfil each other's ecological functions when conditions change (DEFRA, 2007). The non-use value is the value gained without physically using ecosystems (WBCSD, 2011). It is the value of knowing that the natural environment is preserved, for example, people donate money to save whales even though they might never see one (DEFRA, 2007). Non-use value consists of three main components. Firstly, bequest value is the value people attach to knowing

ESs will be preserved for future generations (DEFRA, 2007). Secondly, an altruistic value is the value people place on the availability of ESs to others in the current generation (DEFRA, 2007). Thirdly, existence value is the value people place on knowing ESs exist, even if they have no actual or planned use of it (DEFRA, 2007).

Economic valuation methods are divided into four basic types: (1) direct market valuation, (2) indirect market valuation, (3) contingent valuation, (4) group valuation, as seen in **Table 2-2**. A ómarket for ESsô could be defined as an institution where ESs can be bought and sold (Carpenter & Folke, 2006). Furthermore, for some ESs there are existing markets, such as for food products, while for other ESs markets are emerging, such as for carbon sequestration or pollutant emission quotas (Carpenter & Folke, 2006).

All of the methods mentioned in **Table 2-2** have strengths and weaknesses (Farber *et al*., 2002). As seen in **Table 2-2** it may be necessary to use more than one valuation method simultaneously for some ESs (Farber *et al*., 2002). Usually, only one of the methods described above is used to determine individual values for all ESs (Farber *et al*., 2002). These individual values are then combined to obtain the value for all ESs of a specific area, which can, however, only be achieved if the ESs are used by only one person, and that personõs use has no positive or negative effect on another (Farber *et al*., 2002).

The purpose of the study will influence what valuation methods can be used. According to Dallimer *et al*. (2014) ñif the purpose is to inform a benefit-cost analysis of a project or policy which will have impacts on the natural world, then a monetary valuation of environmental changes is neededò. Nonmonetary measures will be sufficient if the research concerns ñthe extent to which a protected area contributes to well-being or to rank alternative management actions in terms of their impact on well-beingò (Dallimer *et al*., 2014).

Table 2-2: The comparison of monetary valuation methods adapted from TEEB (2011), De Groot *et al*. (2002), Miller and Lloyd-Smith (2012), Brown *et al*. (2006), Czembrowski and Kronenberg, (2016), Farber *et al*. (2002) and DEFRA (2007).

Methods		**Summary**	**Which services?**
Direct market valuation (market prices)		Exchange value that ESs have in trade.	Provisioning ESs, such as food
Indirect market valuation	Avoided cost	How much spending was avoided because of ESs provided? ESs allow society to avoid costs that would have been incurred in the absence of those services.	Carbon sequestration Flood control Waste treatment by wetlands
	Replacement cost	ESs could be replaced with human-made systems. It is determined what the cost will be of replacing a lost environmental good or service.	Regulating ESs, such as natural waste treatment
	Production function or Factor income	How much is the value-added by the ESs based on its input to production?	Provisioning ESs Moderation of extreme events Pollination Biological control
	Hedonic pricing	Service demand may be reflected in the prices people will pay for associated goods or properties. It can be described as the extra amount paid for higher environmental quality or more attributes of the properties.	Use values only, recreation and leisure
	Travel cost	Cost of visiting a site: travel costs (fares, car use) and also the value of leisure expended. The travel costs can be seen as a reflection of the implied value of the service. It is a survey-based technique.	Use values only, recreation and leisure
Contingent valuation (Stated preferences)		Determined how much a survey respondent is willing to pay to have more of a particular ES. A social survey questionnaire is usually used to value a single service.	All ESs
Group valuation	Participatory environmental valuation	Asking members of a community to determine the importance of a non-marketed ES relative to goods or services that are marketed.	All ESs

2.15.1.1 Contingent valuation

The contingent valuation (CV) method, which makes use of questionnaires to obtain people's willingness to pay (WTP), is the most widely applicable and is therefore widely used (Christie *et al*., 2012; Tyrväinen, 2001; Tyrväinen & Väänänen, 1998). The CV method makes use of interactive exchanges between the researcher and participants so that the researcher can obtain a set of responses that reflect the true value as perceived by the participant concerning specific concepts (Zhongmin *et al*., 2003). A CV is used to ñreveal preferences for environmental goods that are not directly observable from market transactionsò (MacMillan *et al*., 2006). A CV can be used to determine the existence value of ecosystems, through determining how many people would be willing to pay for the ESs regardless if they make use of the service or area (Van Wilgen *et al*., 1996). The existence value of ecosystems is in many cases used as an argument for conservation of the ecosystem (Van Wilgen *et al*., 1996), or of endangered species (Salles, 2011).

In a CV survey, the participants are asked what they are willing to pay (WTP) to preserve or improve an environmental asset (Tyrväinen & Väänänen, 1998). The average WTP of the participants can then be calculated and multiplied by the number of consumers to obtain a monetary value for the asset (Tyrväinen & Väänänen, 1998). There have to be complete descriptions of the resources being valued so that accurate benefit estimates using the CV method can be acquired (Loomis *et al*., 2000). This is where the name of the method comes from, namely that values are produced, contingent upon, the description if the good and method of payment (Loomis *et al*., 2000).

There are a few different ways in which the WTP question can be asked, including dichotomous choice, iterative bidding, open-ended and payment card (Tyrväinen, 2001). With the open-ended questions, participants are asked what the maximum amount is they are willing to pay for an asset without suggesting an amount to them (Tyrväinen, 2001). With the close-ended questions, there are pre-specified amounts, which require the participants to give yes or no answers (Tyrväinen, 2001). It is thought that the dichotomous choice question is similar to an actual purchase or voting decision and therefore easier to answer than open-ended questions (Tyrväinen, 2001). With the payment card method, a variety of amounts are presented to the participant, who has to choose the maximum amount he/she is willing to pay (Tyrväinen, 2001; Tyrväinen & Väänänen, 1998). This method is easier to use because it provides visual assistance (Tyrväinen, 2001; Tyrväinen & Väänänen, 1998).

When asking the participants what they are willing to pay, Shackleton *et al*. (2018) stated that the hypothetical payment will go to a local NGO and not to the local municipal authority; since many people experience high levels of dissatisfaction with local authorities. Some participants in the study of Shackleton *et al*. (2018) were more willing to give some of their time rather than their money. When the concept of valuation is communicated, it is better to say “express the value of...” than “putting a price on...” which refers to an idea that it can be sold which is not the point of valuation (Miller & Lloyd-Smith, 2012). Additionally, respondents should be allowed time to think, discuss the concepts and obtain more information for unfamiliar concepts in order to give a more accurate value (MacMillan *et al*., 2006).

Problems with CV includes people disliking putting a monetary value on nature (Clark *et al*., 2000). There is also a discussion on the validity and legitimacy of CV, such as how well WTP can be measured, what it measures, and how acceptable WTP is to represent the perceptions of the public in policy making (Clark *et al*., 2000). When applying CV methods, ideally there has to be a reference amount because some people cannot pay but it does not mean they are not willing to (Clark *et al*., 2000). Other limitations of contingent valuation include: there is sometimes a bias in the responses, it is a resource-intensive method, and the market is hypothetical (DEFRA, 2007). CV values are not necessarily based on actual market values (Chee, 2004). Furthermore, prior knowledge (or the lack thereof), biased opinions and level of understanding can also influence the amount people are willing to pay for ESs (Chee, 2004).

One benefit of the contingent valuation approach is that both use and non-use values are captured (DEFRA, 2007). Another benefit is that the social value of ES can be expressed by making use of the willingness-to-pay approach (Farber *et al*., 2002).

2.15.2 Non-economic valuation

It is not always possible to determine a monetary value for all ESs; thus, when doing only a monetary valuation, some ESs may be excluded (WBCSD, 2011). Therefore, it is important to include a qualitative analysis to give the ESs some weight in an analysis (WBCSD, 2011).

Silvertown (2015) stated that when one is valuing nature, it does not necessarily mean it has to be monetised. According to De Wit *et al*. (2012), the value of ESs can also be interpreted as the amount of money that is saved with the ESs being present.

As previously mentioned De Groot *et al*. (2002) divided the importance or value of ecosystems into three types: ecological, socio-cultural and economic value. The value of the ecological and socio-cultural ESs will therefore mainly be determined by making use of non-economic valuation. The ecological value of a system is determined by the integrity of the regulation and habitat functions of the ecosystem and by ecosystem parameters such as complexity, diversity, and rarity (De Groot, *et al*., 2002). While human perceptions play an important role in determining the socio-cultural value of an ecosystem (De Groot, *et al*., 2002).

2.15.3 Challenges of valuing ecosystem services (ESs)

The valuation of ESs is controversial since such values may influence public opinion and policy decisions (Loomis *et al*., 2000). Many ecologists and some economists feel that the valuation of ESs is unnecessary and even inappropriate (Limburg *et al*., 2002). Some people feel that valuating ecosystems is impossible or unwise. They argue that one cannot place a value on human life, environmental aesthetics, or long-term ecological benefits, which are considered to be intangible (Costanza, 2000). For example, Salles (2011) stated that it would be pointless to put an economic value on nature, rather one should indicate what the value of the loss of ecosystems would be, which will allow one to compare the value with other societal issues. Another argument is that ecosystems should be protected for purely moral or aesthetic reasons, which do not require valuation. However, when considering the moral argument that no human should go hungry, it is in conflict with this argument to protect ecosystems (Costanza, 2000).

There is also a worry that resources could be used to save a certain area that has no value to anybody; such thinking, however, implies that some things are not worth saving, especially if they can be replaced by something that is 'cheaper' (Spash & Aslaksen, 2015). Furthermore, the economic valuation of environments is bound in theory, difficult to apply and inapplicable in some situations (Spash & Aslaksen, 2015). In order to address this, there should be a greater focus on different values that empower different people (Spash & Aslaksen, 2015).

The values people place on ecosystem functions, structures and processes may not always express the full value, due to the fact that humans are one of many species present in an ecosystem (Farber *et al*., 2002). There are additional values concerning ecosystem characteristics to species or the maintenance of health of the ecosystem itself (Farber *et al*., 2002). The functional role of ecosystem structures and processes has 'value', but it may not have direct or indirect value in market economies (Farber *et al*., 2002). Thus, some ESs may have an ecological value but not an economic value. There may also be cases where an ecosystem is isolated from human economic activity, and that the activity occurring in the ecosystem is irrelevant to humans (Farber *et al*., 2002).

Valuation cannot, however, be separated from the choices and decisions that have to be made concerning ecological systems (Costanza, 2000); therefore, the benefits of valuation should be acknowledged.

2.15.4 Benefits of valuation

Our well-being is not guaranteed to improve with an abundance or quality of natural resources (Salles, 2011). Salles (2011) therefore states that the contribution of ecosystems to human well-being is dependent on the valuation of services by societies. The potential services that societies know how to obtain from ecosystems, as well as the ability of societies to rely on alternate resources, are thus important to form a link between ecosystems and human well-being (Salles, 2011). In order to create public support for an urban green area, one has to determine what the public's knowledge and perceptions are of the urban green area and what importance the public attach to that area (Lorenzo *et al.*, 2000).

There are a variety of benefits that could be obtained from valuing ESs, including indicating human dependence on ecological functions (DEFRA, 2007), better conservation (Loc *et al.*, 2018; Demir, 2013), making ecological problems visible (Wilson & Howarth, 2002), sustainable development (WBCSD, 2011), improving our understanding of the natural world (Chee, 2004; Miller & Lloyd-Smith, 2012) and aiding decision making (DEFRA, 2007; Turpie et al., 2017; WBCSD, 2011; Costanza, 2000; García-Orcoyen, 2008).

Better conservation outcomes could be reached as the values strengthen the arguments for justifying the conservation (Loc *et al.*, 2018), and through improved monitoring and the creation of new policies (Demir, 2013). ESs could also not be adequately protected if they remain unpriced as there is a risk that it may be used up (Miller & Lloyd-Smith, 2012).

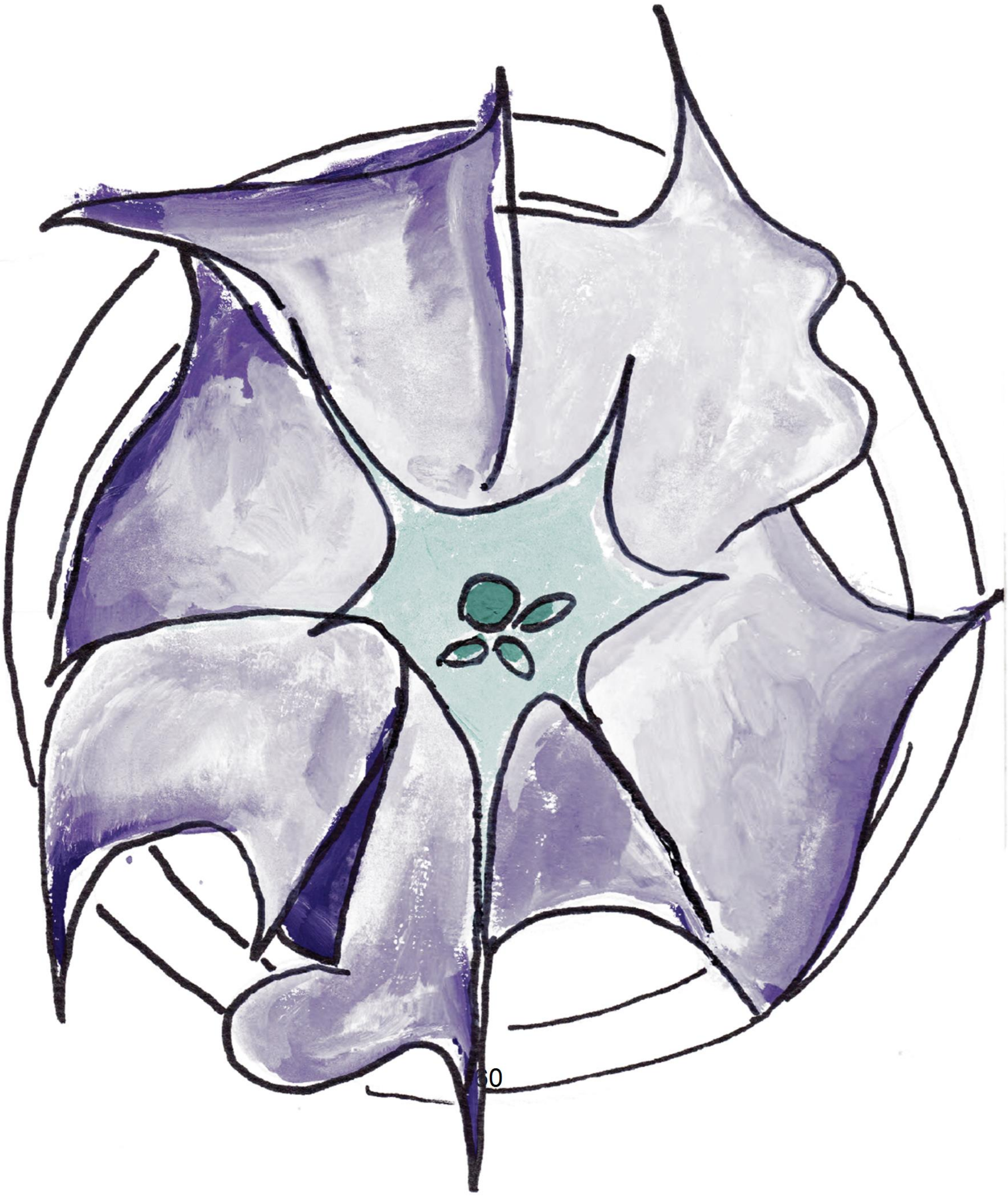
By valuing ESs, it can improve our understanding of problems and trade-offs, it can aid decision making, it can indicate how benefits are distributed which could aid cost-sharing for management initiatives, and it can promote sustainable management of our ecosystems (Chee, 2004; DEFRA, 2007; Turpie *et al.*, 2017; WBCSD; 2011). In order to achieve a more sustainable planet, an accurate account is needed for the value of nature's wealth (WBCSD, 2011).

Better choices can be made concerning ecosystems when the valuation issue, as well as the uncertainties about valuation, is made explicit, which will allow us to develop new and better ways to make decisions concerning the uncertainties (Costanza, 2000). We, therefore, have to be explicit about our short and long-term goals as a society, as well as understanding the relationships between existing activities and policies and their ability to realise these goals (Costanza, 2000). ESs that are not properly valued have no influence on decision-making regarding politics, funding, marketing of environmental products and services, and consumer preferences (García-Orcoyen, 2008). By including more ESs into markets, we would create a "school of thought" that acknowledges conservation interests (García-Orcoyen, 2008).

2.16 Conclusion

Although there has been much research done on the benefits of gardens and the value of the ESs they offer, very little has specifically been done in health clinic gardens specifically. There are also very few studies where it is attempted to valuate a variety of ESs. It is, however, important to valuate these ESs to inform the stakeholders of the health clinic gardens of the benefits the gardens provide to them and the value thereof. This knowledge could contribute to more sustainable and resilient gardening practices, which could address food and nutrition security, especially in our urbanising world as these gardens could serve as centres for co-production of knowledge.

Chapter 3: Presence and actual value of ecosystem services (ESs) and disservices (EDSs) provided by health clinic gardens



CHAPTER 3 – PRESENCE AND ACTUAL VALUE OF ECOSYSTEM SERVICES (ESs) AND DISSERVICES (EDSs) PROVIDED BY HEALTH CLINIC GARDENS

3.1 Introduction

It is suggested that humans have a natural connection with other living things, which is known as biophilia (Stokes, 2006; Tzoulas *et al*., 2007) which is regarded as genetically-based and culturally inspired (Mitchell & Mueller, 2011). Therefore, to obtain psychological well-being and personal fulfilment, contact with nature is essential as this triggers biophilia (Tzoulas *et al*., 2007; Stokes, 2006). Stokes (2006) predicts that a loss of the first-hand experience with nature will reduce the valuation of biodiversity by humans. Biophilia could incline people to display ethic care and conserve nature (Mitchell & Mueller, 2011). This experience with nature can be enhanced by the presence and awareness of ecosystem services (ESs).

ESs arise when a human need or want is directly or indirectly satisfied by ecological functions (Daniel *et al*., 2012), characteristic or process (Costanza *et al*., 2017). ESs are divided into four main groups, namely provisioning, regulating, supporting and cultural services (Langemeyer, 2015). Provisioning services are an ecosystem's material outputs (Langemeyer, 2015) also known as goods (Costanza *et al*., 1997). Regulating services play an important role in maintaining ecological processes and life support systems (De Groot *et al*. 2002). Supporting services support provisioning, regulating and cultural ESs (Lembani, 2015; DEFRA, 2007). Cultural services are the non-material benefits that ecosystems provide (Lembani, 2015). These services benefit humans and can contribute to overall well-being (Daniel *et al*., 2012; Costanza *et al*., 2017) and survival (Jansson & Polasky, 2010). Costanza *et al*. (2017) however stated that the ES concept makes it clear that the whole system matters, namely humans and other species which are part of a society which is then part of nature.

Some people, however, experience nature as being negative, which is regarded as ecosystem disservices (EDSs) (Lyytimäki and Sipilä, 2009) for example being afraid of nature. Biophobia as an EDS is the innate fear of all living things (Mitchell & Mueller, 2011). An example of this is the fear of snakes which is transferred from one generation to the next (Mitchell & Mueller, 2011). These fears are more than instinctive; they have been transferred from their predecessors and are part of their human genetics due to gene-culture coevolution (Mitchell & Mueller, 2011). This fear of nature could be seen as an ecosystem disservice. According to Lyytimäki and Sipilä (2009) when one only considers ESs without acknowledging the EDSs it may be counterproductive, for example, invasive species can be seen to increase the biodiversity of an ecosystem (ESs), but it could also lead to environmental problems such as competition with indigenous species. Lyytimäki and Sipilä (2009), stated that to manage urban environments successfully one has to know what advantages and disadvantages are provided by the ecosystems. According to Lyytimäki and Sipilä (2009), EDSs are best assessed by making use of local knowledge ñsince the valuation of ecosystem functions is largely based on personal values and perceptionsò. Human well-being can be optimised through ecosystem management that stems from an understanding of the biophysical, social, economic and political contents in which EDSs can be controlled (Shackleton *et al*., 2016).

It is quite clear that humans have a unique relationship with nature, which could be enhanced in cities by gardens. These gardens could be viewed as a way to address the problem of unhealthy and/or insufficient food access in urban areas (Ackerman *et al*., 2014). Urban agriculture is seen as a combination of horticultural, agricultural and farming activities which are taking place in small areas in or around an urban area (Ackerman *et al*., 2014). Urban agriculture is usually the informal production of food in urban areas in cities worldwide (Jansson & Polasky, 2010). Urban farms and community food gardens play a role in reducing the urban heat island effect, reducing the effect of urban stormwater impacts, as well as the amount of energy required for transporting food (Ackerman *et al*., 2014). According to Reuther and Dewar (2006), urban agriculture enables the very poor, especially in South Africa, to supplement their diet, reduce their dependency on food bought at stores or markets and gain social capital through a shared effort.

Goodness (2018) found that the utility of a plant is considered during the selection of plants for a garden. Utility characteristics include food (herbs, vegetables, fruit), medicine, consumables (teas, tonics, soaps and scents, fallen leaves for compost), habitat (for birds, bees, toads), and security (hedges, thorns). The selection of different plants, with different traits, is contributing to a more sustainable urban environment, as a larger diversity of plant traits offers more ecosystem functions and services (Goodness, 2018). It is not known if utilitarian plants were intentionally selected and planted in the health clinic gardens, but there are nonetheless high numbers of these utility plants present.

In order to value provisioning services, the goods harvested in the ecosystem have to be quantified in a physical unit (Hein *et al*., 2006). Turpie *et al*. (2017) estimated that the total value of terrestrial provisioning services in South Africa is R 7.5 billion per year. The average value per hectare increases towards the east of South Africa where it is more densely populated (Turpie *et al*., 2017). The process of valuing regulation services is more complex as ñquantification requires spatially explicit analysis of the biophysical impact of the service on the environment in or surrounding the ecosystemò (Hein *et al*., 2006). Knowing the value of the ESs may benefit the management of these systems. According to Carpenter and Folke (2006) in order to manage ESs, it must be clear what they are, where they are, how much there is, as well as the rates of renewal and resilience. This kind of information will likely be more necessary if trade in ESs increase (Carpenter & Folke, 2006).

In this chapter, these urban agricultural benefits are investigated at health clinics to determine whether ESs can be derived from these systems. Health clinic gardens were mainly initiated to provide patients with fresh fruit and vegetables (Cornelius, 2016). In this chapter objective 1 will be addressed, namely to conduct an ecological survey to determine the social, cultural, economic and ecological value of a variety of ESs and EDSs.

3.2 Materials and methods

3.2.1 Sampling and data analysis

A total of 32 health clinics were surveyed regarding provisioning, regulating, supporting and cultural ESs using specific methods to determine their economic, ecological, social and cultural values (**Table 3-1**). Of these clinics, 27 clinics were located in the Dr Kenneth Kaunda District Municipality and the remaining five clinics in the Phokwane local municipality (**Figure 1-1**, **Table 1-1**). The Tswana tshimo layout (Molebatsi *et al.*, 2010) was considered while doing the surveys, in that the specific micro-gardens were recorded and measured. This layout has been identified to be present in clinic gardens of the Bojanala District Municipality by Cornelius (2016).

Tree species can occur in more than one micro-garden; therefore, they were identified and noted separately in each clinic garden. Each plant species was identified to species level if possible or to genus level by expert knowledge. Unknown plant species were noted and a photograph was taken for later identification. The unknown species were then identified by using relevant books and field guides.

The plant species were classified according to their status (exotic or indigenous), endemicity, red-data list status (endangered, rare, least concern, etc.), and if they are exotic whether they are invasive species. Information for each plant species was obtained from different literature sources, namely Van Wyk and Gericke (2000), Venter and Venter (2002), Van Wyk *et al.* (2009), Van Oudtshoorn (2012), Johnson and Johnson (1993), Retief and Herman (1997), Pienaar (1991), Pienaar (1985), Henderson (2001), SANBI ï Red List of South African Plants (2017), Van Wyk and Malan (1988), Joffe (1993) and Pienaar (1994).

The plant species were then identified as either being indigenous or exotic. Indigenous and exotic species were classified as follows (Lubbe *et al*., 2011; Molebatsi *et al*., 2010):

- Indigenous: occurs naturally in South Africa; and
- Exotic: not indigenous to South Africa but occurs in the study area where it sustains self-replacing populations outside of cultivation without direct intervention by people, or not naturalised in the study area but cultivated in gardens and including garden hybrid species (includes invasive aliens).

The conservation status of the indigenous plant species was determined using the following categories, namely extinct (EX), extinct in the wild (EW), regionally extinct (RE), critically endangered, possibly extinct (CR PE), critically endangered (CR), endangered (EN), vulnerable (VU), near threatened (NT), critically rare, rare, and least concern (LC) (SANBI, 2017).

From the list of exotic species, it was then determined which species are declared invaders and divided into the different categories according to Henderson (2001). These categories are defined as follows (Henderson, 2001):

- Declared weed (category 1): these species have to be controlled or removed where possible on any land or water surface in South Africa;
- Declared invader (category 2): these species can be grown in specifically demarcated areas by permit holders otherwise it has to be removed; and
- Declared invader (category 3): these species are not allowed to be planted or traded, and spreading of existing plants should be prevented.

The frequency of occurrence of each plant species (food species, raw material species, medicinal species, bird plants, ornamental species, and allergy-causing species) and bird species was determined by counting the number of clinics where the specific species were noted. Bird species were noted as they could be used in determining the habitat function of the clinic gardens.

3.2.1.1 Statistical analysis

SPSS Version 25 was used for hierarchical linear models where the sub-districts were used as the subject (in other words the sub-districts were compared to each other for each ES). A small *p*-value (< 0.05) is accepted as adequate evidence that the result is statistically significant (Ellis & Steyn, 2003).

The effect size was determined between the five sub-districts, as the effect size is independent of the sample size and is a measure of practical significance (Ellis & Steyn, 2003). Practical significance, according to Ellis and Steyn (2003) refers to a difference being large enough that it could affect practice. An effect size of 0.2 was regarded as small, an effect size of 0.5 was medium, and an effect size of 0.8 was large.

Due to the fact that only 32 clinics were visited and that data is unique to the study, the data was overall normally distributed.

3.2.1.2 Determining provisioning ecosystem services

3.2.1.2.1 Food plant species and market value of food

Different resources were then used to determine if each plant species identified in the health clinic gardens had any potential to be eaten by humans. To determine the food supply, the groundskeepers of each clinic garden were asked what types of food plants they provided as well as the number of fruit or leaves or heads or tubers produced over the last growth season (2017/18). Additionally, the size of the vegetable garden and the plant species present were determined. This information was then used to calculate the average weight of one fruit, vegetable and leaf in kilograms. The number of fruit and vegetables as estimated by the groundskeepers was then converted to kilogram by using the average weights. The average rand value per kilogram was determined by using market values of the Joburg market (http://www.joburgmarket.co.za/dailyprices.php?commodity=116&cid=526) as on 7 June 2018. The average rand value was then multiplied by the calculated weight produced at each clinic, which resulted in rand values for each plant species produced and were added together to get a total value for each clinic.

The yield was also calculated as the amount of food harvested at each clinic garden for one growing season divided by the size of the vegetable garden (Pourias *et al.*, 2015). The rand value per square metre was also determined by dividing the market value of vegetables and fruit produced (rand) by the size of the vegetable garden (m^2).

3.2.1.2.2 Raw materials

By conducting a literature study, it was determined if the plant species found at the clinics had any potential use as raw material. Potential raw material uses include plants used for dyes and tans, utility timbers, fire-making, basketry, weaving, ropes, thatching, mats, and brooms (Van Wyk & Gericke, 2000). This is, however, only based on the potential, it is not known if the plants are used for these purposes at the health clinic gardens.

3.2.1.2.3 Medicinal resources

By conducting a literature study, it was determined which plant species had potential medicinal uses. Examples of medicinal uses include women's health, wounds, burns, skin conditions, and dental care (Van Wyk & Gericke, 2000). This is, however, only based on the potential, it is not known if the plants are used for these purposes at the health clinic gardens.

3.2.1.3 Determining regulating ecosystem services

3.2.1.3.1 Carbon sequestration

In order to calculate carbon sequestration, the stem circumference of each tree was obtained at a height of 1.3 m. The circumference of each stem was recorded if a tree had more than one stem (Van Rooyen *et al*., 2012). If a tree had multiple stems, the individual stems were measured separately and then added together to obtain a single circumference measurement for each tree (Rosenschein *et al*., 1999).

The calculations for carbon sequestration were based on those used by Lembani (2015). Diameter at breast height (DBH) in centimetres was calculated using the following formula:

$DBH=CBH/\pi$

CBH is the stem circumference at breast height and π was derived by using the Microsoft Excel (2010) formula =PI(). The radius of each tree was then determined in centimetres:

$r=DBH/2$

The above-ground biomass was calculated by using the general allometric equation developed by Tietema (1993):

$Y=a(\pi r^2)^{\beta}$

Y is the above-ground biomass in kilograms, a = 0.1936 (Tietema, 1993), π = 3.142, r is the stem radius in centimetres and β= 1.1654 (Tietema, 1993). This formula was determined for 14 tree species indigenous to Botswana and is known as the combi-line (Tietema, 1993). Tietema (1993) stated that this combi-line generally provides a good prediction of tree weight. Tietema (1993) concluded that for a mixed forest in more arid parts of Southern Africa this formula can be used to determine the standing fresh biomass of trees. Lembani (2015) used this formula to calculate the carbon stored of both indigenous and exotic tree species.

The amount of carbon contained in the trees was accepted as 45% of the entire biomass. Lembani (2015) based this assumption on studies conducted by Martin and Thomas (2011) and Thomas and Malczewski (2007) which stated that woody tree components have a carbon concentration of 45 to 55%. Therefore, 45% of the above-ground biomass was calculated to be the carbon stored (kg) in the trees. The stored carbon (kg) was then converted to ton carbon stored per tree.

The proposed carbon price for carbon per ton of carbon dioxide is R 120 (Republic of South Africa, 2017). This value was converted to sequestered carbon by making use of the carbon atomic ratio of 3.67:

$P_3=KxP_2$

P_3 is the carbon price per sequestered carbon per ton, K is the atomic ratio of carbon dioxide (CO_2), and P_2 is the proposed carbon price of R 120 per ton CO_2.

The obtained value for carbon sequestered per ton amounted to R 440, which was multiplied by the stored carbon (ton) to obtain the monetary value of the carbon sequestered in the trees at the health clinic gardens.

3.2.1.3.2 Canopy cover (local climate regulation)

The crown coverage of each tree in the health clinic gardens was determined in order to calculate the total tree cover. Crown measurements were made by measuring to the tips of the longest branches (Rosenschein *et al*., 1999) in two directions in a 90° angle. These measurements were multiplied to calculate the total tree cover in square metres. These measures could be used to determine the local climate regulation; however additional measures on climate variables are required.

3.2.1.4 Determining supporting ecosystem services

3.2.1.4.1 Habitat diversity (micro-gardens)

The different micro-gardens (Tswana tshimo ï ornamental, lawn, vegetable, naga, medicinal, and hedge) present and their size (m^2) were determined at each health clinic to verify the habitat service. The sizes (m^2) and the presence of lebala and paving were also determined. The total yard size for each health clinic was calculated by adding the sizes of the micro-gardens, lebala and paving. The total habitable size of each health clinic was calculated by only adding the sizes of the micro-gardens.

The number of micro-gardens of each health clinic was counted; the maximum number of micro-gardens was six.

The percentage of each garden potentially available as habitat for plants and animals was determined in Microsoft Excel (2010).

3.2.1.4.2 Habitat for birds

All bird nests and bird species observed in the health clinic gardens during a one-hour period during the ecological surveys were recorded. Observations were made during the time of visitation to the specific clinics, and were not, therefore, done at the same time for all the clinics. The weather conditions were also not always the same, some were sunshine days, others were rainy days. A literature study was also done to determine which plants found in the health clinic gardens had the potential to attract bird species.

3.2.1.5 Determining cultural ecosystem services

3.2.1.5.1 Recreation

The presence of garden benches was recorded, and any sign that people use the garden benches. Additionally, people sitting on the lawn and/or children playing in the garden were recorded. These observations were made during the visits to the clinics, and was thus not at a specific time. This is a factor that could be addressed in future studies.

3.2.1.5.2 Aesthetic appreciation

A literature study was conducted to determine if any of the plant species identified at the health clinic gardens had the potential to be of ornamental importance. All species that were listed as being ornamental were included.

3.2.1.5.3 Spiritual or cultural value

A literature study was done to determine if there were any plant species present in the health clinic gardens that could potentially have a spiritual or cultural value. All species that were listed as being used by a specific culture for specific rituals were included.

3.2.1.6 Ecosystem disservices

3.2.1.6.1 Allergies

A literature study was conducted to determine if any of the identified species are known to cause allergic reactions in humans. Species that were included are those that are wind pollinated and species that are known to cause allergies (not necessarily wind pollinated).

3.2.1.6.2 Accidents

During visits to the clinics, it was recorded if any branches were hanging over buildings and/or parking areas, if there were any low hanging branches and if the trees had branches that formed Ó45° angle with the stem of the tree. It was assumed that branches with an angle of Ó45° pose a larger risk of falling than other branches.

3.2.1.6.3 Damage to buildings and other structures

During the visits to the clinics, it was recorded if any plants had already caused damage to buildings or other structures and if there was a possibility that plants could cause damage to buildings and other structures. Dobbs *et al*. (2014) used the tree condition to determine the possibility of trees causing damage to infrastructure. It was found that a tree becomes more hazardous if it is structurally unsound which usually occurs to the end of a treeôs useful life expectancy (Dobbs *et al*., 2014).

3.2.2 Rating health clinic gardens

In order to determine the economic, ecological, social and cultural value of the ESs provided by the health clinic gardens the clinics were rated. The rating given was subjective and was determined by the researcher. It is important to note that the clinics were only compared to each other, meaning that a clinic with a high rating does not mean that it is in an ideal condition (Cornelius, 2016).

The ESs as in **Table 3-1** were considered to determine the ratings for each health clinic garden. The values given were based on the five types of capital (Morse & McNamara, 2013; Fabricius & Collins, 2007) and the three values of ecosystems as stated by De Groot *et al*. (2002). Due to the fact that it was quite difficult to distinguish between social and cultural values when concerning the ecological surveys, it was decided to make use of only three values as described by De Groot *et al*. (2002), namely ecological value, socio-cultural value and economic value, instead of using the four values (ecological, economic, social and cultural). Initially, it was not known that it would be difficult to distinguish between social and cultural values, therefore it was included in the questionnaires separately.

The five types of capital mentioned in the literature review (Morse & McNamara, 2013; Fabricius & Collins, 2007) were used to determine the values of ESs. Four of these capitals were used, namely natural capital (ecological value), human capital (cultural value), economic or financial capital (economic value) and social capital (social value). In this study, the human and social capital were combined, so that it corresponds with the values of De Groot *et al*. (2002).

De Groot *et al*. (2002) divided the importance or value of ecosystems into three types: ecological, socio-cultural and economic value. The ecological value of a system is determined by the integrity of the regulation and habitat functions of the ecosystem and by ecosystem parameters such as complexity, diversity, and rarity (De Groot, *et al*., 2002). Human perceptions play an important role in determining the socio-cultural value of an ecosystem. Social reasons play an important role in identifying important environmental functions (De Groot, *et al*., 2002). According to Sutherland *et al*. (2016), it is ñimportant to trace the social and political trajectories of local practices and decision makingò to better understand the changing value of ESs. The concept of ecological economics is used by Sutherland *et al*. (2016), which focuses on creating markets for ESs and payments for ecosystem services (PESs) programmes in order to value the environment.

Table 3-1: The ecosystem services assessed in the ecological surveys and their rated value(s).

Ecosystem service	Ecosystem service types	Value
Provisioning services	Number of potential food plant species	Ecological and Socio-cultural value
	The market value of food	Economic value
	Total yield	Ecological value
	Food rand value per m^2	Economic value
	Raw materials	Socio-cultural value
	Medicinal resources	Socio-cultural value
Regulating services	Amount of carbon stored	Ecological value
	Value of stored carbon	Economic value
	Local climate regulation	Ecological value
Supporting services	Number of micro-gardens	Ecological value
	Total size of garden	Ecological value
	Size of habitat	Ecological value
	Percentage of garden habitable	Ecological value
	Number of species	Ecological value
	Rare species	Ecological value
	Number of birds and nests observed	Ecological value
	Number of potential bird attracting plants	Ecological value
Cultural services	Number of potential ornamental plants	Socio-cultural value
	Plants with spiritual or cultural value	Socio-cultural value

The median values for all of the ES types rather than their average values were used to give ratings to each clinic for the different ESs (**Table 3-2**). The median is the number that occurs in the middle of all the values if the values are placed from smallest to largest value and is used when there are outliers that would otherwise skew the data (Swanepoel *et al.*, 2011), as was the case in this study. Outliers are those clinics of which the numbers are much higher than the others and stand out above the rest. In some cases, no outlier(s) were identified if there were many clinics with the same value (e.g. the number of the micro-gardens present). Median and average values were both given in all the graphs to show the difference.

When concerning the rare species, only the clinics that had the one rare species in their gardens were given a value of one, while the other clinics received no value. Preference was given to indigenous species. Thus, when the number of species was concerned the total number of species was used as well as an additional rating for the number of indigenous species.

Table 3-2: The values assigned to each clinic based on its position on the graphs.

Clinic position on the graph	Value
No data	0
Below median	1
Above median	2
Outlier	3

All of these analyses were done in Microsoft Excel (1010).

Results of the rating of health clinic gardens in terms of the actual value of ESs can be found in section 3.3.6. These results will also be used in Chapter 6 to compare the actual value ratings to the perceived value ratings.

3.3 Results

There were only eight ESs that were statistically significantly different between the different sub-districts (shaded in **Table 3-3**). Each of these was discussed under the specific ESs.

Table 3-3: The descriptive statistics of the ecological data based on hierarchical linear models. (Not statistically significant ï unshaded and the ecological data that was statistically significant ï shaded).

	Ecosystem services	N	Minimum	Maximum	Mean	Std. Deviation
Provisioning ESs	The market value of vegetables and fruit produced (rand)	32	0.00	1653.81	277.74	421.17
	Total number of potential food plants	32	2	27	13.66	6.131
	Number of potential food plants (indigenous)	32	0	9	3.53	2.185
	Number of potential food plants (exotic)	32	2	23	10.13	4.969
	Total number of potential medicinal plants	32	4	31	17.44	6.545

	Number of potential medicinal plants (indigenous)	32	1	10	5.91	2.810
	Number of potential medicinal plants (exotic)	32	2	23	11.53	4.663
	Total number of plants that can be potentially used as raw materials	32	3	26	11.91	5.239
	Number of plants that can be potentially used as raw materials (indigenous)	32	1	13	4.41	2.487
	Number of plants that can be potentially used as raw materials (exotic)	32	2	15	7.50	3.574
Regulating ESs	Amount of carbon stored (kg)	32	0.00	163481.87	11063.79	29124.79
	Value of stored carbon (rand)	32	0.00	71932.02	4868.07	12814.91
	Total tree cover (m²)	32	0.27	9620.80	849.75	1697.48
Supporting ESs	Number of micro-gardens present	32	1	4	2.81	0.998
	Total size of garden (m²)	32	513.0	13531.0	2495.38	3032.9578
	Size of habitat for plants and birds (m²)	32	50.0	10359.0	1390.703	2418.1603
	% of garden potentially habitat for plants and birds	32	2.85	100.00	44.05	26.81
	Total number of species	32	15	70	37.19	15.67
	Number of indigenous species	32	3	28	12.66	6.75
	Number of exotic species	32	9	49	24.53	10.90
	Number of least concern species	32	3	26	12.19	6.59
	Number of rare species	32	0	1	0.13	0.34
	Total number of invasive species (declared invaders)	32	0	15	2.66	2.93
	Total number of Category 1 invasive species	32	0	3	0.97	0.82
	Total number of Category 2 invasive species	32	0	10	0.59	1.90
	Total number of Category 3 invasive species	32	0	4	1.09	0.995
	Number of birds species observed in garden	32	0	7	2.41	1.64
	Number of bird nests observed in garden	32	0	14	3.97	4.728
	Total number of potential bird plants	32	0	8	2.44	1.83
	Number of potential bird plants (indigenous)	32	0	5	1.50	1.344
	Number of potential bird plants (exotic)	32	0	3	0.94	0.801
Cultural ESs	Number of potential plants with a spiritual or cultural value	32	0	2	0.56	0.716

3.3.1 Provisioning ecosystem services

3.3.1.1 Number of potential food plant species

The most frequently occurring potential food plant species were *Portulaca oleracea* and *Prunus persica* which both occurred at 20 clinics (Table 3-4). *Portulaca oleraceae* is an exotic succulent weed and is used in a similar way spinach is used, and the leaves are also eaten raw by children (Van Wyk & Gericke, 2000). *Prunus persica* is a fruit-bearing tree.

The clinics with the most potential food plants were Steve Tshwete (27 species), Khuma (27 species), and Jan Kempdorp (23 species) (**Figure 3-1**). At all the clinics, except Delekile Khoza, the exotic potential food plant species were more than the indigenous species. Jan Kempdorp had the highest number of indigenous potential food plant species.

Table 3-4: The most frequently occurring potential food plant species found at the health clinic gardens.

Position	Plant species	Status	Frequency of occurrence in clinic gardens
1	*Portulaca oleracea*	Exotic	**20**
2	*Prunus persica* (peach)	Exotic	**20**
3	*Urochloa mosambicensis*	Indigenous (LC)	**19**
4	*Alternanthera pungens*	Exotic	**18**
5	*Physalis viscosa*	Exotic	**16**
6	*Amaranthus viridis*	Exotic	**15**
7	*Eragrostis tef*	Exotic	**14**
8	*Spinacia oleracea* (spinach)	Exotic	**14**
9	*Sonchus oleraceus*	Exotic	**13**
10	*Bidens pilosa*	Exotic	**11**
11	*Oxalis corniculata*	Exotic	**11**
12	*Eragrostis chloromelas*	Indigenous (LC)	**11**
13	*Citrus limon* (lemon)	Exotic	**8**
14	*Eleusine indica*	Indigenous (LC)	**8**
15	*Searsia lancea*	Indigenous (LC)	**8**

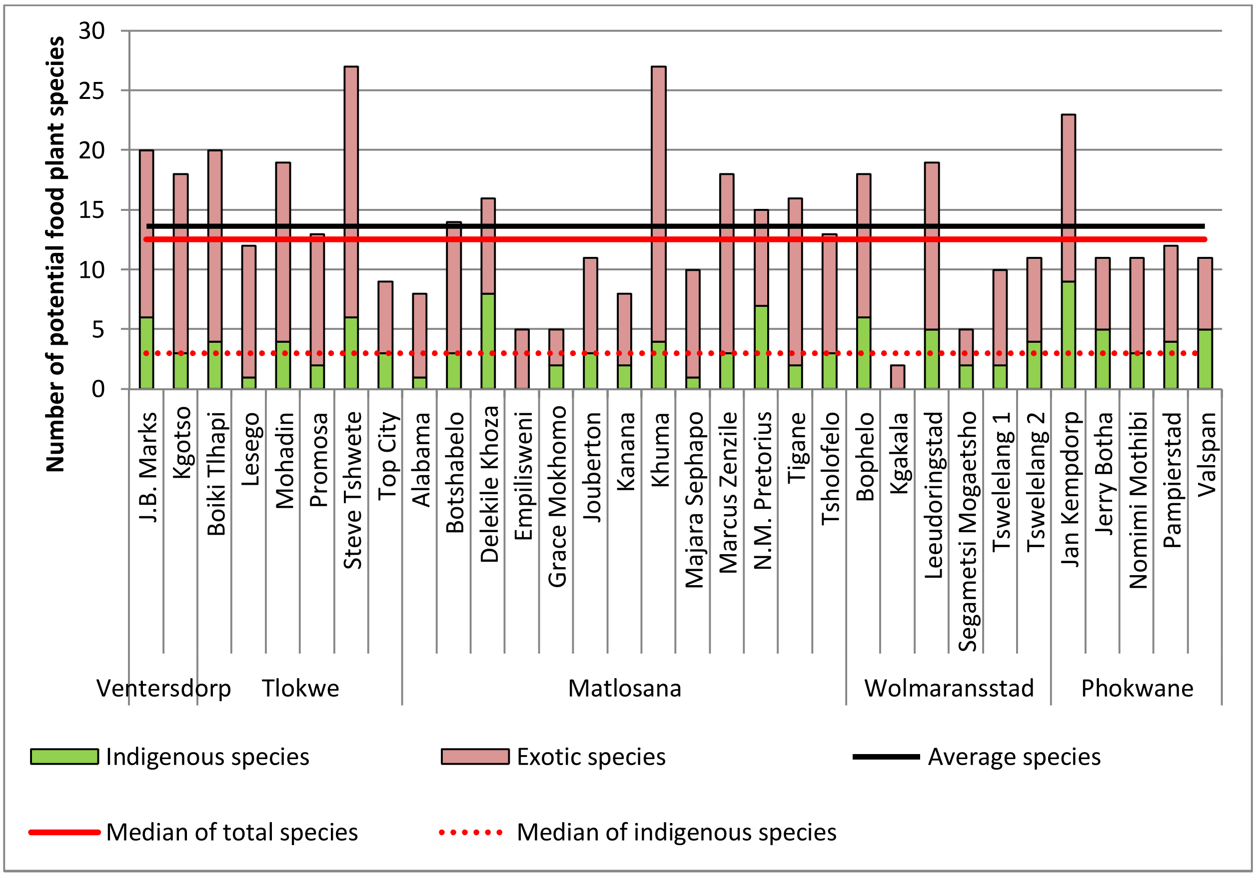


Figure 3-1: The number of potential food species at each clinic garden and their median and average values.

3.3.1.2 The market value of vegetables and fruit produced

As seen in **Figure 3-2** twelve clinics produced no vegetables or fruit or gave none away in the last season. The clinics that had the highest vegetable and fruit market value were Nomimi Mothibi (R 1653.81), Mohadin (R 1224.59), Marcus Zenzile (R 1167.93) and Tswelelang 1 (R 1031.19). There were 16 clinics of which the market value of the vegetables and fruit produced were above the median value.

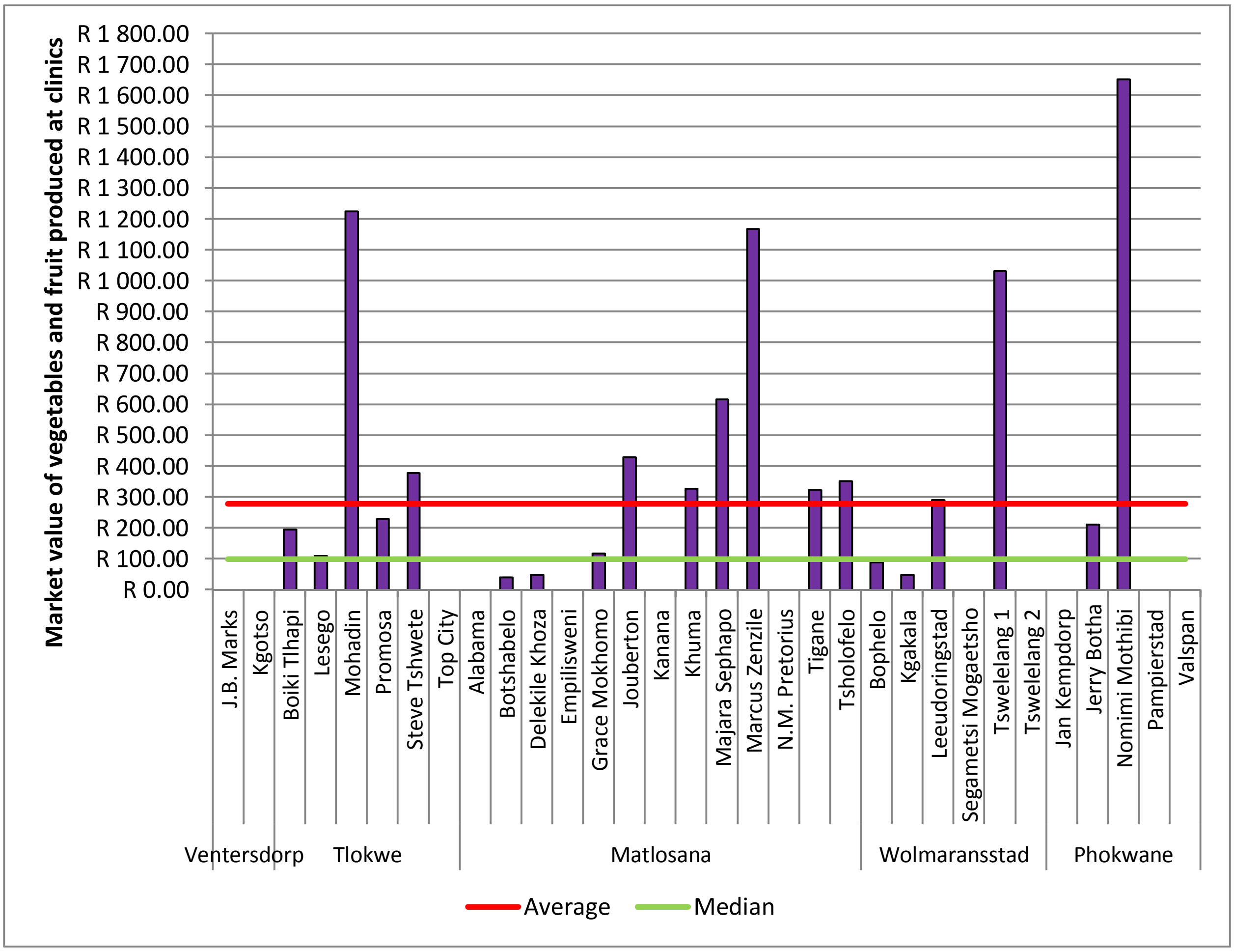


Figure 3-2: The market value of vegetables and fruit produced at some clinic gardens for 2017 to 2018 and their median and average values.

The total yield (kg/m²) of the vegetables and fruit that were produced in the last growth season (2017/18) can be seen in **Figure 3-3**. Tswelelang 1 clinic had the highest yield (2.9930 kg/m^2) of vegetables and fruit produced, while Botshabelo clinic had the lowest yield (0.0163 kg/m^2) (**Figure 3-3**).

Figure 3-4 indicates the total weight (kg) of vegetables and fruit produced in the last growing season in comparison with the size of the vegetable gardens in each clinic garden. Marcus Zenzile clinic had a high total weight (176.851 kg) as well as the largest vegetable garden (1185 m^2). Kgakala clinic and Jerry Botha clinic both had small weights produced (4.12 kg and 9.997 kg respectively) and small vegetable gardens (27.5 m^2 and 90 m^2 respectively). Tswelelang 1 clinic had a relatively small vegetable garden (60 m^2) but produced the largest weight of vegetables and fruit (179.58 kg).

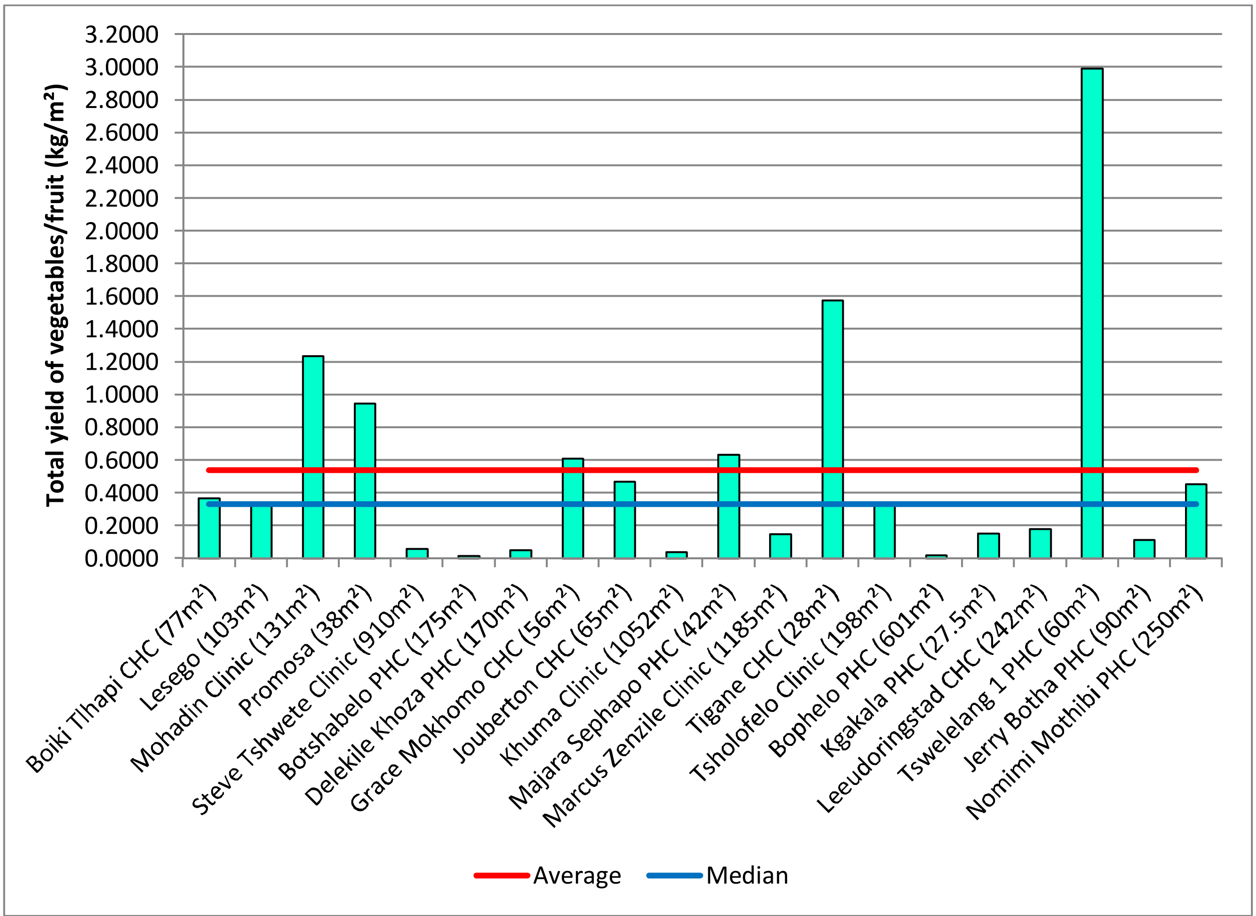


Figure 3-3: The total yield (kg/m²) of clinics where food was produced in the last growing season and their median and average values.

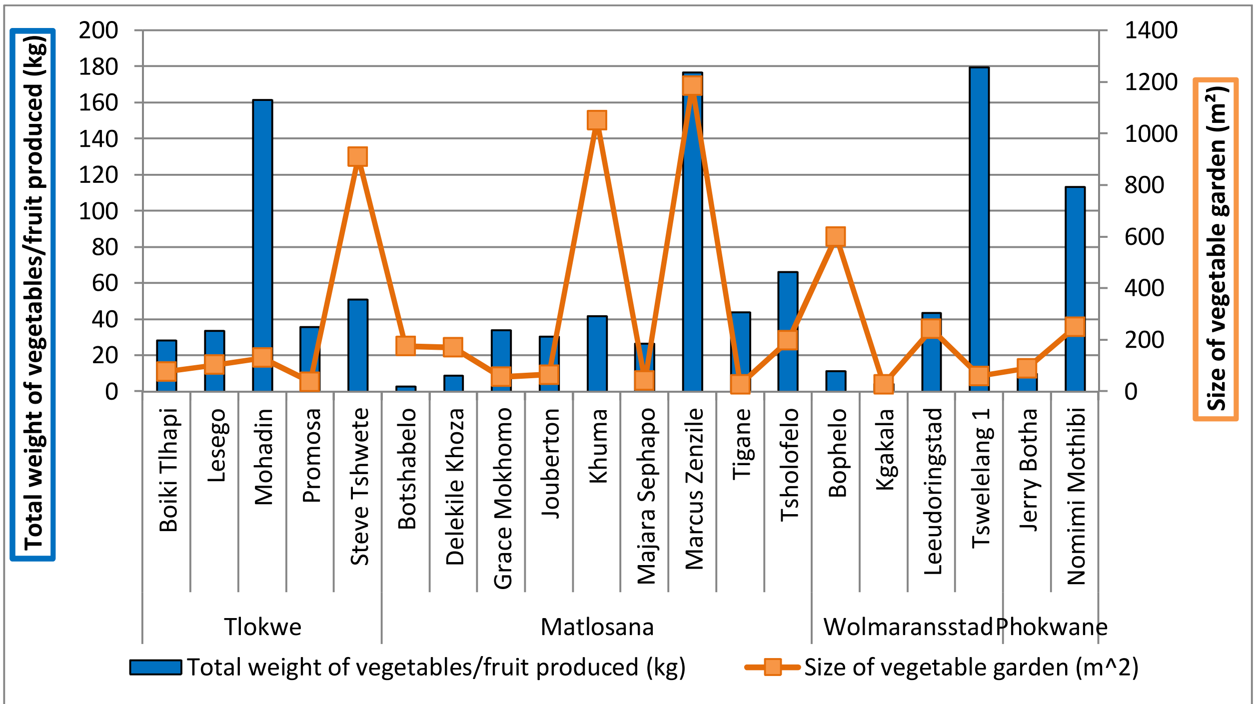


Figure 3-4: The comparison between the total weight (kg) of vegetables and fruit produced in the last growing season and the size of the vegetable gardens at the different clinics. Only the clinics that produced vegetables and fruit in the last growing season were included.

As seen in **Figure 3-5** Tswelelang 1 clinic yielded R 17.19 per m², Majara Sephapo clinic yielded R 14.66 per m² and Tigane clinic yielded R 11.57 per m². The clinic with the lowest yield was Bophelo clinic with R 0.15 per m². There were 12 clinics which had a larger yield than the median yield.

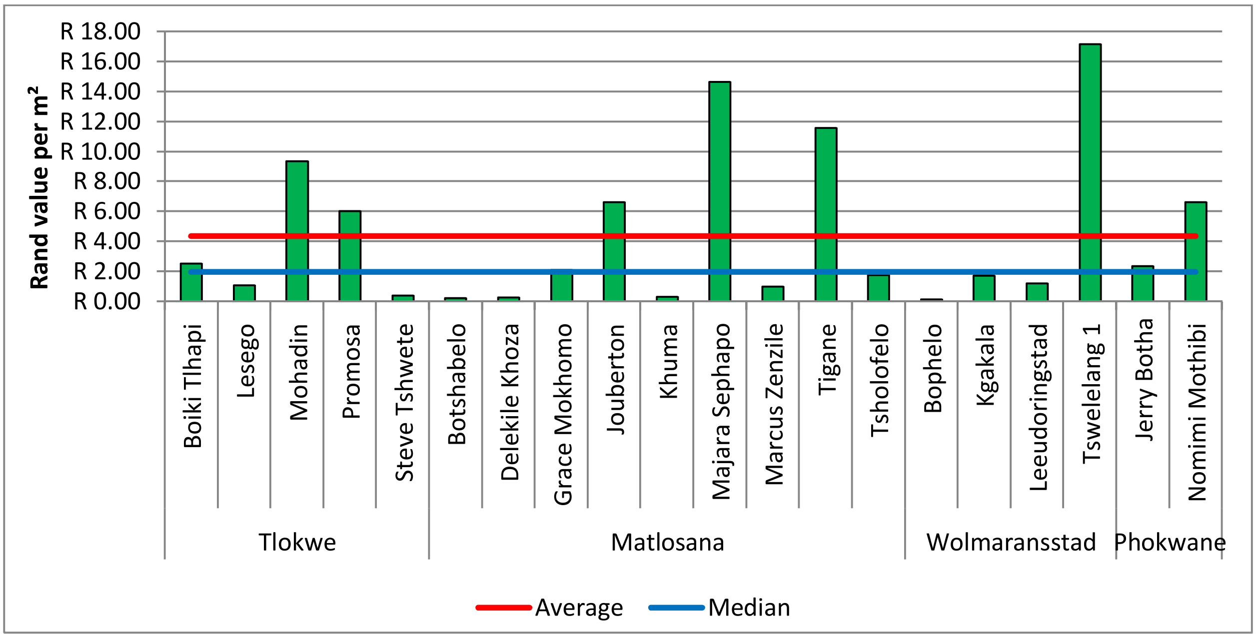


Figure 3-5: The total value (Rand) per m² of the vegetable garden for the clinics where food was produced in the last growing season and their median and average values.

3.3.1.3 Raw materials

3.3.1.3.1 Comparison between clinics

There were 56 potential exotic raw material species and 36 potential indigenous raw material species. The most frequent occurring potential raw material species was *Cynodon dactylon*, which was found at 23 clinics (**Table 3-5**).

The clinic with the highest number of potential raw material species was Jan Kempdorp with 26 species of which 13 were exotic species and 13 were indigenous species (**Figure 3-6**). Other clinics with a high number of potential raw material species were Steve Tshwete, Khuma, and Leeudoringstad all with 20 species. Twenty-eight of the clinics had more potential exotic raw material species than indigenous species. There were 17 clinics which had more potential raw material species than the median number of species, and 17 clinics which had more potential indigenous raw material species than the median number of indigenous species.

Table 3-5: The most frequently occurring potential raw material plant species found at the health clinic gardens.

Position	Plant species	Status	Frequency of occurrence in clinic gardens
1	*Cynodon dactylon*	Indigenous (LC)	**23**
2	*Pennisetum clandestinum*	Exotic	**22**
3	*Portulaca oleracea*	Exotic	**20**
4	*Prunus persica* (peach)	Exotic	**20**
5	*Urochloa mosambicensis*	Indigenous (LC)	**19**
6	*Eragrostis tef*	Exotic	**14**
7	*Sonchus oleraceus*	Exotic	**13**
8	*Tagetes minuta*	Exotic	**13**
9	*Citrus limon* (lemon)	Exotic	**8**
10	*Medicago lupulina*	Exotic	**8**
11	*Combretum erythropyllum*	Indigenous (LC)	**8**
12	*Eleusine indica*	Indigenous (LC)	**8**
13	*Searsia lancea*	Indigenous (LC)	**8**

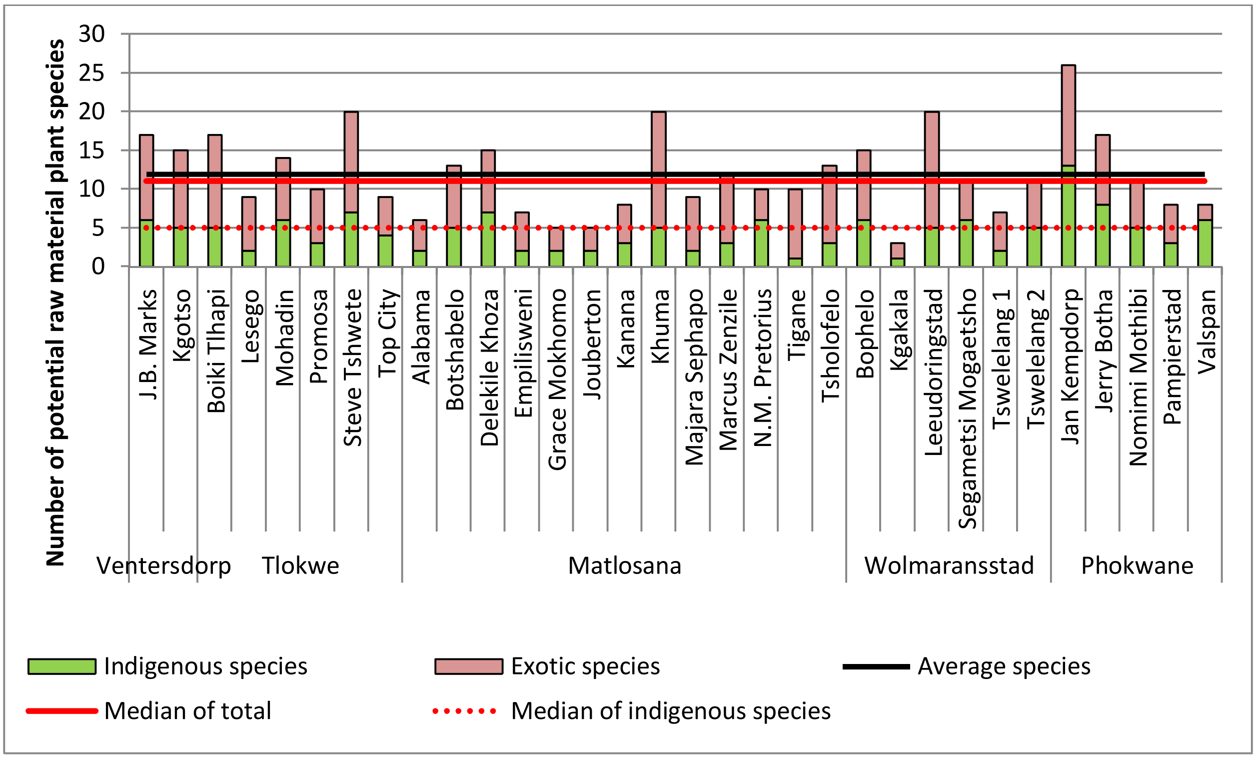


Figure 3-6: The number of plants that could potentially be used as raw materials at each clinic garden and their median and average values.

3.3.1.3.2 Comparison between sub-districts

The effect sizes for all the sub-districts were more than 0.5 (medium) or 0.8 (high) and were therefore significant (**Table 3-6**). The Phokwane sub-district was significantly different from the other clinics when concerning the number of potential indigenous raw material plant species.

The average number of potential indigenous raw material species for the Phokwane sub-district was 7.000 which was the highest number (**Table 3-7**). The smallest effect size was that of Ventersdorp (0.66), and when comparing the average number of species between Phokwane and Ventersdorp, it was seen that the average number of species (5.500) was the closest to that of Phokwane (7.000).

Table 3-6: The pairwise comparisons made between the different sub-districts to indicate the effect size of the number of indigenous plants that can be potentially used as raw materials.

Number of plants that can be potentially used as raw materials (Indigenous)			
Pairwise comparisons		**Mean difference**	**Effect size**
Phokwane	Matlosana	3.692	1.62
	Tlokwe	2.500	1.1
	Ventersdorp	1.500	0.66
	Wolmaransstad-Maquassie	2.833	1.25

Table 3-7: The number of indigenous species with the potential to be used as raw material, the number of clinics in each sub-district and the average number of potential indigenous raw material species in each sub-district.

Sub-district	Number of indigenous species	Number of clinics	Average number of species
Matlosana	43	13	3.308
Phokwane	35	5	7.000
Tlokwe	27	6	4.500
Ventersdorp	11	2	5.500
Wolmaransstad-Maquassie Hills	25	6	4.167

3.3.1.4 Medicinal resources

3.3.1.4.1 Comparison between clinics

The most frequent occurring potential medicinal plant species was *Cynodon dactylon* which occurred in 23 clinic gardens (**Table 3-8**). There were two species that are endemic to South Africa, namely *Agapanthus africanus* and *Tulbaghia simmleri.*

The clinics with the highest number of potential medicinal species were J.B. Marks (31 species), Steve Tshwete (31 species), Boiki Tlhapi (28 species) and Khuma (27 species) (**Figure 3-7**). The clinics with the highest number of potential indigenous medicinal plant species were J.B. Marks and Jerry Botha both with ten species. The clinics with the highest number of potential exotic medicinal plant species were Steve Tshwete (23 species) and J.B. Marks (21 species). There were 16 clinics which had more potential medicinal plant species than the median number of medicinal plant species, and 19 clinics which had more potential indigenous medicinal plant species than the median number of indigenous species.

Table 3-8: The most frequently occurring potential medicinal plants found at the health clinic gardens.

Position	Plant species	Status	Frequency of occurrence in clinic gardens
1	*Cynodon dactylon*	Indigenous (LC)	**23**
2	*Conyza bonariensis*	Exotic	**22**
3	*Euphorbia prostrata*	Exotic	**20**
4	*Portulaca oleracea*	Exotic	**20**
5	*Prunus persica* (peach)	Exotic	**20**
6	*Alternanthera pungens*	Exotic	**18**
7	*Plantago lanceolata*	Indigenous (LC)	**17**
8	*Physalis viscosa*	Exotic	**16**
9	*Spinacia oleracea* (spinach)	Exotic	**14**
10	*Sonchus oleraceus*	Exotic	**13**
11	*Tagetes minuta*	Exotic	**13**
12	*Schkuhria pinnata*	Exotic	**12**
13	*Tribulus terrestris*	Indigenous (LC)	**12**
14	*Bidens pilosa*	Exotic	**11**
15	*Oxalis corniculata*	Exotic	**11**
16	*Agapanthus* sp.	Indigenous (LC) ï endemic to RSA	**10**
17	*Tulbaghia simmleri*	Indigenous (LC) ï endemic to RSA	**9**

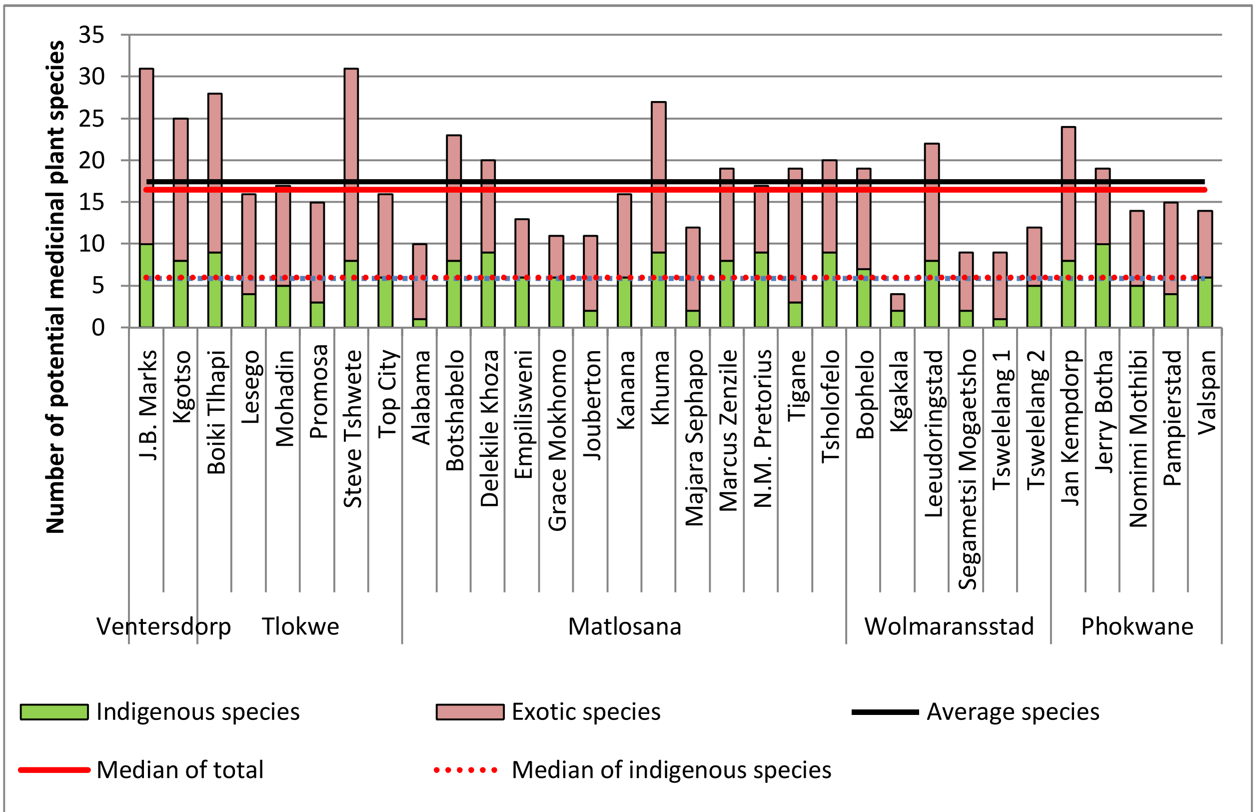


Figure 3-7: The number of plants that could potentially be used as a medicinal resource at each clinic garden and their median and average values.

3.3.1.4.2 Comparison between sub-districts

The total number of potential medicinal plant species had a p-value of 0.027 and was therefore considered to be statistically significant. The effect sizes for all the sub-districts were higher than 0.8 and were therefore considered to be significant (**Table 3-9**). The high effect sizes indicate that the average number of potential medicinal plant species of the Ventersdorp sub-district differs significantly from the other sub-districts. The sub-district with the highest average of potential medicinal plants was Ventersdorp sub-district with 28 species while Wolmaransstad-Maquassie Hills sub-district as the lowest average of potential medicinal plants with 12.5 species (**Figure 3-8**).

Table 3-9: The pairwise comparisons made between the different sub-districts to indicate the effect size of the total number of potential medicinal plants.

Total number of potential medicinal plants		
Pairwise comparisons		**Effect size**
Ventersdorp	Matlosana	1.95
	Phokwane	1.87
	Tlokwe	1.3
	Wolmaransstad-Maquassie	2.69

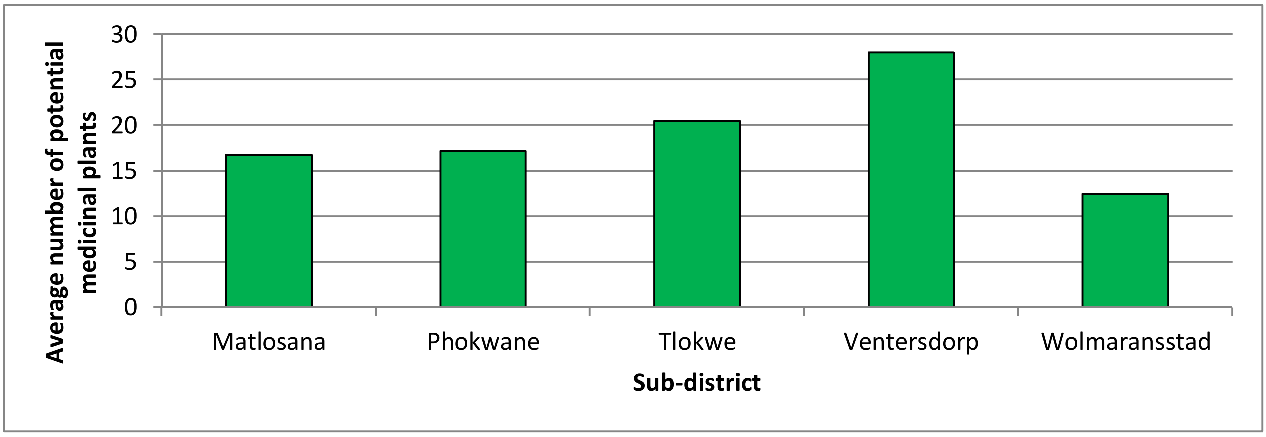


Figure 3-8: The average number of medicinal plants identified in the different sub-districts.

The number of potential exotic medicinal plant species had a p-value of 0.014 and was therefore considered to be statistically significant. The effect sizes for all the sub-districts were higher than 0.8 and were therefore considered to be significant (**Figure 3-10**). The average number of potential exotic medicinal plant species in the Ventersdorp sub-district (19.000) was significantly higher than that of the other sub-districts especially that of the Wolmaransstad-Maquassie Hills sub-district (8.333), as seen in **Table 3-11**.

Table 3-10: The pairwise comparisons made between the different sub-districts to indicate the effect size of the number of potential exotic medicinal plants.

Number of potential medicinal plants (exotic)		
Pairwise comparisons		**Effect size**
Ventersdorp	Matlosana	2.06
	Phokwane	2.1
	Tlokwe	1.09
	Wolmaransstad-Maquassie	2.67

Table 3-11: The number of exotic species with potential to be used as a medicinal plant, the number of clinics in each sub-district and the average number of potential exotic medicinal plant species in each sub-district.

Sub-district	Number of potential exotic medicinal plant species	Number of clinics	Average number of potential exotic medicinal plants
Matlosana	140	13	10.769
Phokwane	53	5	10.600
Tlokwe	88	6	14.667
Ventersdorp	38	2	19.000
Wolmaransstad-Maquassie Hills	50	6	8.333

3.3.2 Regulating ecosystem services

3.3.2.1 Carbon sequestration by trees

The most amount of carbon stored within woody plants was at the Jan Kempdorp clinic (163481.87 kg) with the second highest amount at the Botshabelo clinic (49036.46 kg) (**Figure 3-9**). There was only one clinic where no carbon was stored, namely Segametsi Mogaetsho. As seen in **Figure 3-10** the value of the stored carbon was very similar to **Figure 3-9** of the amount of carbon stored. The highest value of stored carbon was for Jan Kempdorp (R 71932.02) followed by Botshabelo (R 21576.04) and the same 17 clinics that had a higher value of stored carbon than the median value.

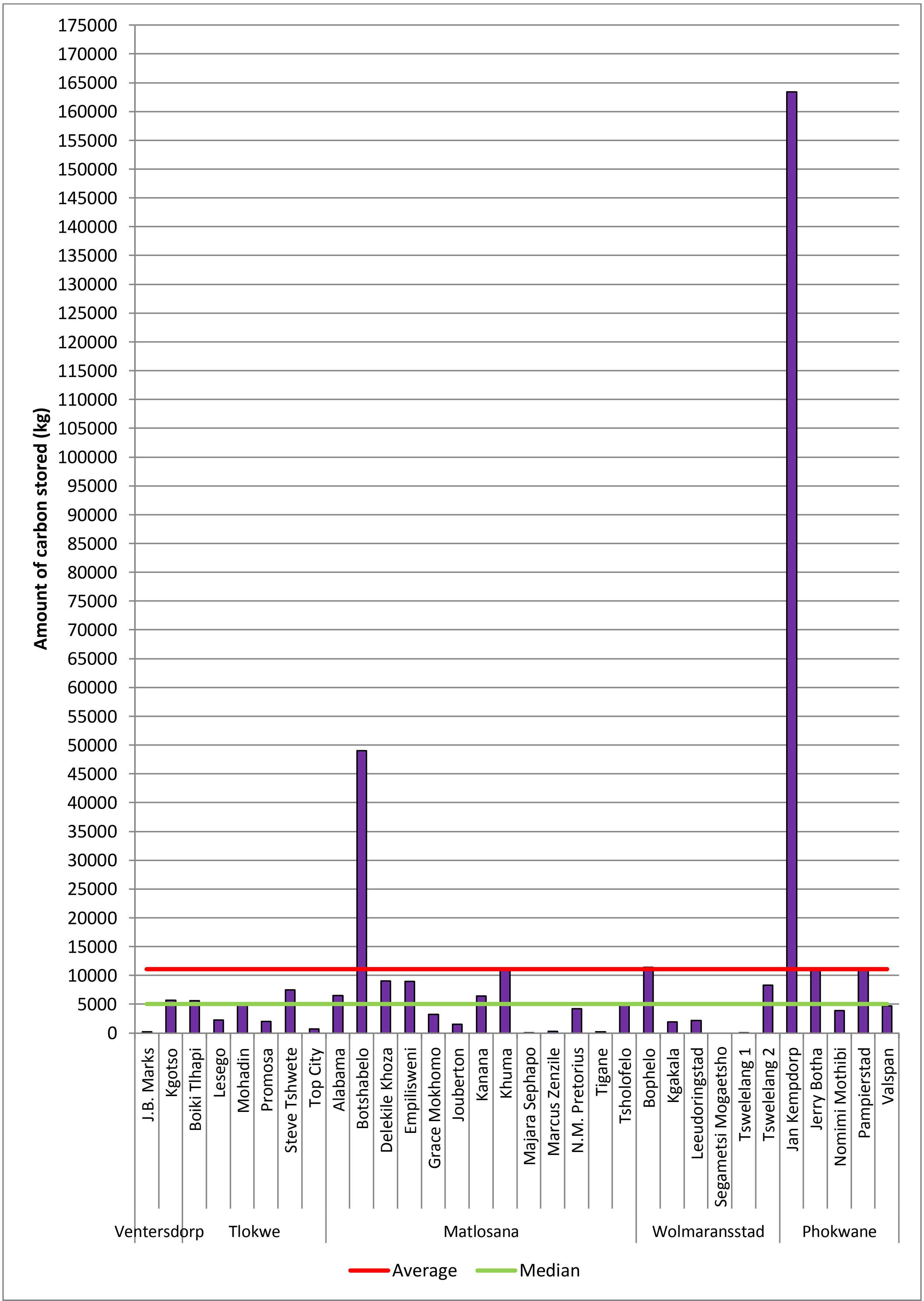


Figure 3-9: The amount of sequestered carbon (kg) stored within the plants of each clinic garden and the median and average values.

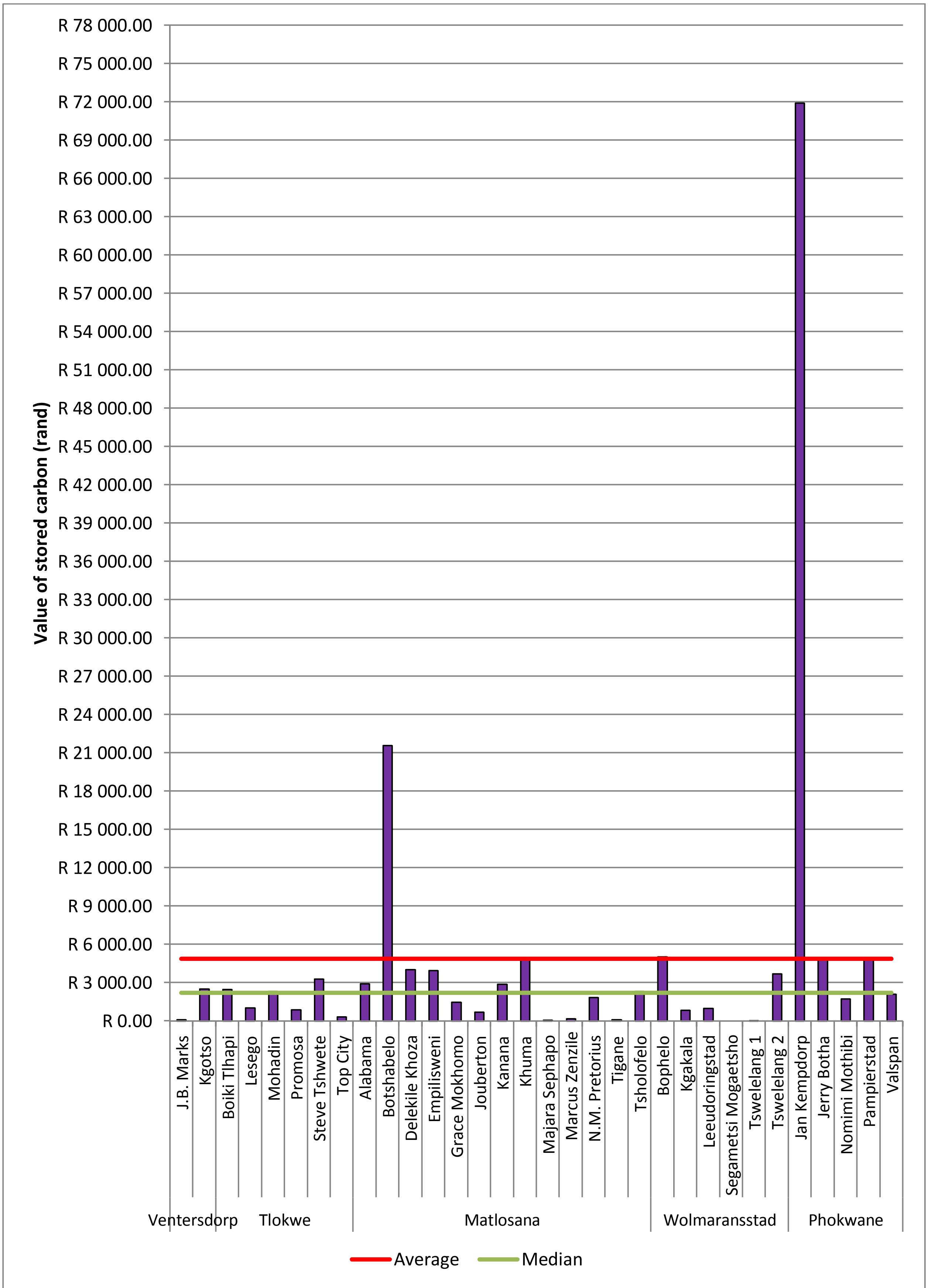


Figure 3-10: The monetary value of the stored carbon at each clinic garden and the median and average values.

3.3.2.2 Local climate regulation

The clinics with high total tree cover were Jan Kempdorp (9620.8 m^2) and Botshabelo (2536.9 m^2) while Segametsi Mogaetsho clinic had a very low tree cover of 0.27 m^2 (**Figure 3-11**).

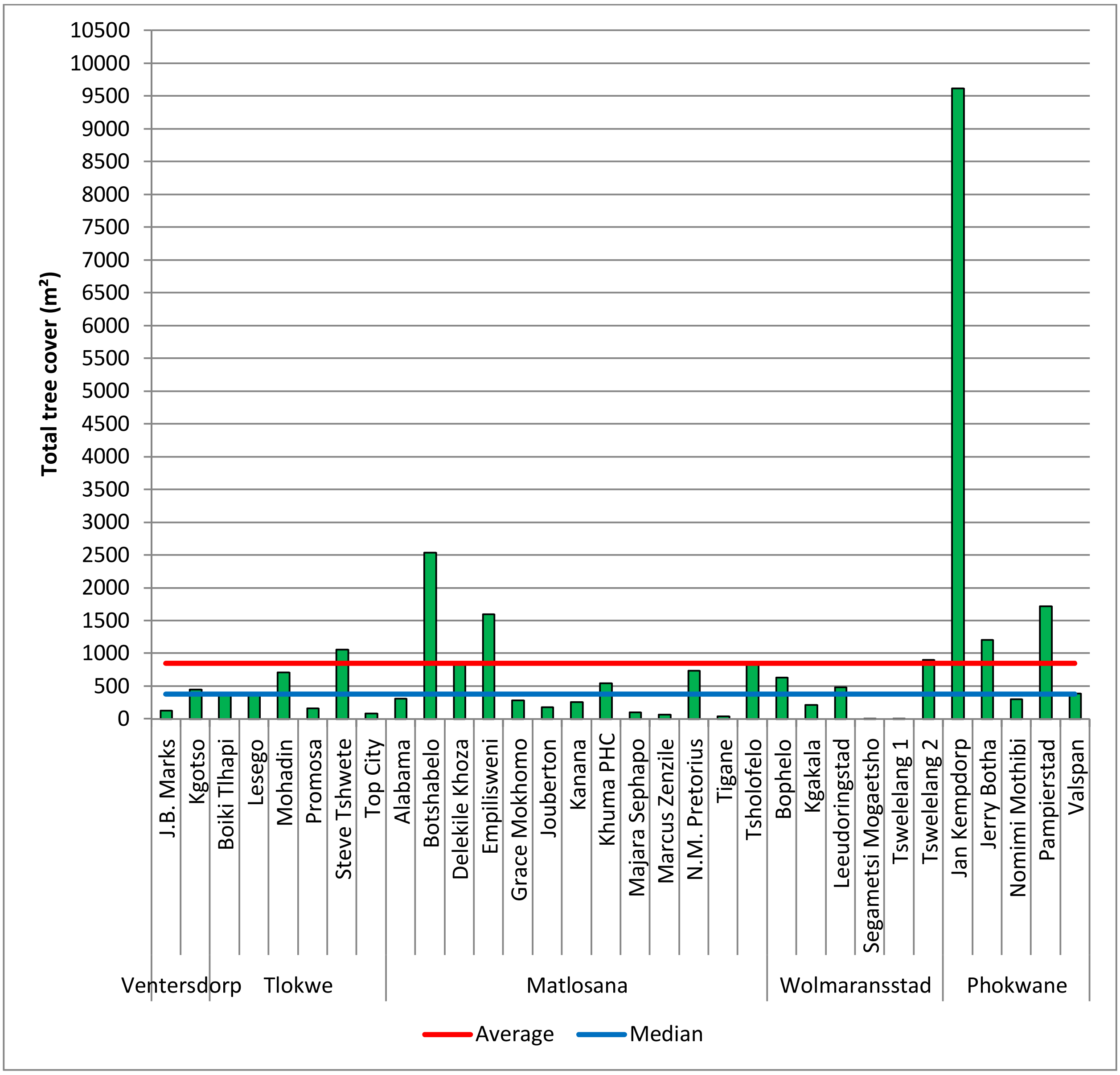


Figure 3-11: The total tree cover (m^2) at each clinic and the median and average values.

3.3.3 Supporting ecosystem services

3.3.3.1 Habitat diversity (micro-gardens)

3.3.3.1.1 Comparison between clinics

As seen in **Table 3-12** the largest lawn was located at the Empilisweni clinic, the largest vegetable garden was located at the Marcus Zenzile clinic, the largest ornamental garden was located at the Jerry Botha clinic, and the largest naga (natural area) was located at the Jan Kempdorp community health centre. There was only one medicinal garden identified at all the clinics and is located at the Marcus Zenzile clinic as well as one hedge identified at the Promosa clinic. The largest garden when excluding paving was that of Jan Kempdorp community health centre followed by J.B. Marks community health centre. The largest area that can serve as habitat for organisms (i.e. excluding paving and lebala) was that of Jan Kempdorp community health centre followed by J.B. Marks community health centre.

Ten clinics had four micro-gardens within the clinic boundaries that may potentially serve as habitat for different species while only three clinics had one micro-garden (**Figure 3-12**).

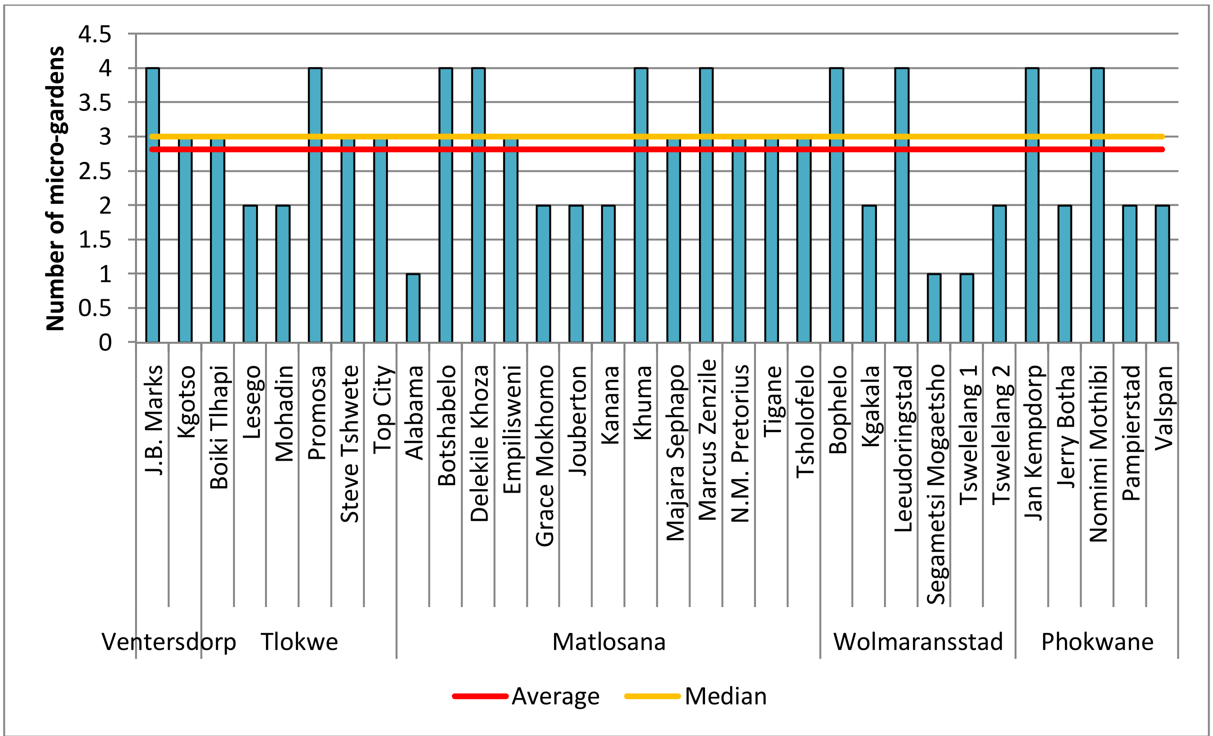


Figure 3-12: The number of micro-gardens at each clinic garden and the median and average values.

Table 3-12: The size of the micro-gardens present at each health clinic and the total size of the garden at each health clinic. Grey cells indicate the largest areas.

		Micro-gardens (m²)										
Sub-districts	Clinics	Lawn	Vegetable garden	Ornamental garden	Naga	Medicinal garden	Hedge	Lebala (m²)	Paving (m²)	TOTAL (m^2)	TOTAL (without paving) (m^2)	TOTAL (without paving and lebala) (m^2)
Phokwane	Jan Kempdorp	196	812	174	9177			820	2352	13531	11179	10359
	Jerry Botha		90	193				3025	231	3539	3308	283
	Pampierstad		56	50.5				2438	748	3292.5	2544.5	106.5
	Nomimi Mothibi	351	250	56	283			533	300	1773	1473	940
	Valspan	612	54					670	48	1384	1336	666
Wolmaransstad-Maquassie Hills	Leeudoringstad	145	242	152	119			60	528	1246	718	658
	Segametsi Mogaetsho	752						117	277	1146	869	752
	Bophelo	492	601	85	592				1287	3057	1770	1770
	Tswelelang 1		60					522	8	590	582	60
	Tswelelang 2			14	528			601	31	1174	1143	542
	Kgakala	262		27.5					239	528.5	289.5	289.5
Ventersdorp	Kgotso	129	192	39.5					373	733.5	360.5	360.5
	J.B. Marks	4708.5	903	65	2940				2976	11593	8616.5	8616.5
Matlosana	Grace Mokhomo		56	41				740.5	801	1638.5	837.5	97
	Botshabelo	3190	175	141	330			1458	1785	7079	5294	3836
	Delekile Khoza	37	170	12	231			542	748	1740	992	450
	Tigane	109	28	14				60	401	612	211	151
	Alabama		50					330	1375	1755	380	50
	Tsholofelo	199	198	56				704	60	1217	1157	453
	Empilisweni	5085	62	152					622	5921	5299	5299
	Jouberton		65		493			84	777	1419	642	558

	N.M. Pretorius	160		18	496				88	762	674	674
	Majara Sephapo	284	42	22.5				324	893	1565.5	672.5	348.5
	Khuma	202	1052	65	456			333	453	2561	2108	1775
	Kanana	159		123				450	113	845	732	282
	Marcus Zenzile	951	1185	40		2				2178	2178	2178
Tlokwe	Promosa	5	38	76			21		484.5	624.5	140	140
	Lesego		103	15				160	1049	1327	278	118
	Top City	108	234	12				65	256	675	419	354
	Boiki Tlhapi	296.5	77	43				66.5	851	1334	483	416.5
	Mohadin	30	131					112	240	513	273	161
	Steve Tshwete	724.5	910	124				172	568	2498.5	1930.5	1758.5

The clinics with the largest areas, as seen in **Figure 3-13**, that could potentially serve as habitat for plants and animals were Jan Kempdorp, J.B. Marks and Empilisweni. Fifteen clinics had a larger potential habitat for plants and animals than the median size of habitat available. The clinics with the highest percentage of the garden that could potentially serve as habitat for plants and animals were Marcus Zenzile, Empilisweni, N.M. Pretorius, Jan Kempdorp and J.B. Marks. There were 15 clinics that had a higher percentage of the garden that could potentially serve as habitat for plants and animals than the median percentage.

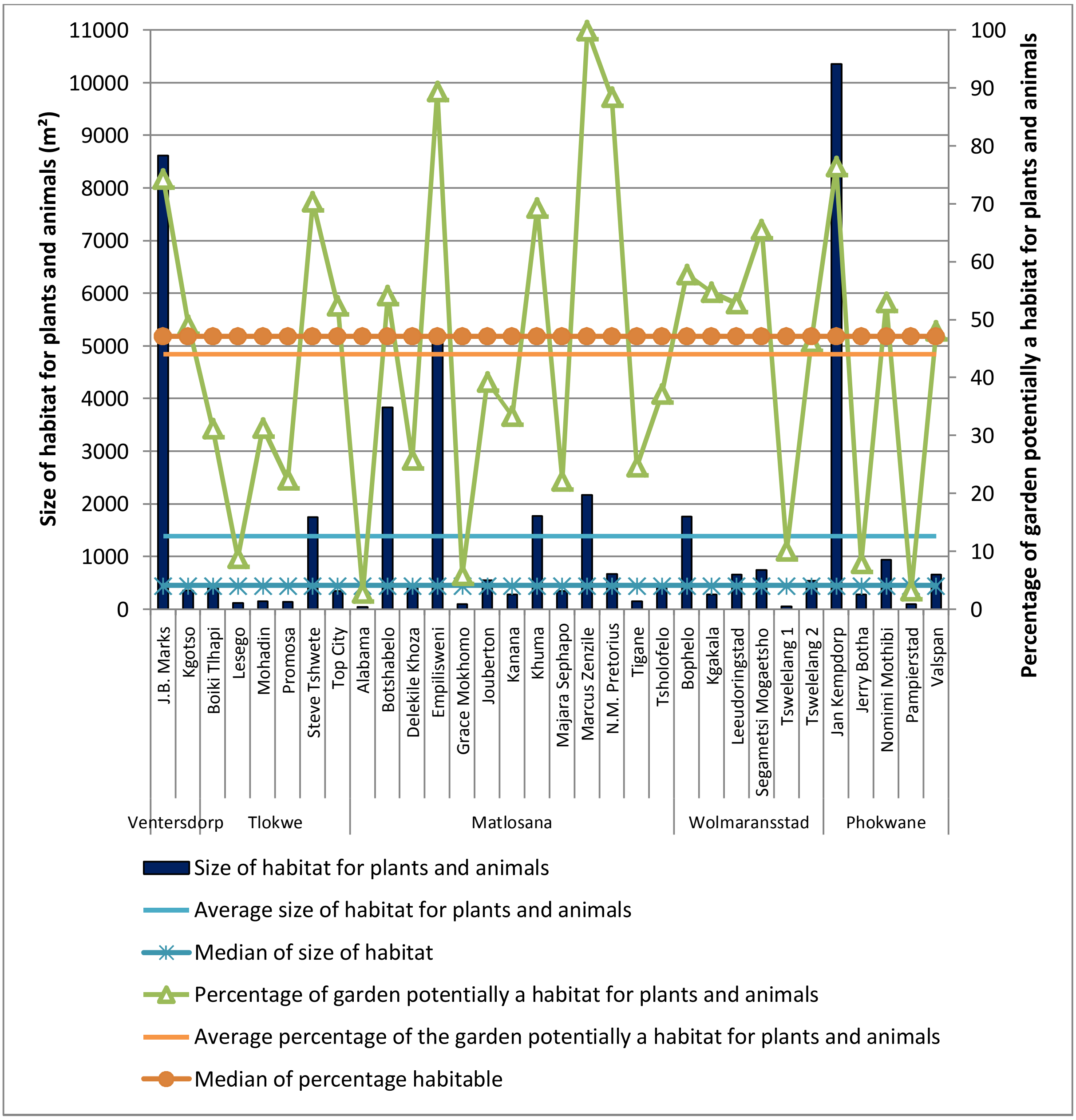


Figure 3-13: The size of the potential habitat for plants and animals (m^2) as well as the percentage this habitat makes out of the entire garden.

3.3.3.1.2 Comparison between sub-districts

The effect sizes for the different sub-districts were higher than 0.5 and was therefore significant when Ventersdorp sub-district was compared to the other sub-districts, and the highest effect size (1.78) was between Ventersdorp and Tlokwe sub-districts (**Table 3-13**). When comparing the average size of the gardens in each sub-district, the average size of Ventersdorp gardens was 6163 m^2 while that of Tlokwe was 1162 m^2 (**Table 3-14**). The smallest effect size (0.52) was between Ventersdorp and Phokwane sub-districts. When comparing the average size of the gardens in each sub-district, the average size of Ventersdorp gardens was 6163 m^2, while that of Phokwane was 4703.9 m^2 (**Table 3-14**). These two sub-districts were the most similar in size.

Table 3-13: The pairwise comparisons of the different sub-districts that indicate the effect size of the total size of the garden (m^2).

Total size of garden (m^2)		
Pairwise comparisons		**Effect size**
Ventersdorp	Matlosana	1.39
	Phokwane	0.52
	Tlokwe	1.78
	Wolmaransstad-Maquassie	1.73

Table 3-14: The total size (m^2) of all the gardens within each sub-district, the number of clinics in each sub-district and the average size of the gardens within each sub-district (m^2).

Sub-district	Total size of gardens of all clinics (m^2)	Number of clinics	Average size of gardens
Matlosana	29293	13	2253.308
Phokwane	23519.5	5	4703.900
Tlokwe	6972	6	1162.000
Ventersdorp	12326	2	6163.000
Wolmaransstad-Maquassie Hills	7741.5	6	1290.250

3.3.3.2 Plant species diversity

3.3.3.2.1 Comparison between clinics

The clinics with the highest number of plant species were J.B. Marks (70 species), Steve Tshwete (66 species), Khuma (65 species), Jan Kempdorp (63 species) and Leeudoringstad (58 species) (**Figure 3-14**). There were 16 clinics that had more species than the median number of species. The clinics with the highest number of indigenous species were Jan Kempdorp (28 species), J.B. Marks (27 species) and Delekile Khoza (25 species). The clinics with the highest number of exotic species were Steve Tshwete (49 species), Khuma (49 species) and J.B. Marks (43 species).

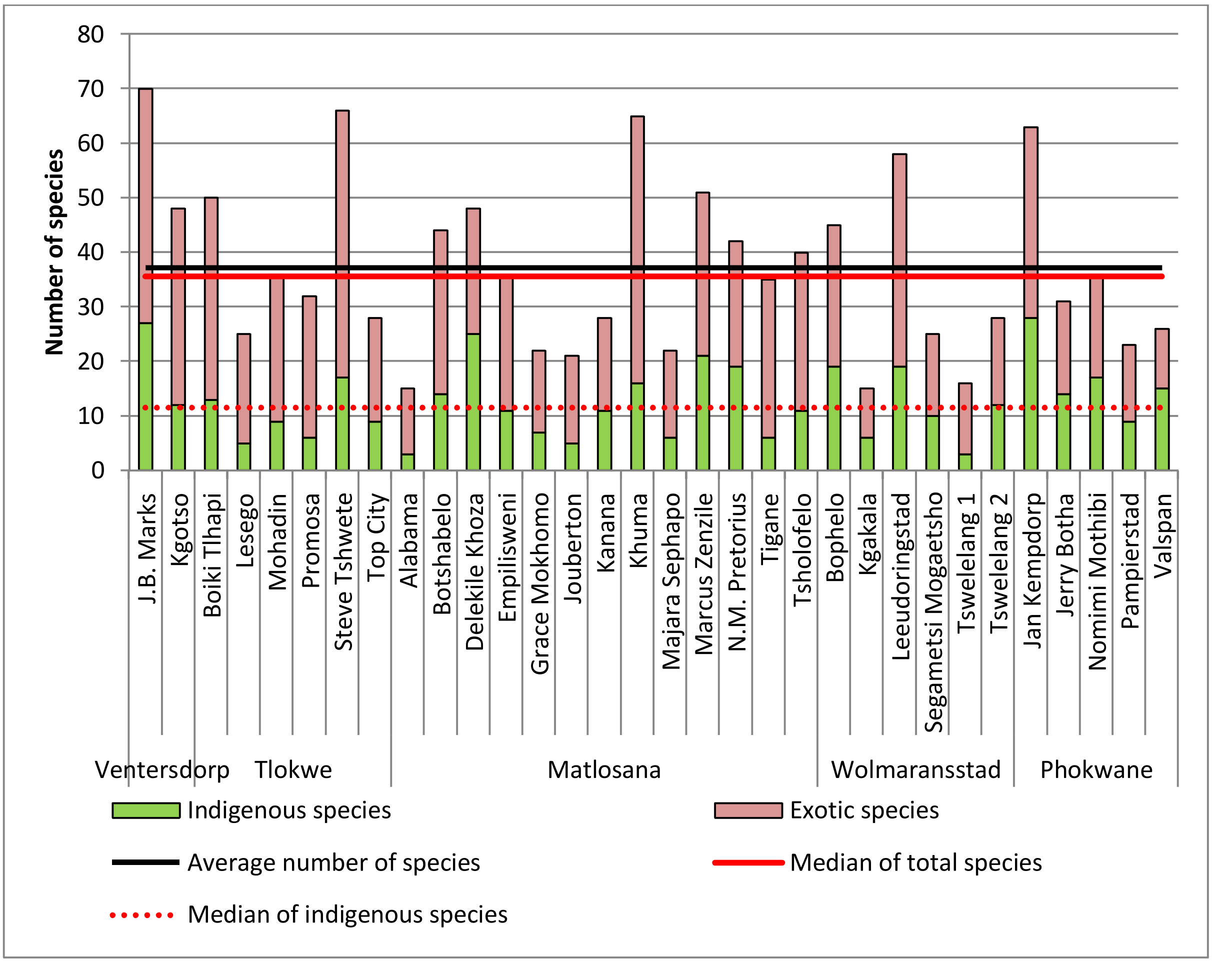


Figure 3-14: The total number of species found at each clinic, as well as the number of indigenous and exotic species and their median and average values.

In this study, there was only one rare species, a species where at least one IUCN criteria for rarity is met and is not under immediate threat (SANBI, 2017). All the remaining plant species were a least concern (LC) meaning they are species that have a low risk of extinction and are generally widespread and abundant (SANBI, 2017). As seen in **Figure 3-15** there were only four clinics that had one rare species each. The clinics with the highest number of least concern species were J.B. Marks (26 species), Jan Kempdorp (26 species) and Delekile Khoza (25 species).

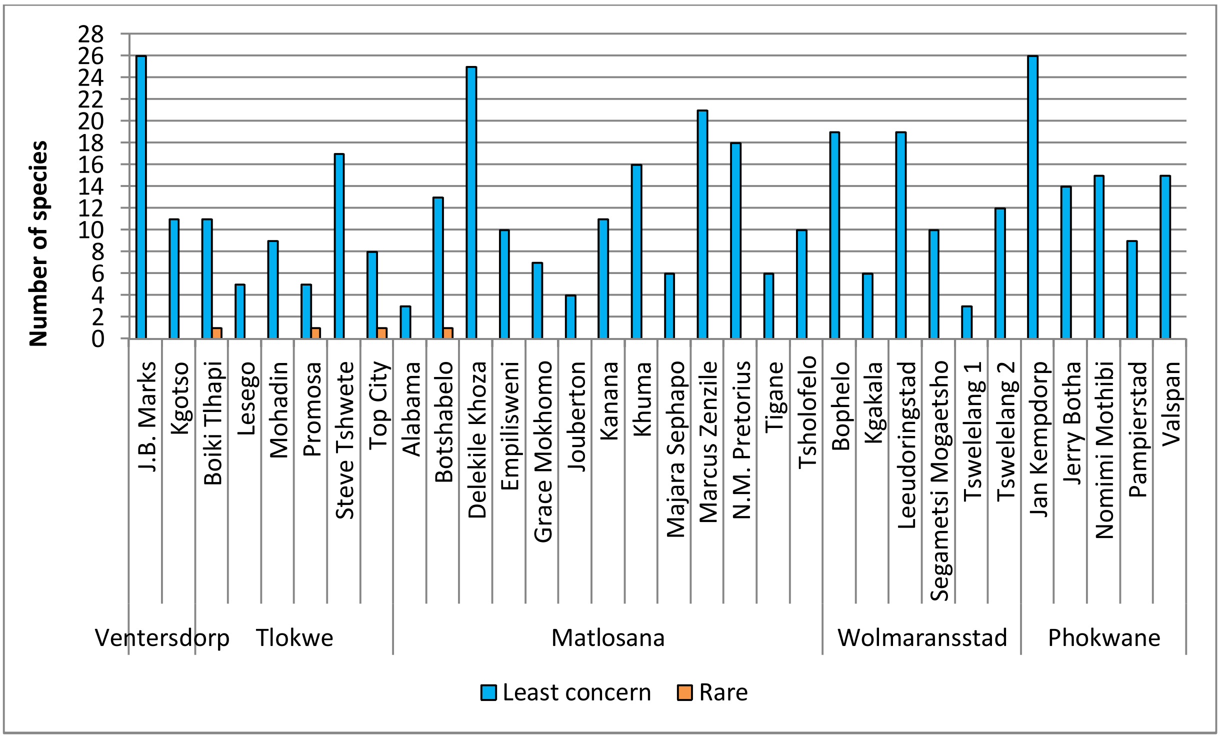


Figure 3-15: The least concern and rare species for each clinic garden according to the red data list.

As seen in **Figure 3-16** the clinics that had the highest number of invasive species were J.B. Marks (15 species), Jan Kempdorp (8 species), Khuma (7 species) and Empilisweni (6 species). There were two clinics that did not have any invasive species, namely Bophelo and Kgakala. The clinic that had the highest number of Category 1 invasive species was J.B. Marks (3 species). There were ten clinics that did not have any Category 1 invasive species. The clinic with the highest number of Category 2 invasive species was J.B. Marks (10 species). There were 26 clinics that did not have any Category 2 species. The clinics with the highest number of Category 3 invasive species were Khuma (4 species), Boiki Tlhapi (3 species) and Jan Kempdorp (3 species). There were nine clinics that did not have any Category 3 invasive species.

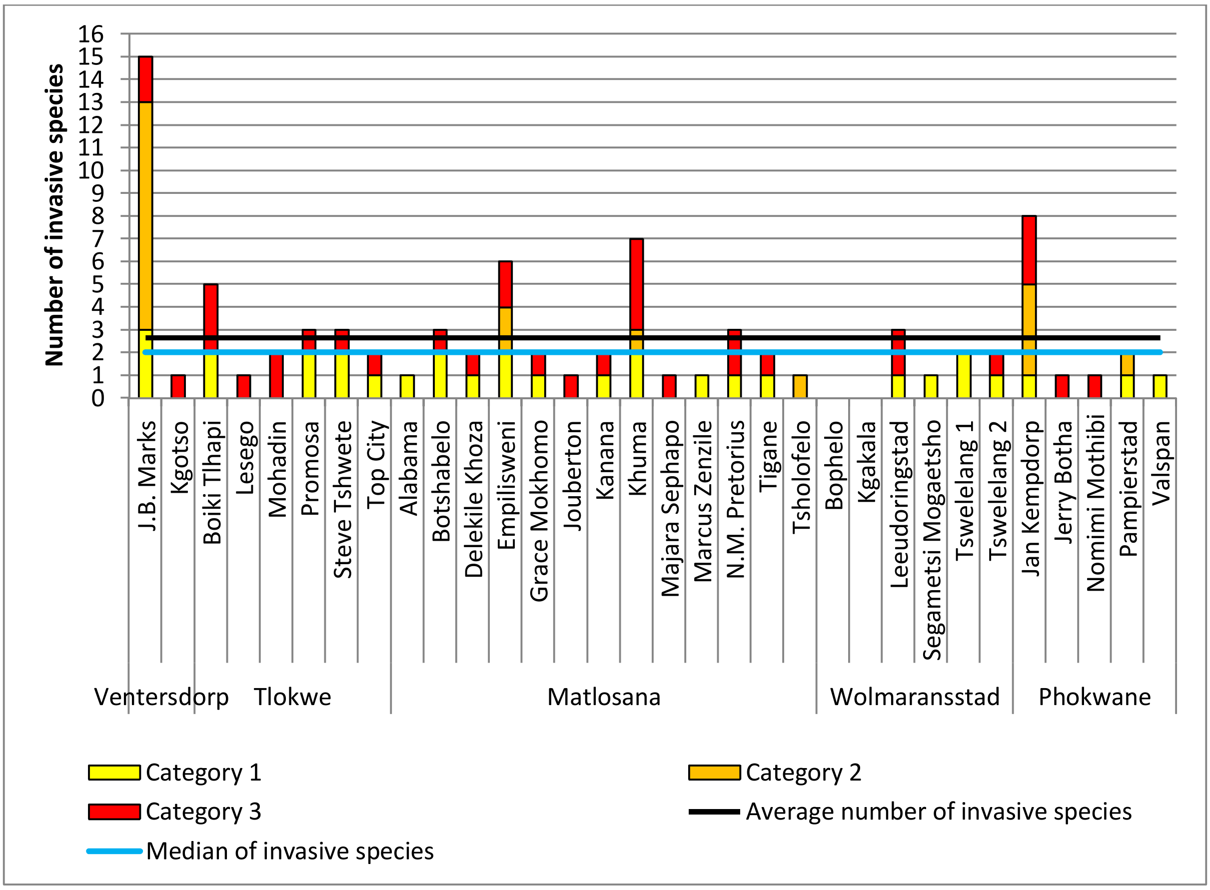


Figure 3-16: The number of invasive species of each category found in the clinic gardens and the median and average values.

3.3.3.2.2 Comparison between sub-districts

As seen in **Table 3-15** the effect sizes for the different sub-districts were higher than 0.8 and was therefore significant. There were significant differences between the average number of invasive species of Ventersdorp sub-district and the other sub-districts. The highest effect size was between Ventersdorp and Wolmaransstad-Maquassie Hills sub-districts (2.47). When comparing the average number of invasive species (**Table 3-16**) it was seen that Ventersdorp had an average number of invasive species of 8.000 while Wolmaransstad-Maquassie Hills had an average of 1.333 invasive species.

Table 3-15: The pairwise comparisons of the different sub-districts that indicate the effect size of the total number of invasive species which are declared invaders identified in the health clinic gardens.

Total number of invasive species (declared invaders)		
Pairwise comparisons		**Effect size**
Ventersdorp	Matlosana	2.05
	Phokwane	2
	Tlokwe	1.97
	Wolmaransstad-Maquassie	2.47

Table 3-16: The total number of invasive species for each sub-district, the number of clinics in each sub-district and the average number of invasive species in each sub-district.

Sub-district	Total number of invasive species	Number of clinics	Average number of invasive species
Matlosana	32	13	2,462
Phokwane	13	5	2,600
Tlokwe	16	6	2,667
Ventersdorp	16	2	8,000
Wolmaransstad-Maquassie Hills	8	6	1,333

The total number of Category 2 invasive species had a p-value of 0.006 and was therefore considered to be statistically significant. As seen in **Table 3-17** the effect sizes for the different sub-districts were higher than 0.8 and was therefore significant. The largest effect sizes were between Ventersdorp and Tlokwe (3.18) and between Ventersdorp and Wolmaransstad-Maquassie Hills (3.18). When comparing the average number of Category 2 invasive species between these clinics (**Table 3-18**), it was seen that Ventersdorp had an average of 5.000 while Tlokwe and Wolmaransstad-Maquassie Hills had an average of 0.000.

Table 3-17: The pairwise comparisons of the different sub-districts that indicate the effect size of the total number of Category 2 invasive species identified in the health clinic gardens.

Total number of Category 2 invasive species		
Pairwise comparisons		**Effect size**
Ventersdorp	Matlosana	2.98
	Phokwane	2.54
	Tlokwe	3.18
	Wolmaransstad-Maquassie	3.18

Table 3-18: The total number of Category 2 invasive species in each sub-district, the number of clinics in each sub-district and the average number of Category 2 invasive species in each sub-district.

Sub-district	Total number of Category 2 invasive species	Number of clinics	Average number of Category 2 invasive species
Matlosana	4	13	0,308
Phokwane	5	5	1,000
Tlokwe	0	6	0.000
Ventersdorp	10	2	5,000
Wolmaransstad-Maquassie Hills	0	6	0.000

3.3.3.3 Habitat for bird species

3.3.3.3.1 Comparison between clinics

The clinics where the most bird species were observed were Kanana (7 species), Empilisweni (5 species) and Tswelelang 2 (5 species) but in three clinics no birds were observed (**Figure 3-17**). The clinics where the most bird nests were observed were Mohadin (14 nests), Jan Kempdorp (14 nests) and Botshabelo (13 nests). There were 11 clinics where no nests were observed. The bird species that occurred at most of the clinics was the House Sparrow, occurring at 27 of the clinics (**Table 3-19**). The most nests observed were also from the House Sparrow (63), observed at 18 clinics (**Table 3-20**).

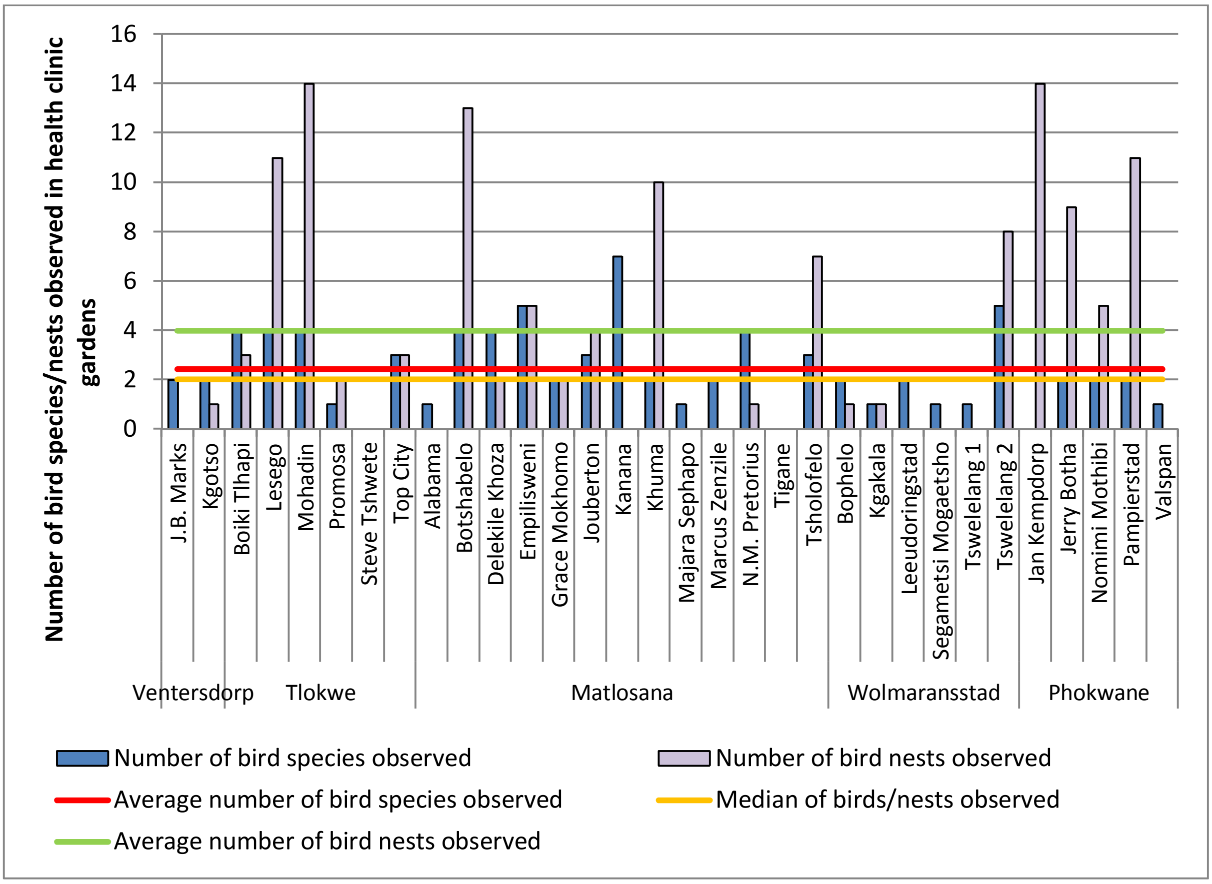


Figure 3-17: The number of birds and nests observed at each clinic garden and their median and average values.

Table 3-19: The bird species observed in the health clinic gardens and the frequency of occurrence of each species. (* indicates exotic species).

Bird species	Common name	Frequency of occurrence in clinics
*Passer domesticus**	House Sparrow	**27**
*Columba livia**	Rock Pigeon	**16**
Ploceus velatus	Masked Weaver	**12**
Streptopelia senegalensis	Laughing Dove	**9**
*Acridotheres tristis**	Indian Myna	**3**
Euplectes orix	Red Bishop	**2**
Serinus canicollis	Cape Canary	**2**
Tricholaema leucomelas	Pied Barbet	**1**
Swallow species	Swallow	**1**
Turdus olivaceus	Olive Thrush	**1**
Streptopelia capicola	Cape Turtle Dove	**1**

Table 3-20: The bird species of which nests were observed, the number of nests observed in all the clinics and the frequency of occurrence of the nests in the health clinic gardens.

Bird species	Common name	Number of nests observed	Frequency of occurrence in clinics
Streptopelia senegalensis	Laughing dove	6	**6**
Ploceus velatus	Southern masked weaver	59	**12**
*Passer domesticus**	House sparrow	63	**18**

The most frequent occurring plant species attracting birds was *Celtis sinensis* an exotic tree species; while there were eight indigenous species in the top 13 most frequent bird attracting plants but none of them was endemic or rare species (**Table 3-21**).

Table 3-21: The most frequently occurring bird plants found in the health clinic gardens.

Position	Plant species	Status	Frequency of occurrence in clinic gardens
1	*Celtis sinensis*	Exotic	**15**
2	*Combretum erythropyllum*	Indigenous (LC)	**8**
3	*Searsia lancea*	Indigenous (LC)	**8**
4	*Celtis africana*	Indigenous (LC)	**7**
5	*Searsia pendulina*	Indigenous (LC)	**7**
6	*Olea europaea* subsp. *africana*	Indigenous (LC)	**6**
7	*Morus alba/nigra*	Exotic	**5**
8	*Melia azedarach*	Exotic	**3**
9	*Dovyalis caffra*	Indigenous (LC)	**3**
10	*Celtis australis*	Exotic	**2**
11	*Ficus carica*	Exotic	**2**
12	*Cotyledon orbiculata*	Indigenous (LC)	**2**
13	*Panicum maximum*	Indigenous (LC)	**2**

The clinics with the highest number of potential bird plant species were Jan Kempdorp (8 species), and Botshabelo (6 species) and only four clinics had no potential bird plant species (**Figure 3-18**). The clinics with the highest number of potential indigenous bird species were Jan Kempdorp (5 species), Botshabelo (4 species) and Jerry Botha (4 species). There were eight clinics that did not have any potential indigenous bird plant species. The clinic with the highest number of potential exotic bird plant species was Jan Kempdorp (3 species). There were ten clinics where there were no potential exotic bird plant species. Clinics, where there were only potential exotic bird plant species, were Grace Mokhomo, Kanana, Tigane and Leeudoringstad.

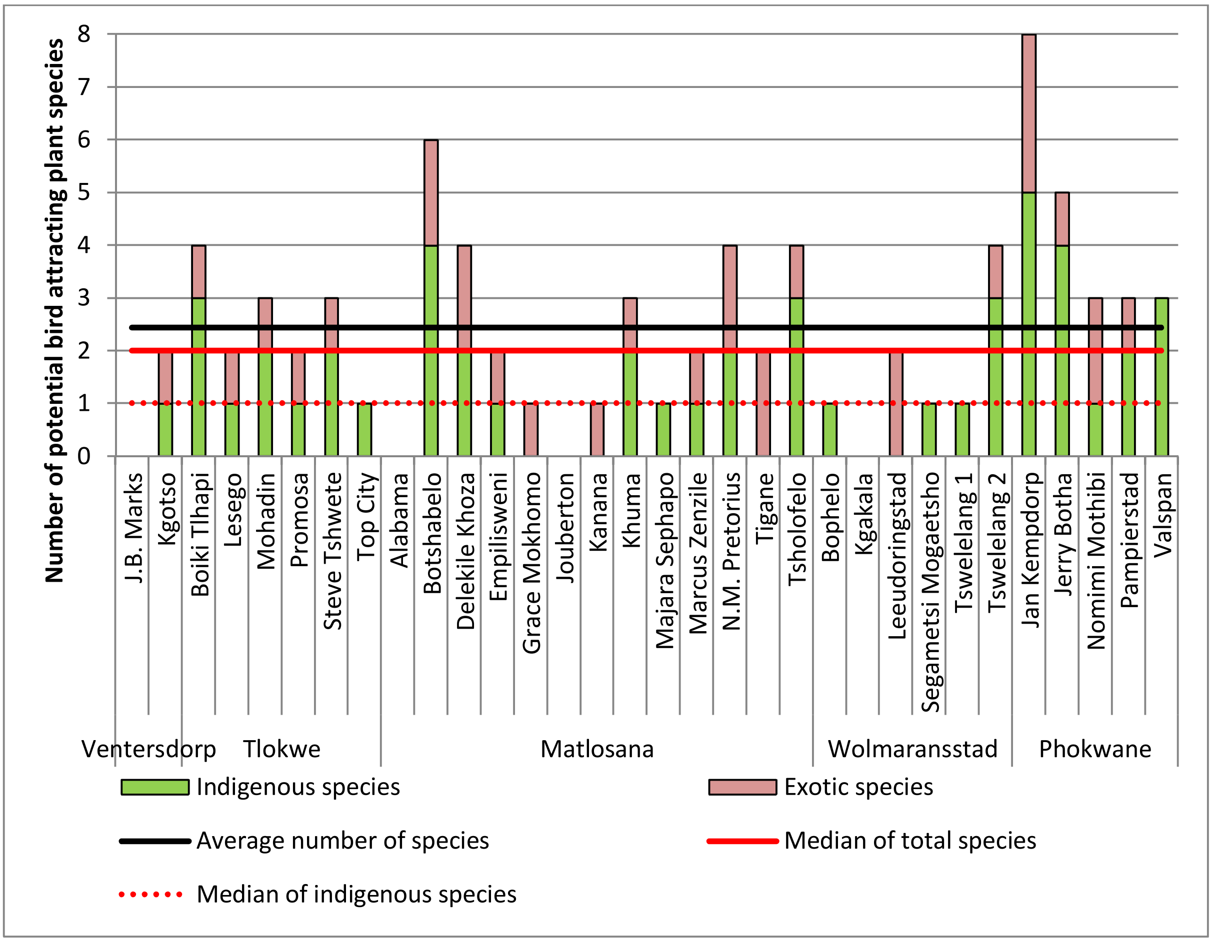


Figure 3-18: The number of potential exotic and indigenous bird plants at each clinic garden and their median and average values.

3.3.3.3.2 Comparison between sub-districts

The effect sizes for all the sub-districts were higher than 0.8 and was therefore significant (**Table 3-22**). In **Table 3-23** it was seen that when the average number of potential bird plant species of the Phokwane sub-district was compared to the other sub-districts, there was a significant difference in averages. The highest effect size was between Phokwane and

Ventersdorp (2.04). When the average number of potential bird plant species between these clinics was compared it was seen that Phokwane had an average of 4.400 while Ventersdorp had an average of 1.000 potential bird plant species (**Table 3-23**).

Table 3-22: The pairwise comparisons of the different sub-districts that indicate the effect size of the total number of potential bird plant species identified in the health clinic gardens.

Total number of potential bird plants		
Pairwise comparisons		**Effect size**
Phokwane	Matlosana	1.26
	Tlokwe	1.14
	Ventersdorp	2.04
	Wolmaransstad-Maquassie	1.74

Table 3-23: The total number of potential bird plant species in each sub-district, the number of clinics in each sub-district and the average number of potential bird plant species for each sub-district.

Sub-district	Total number of potential bird plants	Number of clinics	Average number of potential bird plants
Matlosana	30	13	2,308
Phokwane	22	5	4,400
Tlokwe	15	6	2,500
Ventersdorp	2	2	1,000
Wolmaransstad-Maquassie Hills	9	6	1,500

The effect sizes for all the sub-districts were higher than 0.8 and was therefore significant, and there was a significant difference between the average number of potential indigenous bird plant species of the Phokwane sub-district and the other sub-districts (**Table 3-24**). The highest effect size was between Phokwane and Ventersdorp (2.05). When comparing the average number of potential indigenous bird plant species (Table 3-25) it was seen that Phokwane had an average number of potential bird plant species of 3.000 while Ventersdorp had an average of 0.500.

Table 3-24: The pairwise comparisons of the different sub-districts that indicate the effect size of the number of potential indigenous bird plant species identified in the health clinic gardens.

Number of potential bird plants (indigenous)		
Pairwise comparisons		**Effect size**
Phokwane	Matlosana	1.45
	Tlokwe	1.09
	Ventersdorp	2.05
	Wolmaransstad-Maquassie	1.64

Table 3-25: The total number of potential indigenous bird plant species in each sub-district, the number of clinics in each sub-district and the average number of potential indigenous bird plant species for each sub-district.

Sub-district	Total number of potential indigenous bird plant species	Number of clinics	Average number of potential indigenous bird plant species
Matlosana	16	13	1,231
Phokwane	15	5	3,000
Tlokwe	10	6	1,667
Ventersdorp	1	2	0,500
Wolmaransstad-Maquassie Hills	6	6	1,000

3.3.4 Cultural ecosystem services

3.3.4.1 Recreation

Only seven clinics had garden benches (**Figure 3-20**), and only in six clinics, people were observed to sit on the lawn (Table 3-26). There was, however, still potential for people to sit on the lawn; therefore, it was stated in Table 3-26 that people could potentially sit on the lawn. A few clinics even provided opportunities for recreation for children (**Figure 3-19**).

Figure 3-19: The children's play area at the Majara Sephapo clinic.

Table 3-26: The clinic gardens where benches were observed to be used by people and the clinics where people were observed sitting on the lawn or clinics where people could potentially sit on the lawn.

		Garden benches	People sitting on lawn
Ventersdorp	JB Marks	Yes	Potentially
	Kgotso	No	Potentially
Tlokwe	Boiki Tlhapi	No	Potentially
	Lesego	No	Potentially
	Mohadin	No	Yes
	Promosa	No	Potentially
	Steve Tshwete	No	Potentially
	Top City	No	Potentially
Matlosana	Alabama	No	Potentially
	Botshabelo	Yes	Potentially
	Delekile Khoza	No	Potentially
	Empilisweni	No	Yes
	Grace Mokhomo	Yes	Potentially
	Jouberton	No	Potentially
	Kanana	No	Potentially
	Khuma	No	Yes
	Majara Sephapo	No	Potentially
	Marcus Zenzile	No	Yes
	NM Pretorius	No	Potentially
	Tigane	No	Potentially
	Tsholofelo	No	Yes
Wolmaransstad-Maquassie Hills	Bophelo	Yes	Potentially
	Kgakala	No	Potentially
	Leeudoringstad	No	Potentially
	Segametsi Mogaetsho	No	Potentially
	Tswelelang 1	No	Potentially
	Tswelelang 2	No	Yes
Phokwane	Jan Kempdorp	Yes	Potentially
	Jerry Botha	Yes	Potentially
	Nomimi Mothibi	Yes	Potentially
	Pampierstad	No	Potentially
	Valspan	No	Potentially

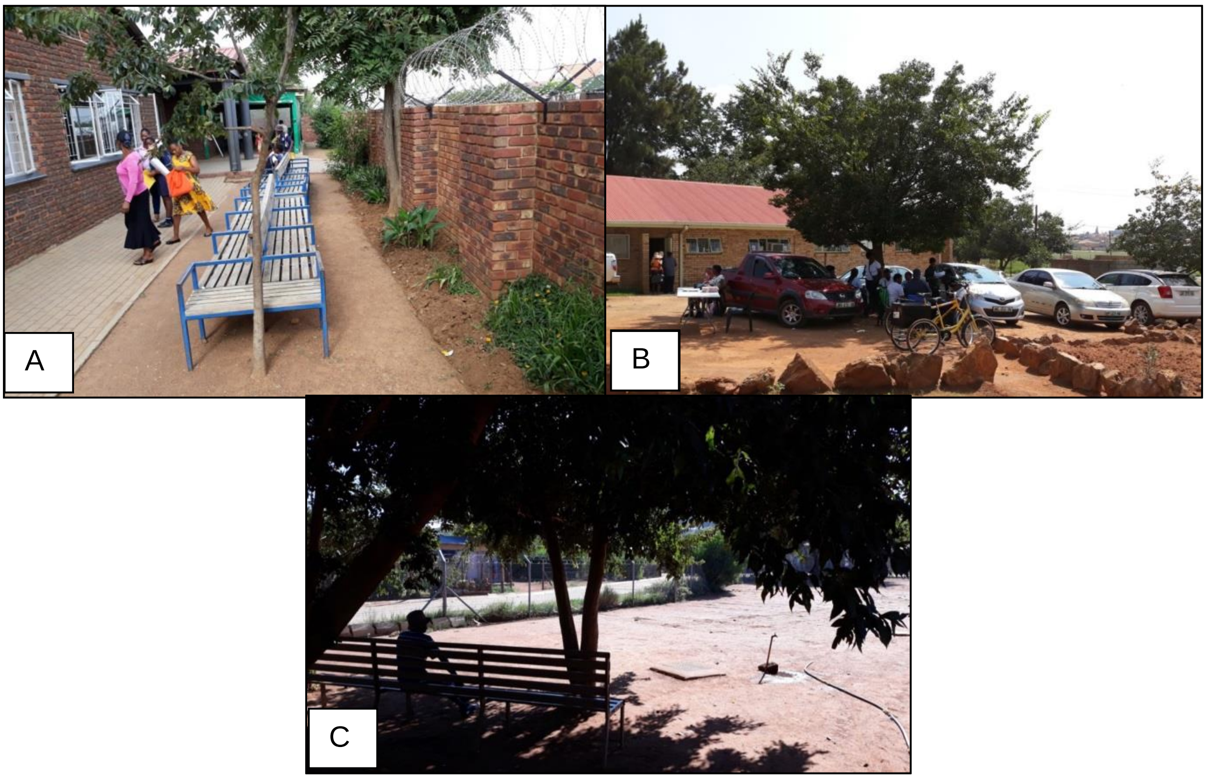


Figure 3-20: A. The garden benches in the garden of the Grace Mokhomo community health centre. B. People sitting under a tree at the Tsholofelo clinic. C. Benches under *Celtis africana* and *Combretum erythrophyllum* trees in the Jerry Botha clinic garden.

3.3.4.2 Aesthetic appreciation

The clinics with the most potential ornamental plant species were Jan Kempdorp (21 species), Botshabelo (19 species) and Tsholofelo (19 species) (**Figure 3-21**). The clinics with the most potential indigenous ornamental plant species were Jerry Botha (10 species), Botshabelo (8 species), Bophelo (8 species) and Jan Kempdorp (8 species) while only one clinic did not have any potential indigenous ornamental plant species, namely Alabama. The clinics with the most potential exotic ornamental plant species were Khuma (14 species), Steve Tshwete (13 species), Leeudoringstad (13 species) and Jan Kempdorp (13 species).

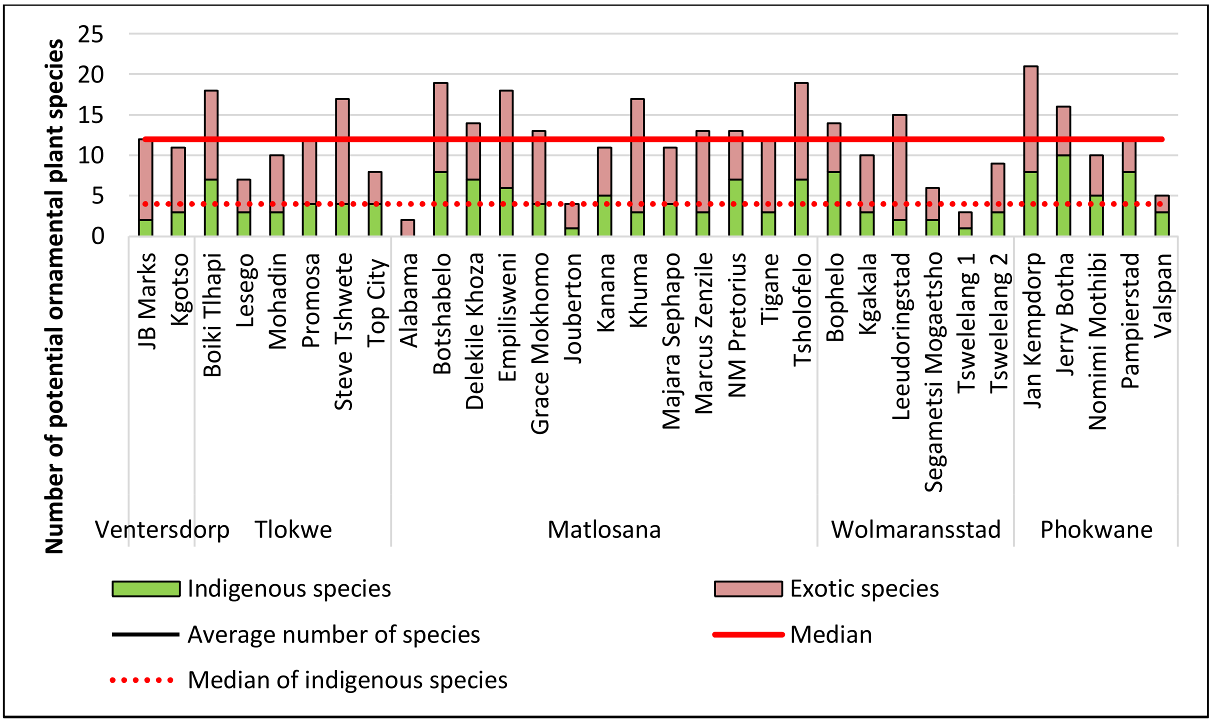


Figure 3-21: The number of potential ornamental plant species found at each clinic garden and their median and average values.

The most frequently occurring potential ornamental plant species was *Pennisetum clandestinum* an exotic plant species occurring at 22 health clinics (**Table 3-27**). There were two species which are endemic to South Africa, and all indigenous species were least concern (**Table 3-27**).

Table 3-27: The most frequent occurring potential ornamental species identified at the health clinic gardens.

Position	Plant species	Status	Frequency of occurrence in clinic gardens
1	*Pennisetum clandestinum*	Exotic	**22**
2	*Celtis sinensis*	Exotic	**15**
3	*Eragrostis tef*	Exotic	**14**
4	*Cestrum laevigatum*	Exotic	**11**
5	*Oxalis corniculata*	Exotic	**11**
6	*Agapanthus africanus*	Indigenous (LC) - endemic to RSA	**10**
7	*Felicia muricata* subsp. *muricata*	Indigenous (LC)	**10**
8	*Canna x generalis*	Exotic	**9**
9	*Gazania krebsiana*	Indigenous (LC)	**9**
10	*Iris germanica*	Exotic	**9**
11	*Tulbaghia simmleri*	Indigenous (LC) - endemic to RSA	**9**
12	*Verbena bonariensis*	Exotic	**8**

3.3.4.3 Spiritual or cultural value

The clinics with the highest number of plant species with potential spiritual or cultural value were Promosa, Top City, Botshabelo and Delekile Khoza all with only two species, while 18 clinics did not have any plants with a potential spiritual or cultural value (**Figure 3-22**). All of the plant species with potential spiritual or cultural value were indigenous (Table 3-28). There was also one rare species which was also endemic to South Africa. The most frequent occurring plant species with potential spiritual or cultural value was *Celtis Africana*, occurring in 7 health clinic gardens.

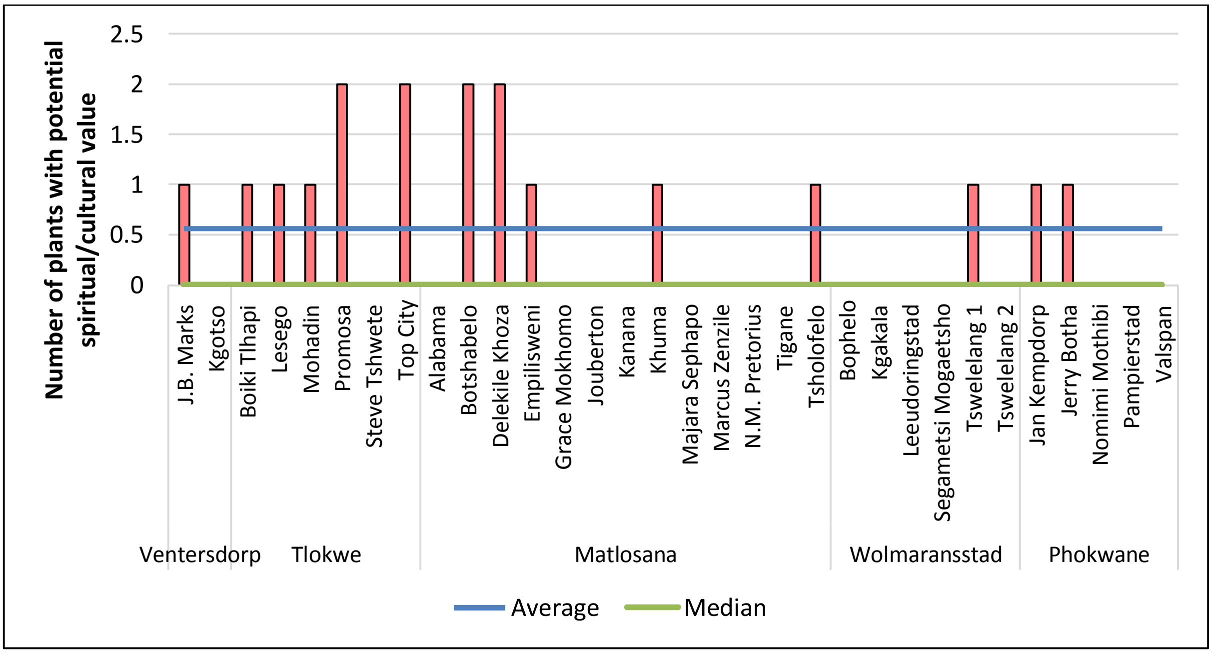


Figure 3-22: The number of potential plant species with spiritual and/or cultural value at each clinic.

Table 3-28: The plant species that had potential spiritual and/or cultural value.

Position	Plant species	Status	Frequency of occurrence in clinic garden
1	*Celtis africana*	Indigenous (LC)	**7**
2	*Dietes bicolor*	Indigenous (Rare) ï endemic to RSA	**4**
3	*Helichrysum aureonitens*	Indigenous (LC)	**2**
4	*Crinum bulbispermum*	Indigenous (LC)	**1**
5	*Hermannia depressa*	Indigenous (LC)	**1**
6	*Plumbago auriculata*	Indigenous (LC)	**1**
7	*Senegalia caffra*	Indigenous (LC)	**1**
8	*Ziziphus mucronata*	Indigenous (LC)	**1**

3.3.5 Ecosystem disservices

3.3.5.1 Allergies

The clinics with the most plant species that could potentially cause allergies were Jan Kempdorp (18 species), J.B. Marks (17 species) and Khuma (14 species) (**Figure 3-23**). The clinics with the most indigenous plant species that could potentially cause allergies were Jan Kempdorp (14 species), J.B. Marks (11 species), Khuma (10 species) and Leeudoringstad (10 species). Pampierstad clinic had the fewest number of indigenous plant species that could potentially cause allergies (1 species). The clinics with the most exotic plant species that could potentially cause allergies were J.B. Marks (6 species) and Kgotso (5 species). Valspan had no exotic species that could potentially cause allergies.

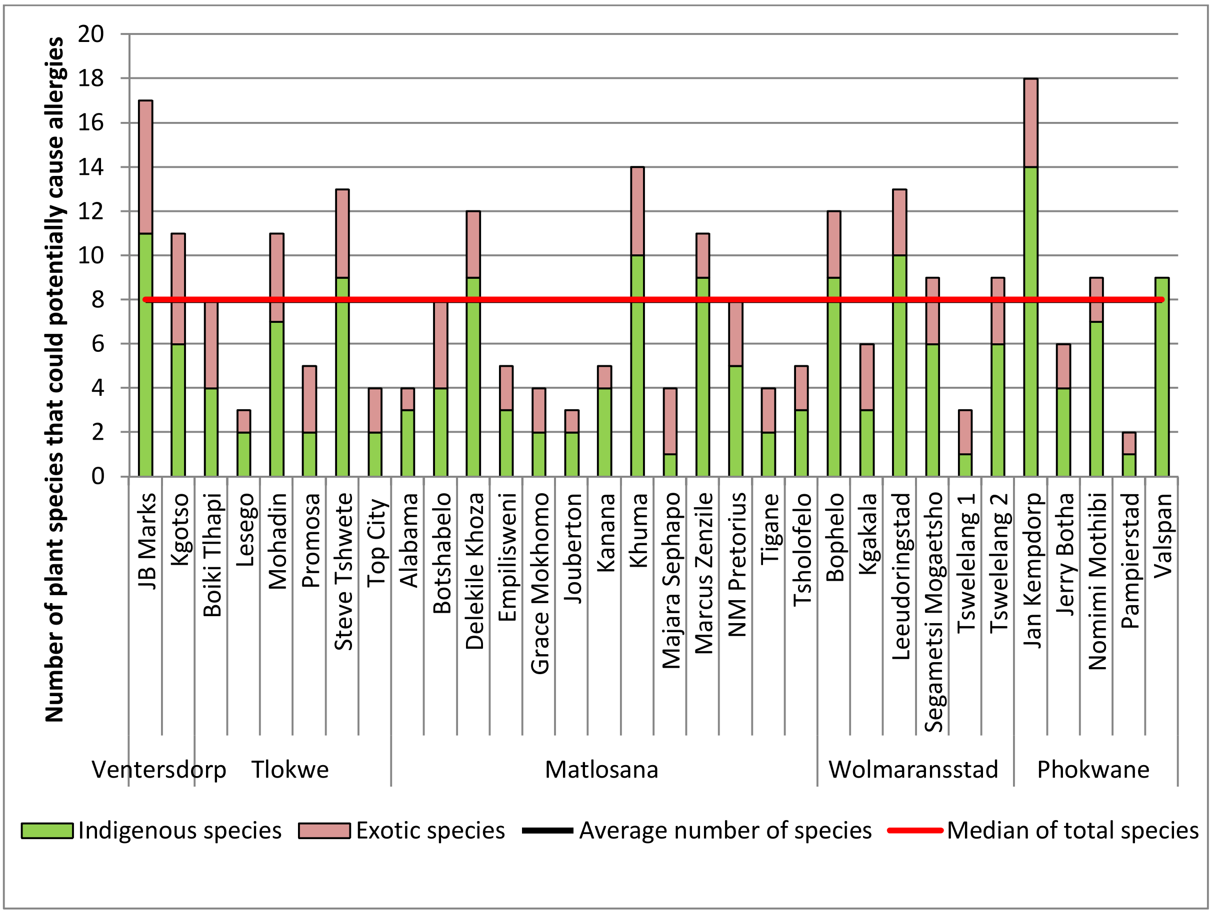


Figure 3-23: The number of species that could potentially cause people to experience allergic reactions in the health clinic gardens and their median and average values.

The most frequently occurring plant species that could potentially cause allergies were *Cynodon dactylon,* an indigenous grass which occurred at 23 clinics (**Table 3-29**). There was one declared invader plant species, namely *Ligustrum lucidum* that could potentially cause allergic reactions.

Table 3-29: The most frequent occurring plant species with the potential to cause allergies in the health clinic gardens.

Position	Plant species	Status	Frequency of occurrence in clinic gardens
1	*Cynodon dactylon*	Indigenous (LC)	**23**
2	*Pennisetum clandestinum*	Exotic	**22**
3	*Urochloa mosambicensis*	Indigenous (LC)	**19**
4	*Plantago lanceolata*	Indigenous (LC)	**17**
5	*Eragrostis lehmanniana*	Indigenous (LC)	**14**
6	*Eragrostis tef*	Exotic	**14**
7	*Eragrostis chloromelas*	Indigenous (LC)	**11**
8	*Cynodon hirsutus*	Indigenous (LC)	**8**
9	*Eleusine indica*	Indigenous (LC)	**8**
10	*Celtis africana*	Indigenous (LC)	**7**
11	*Chloris pycnothrix*	Indigenous (LC)	**7**
12	*Ligustrum lucidum*	Exotic - Declared invader (Category 3)	**7**
13	*Paspalum dilatatum*	Exotic	**7**

3.3.5.2 Accidents

The clinic with the most plant species that overhang buildings was Mohadin with six species; and the clinic with the most plant species that overhang parking areas was Jan Kempdorp with four species (**Figure 3-24**). The clinic with the most plant species that had low-hanging branches was Steve Tshwete with two species. The clinic with the most plant species that had a branch to tree angle of more than 45° was Mohadin with four species. There were ten clinics that did not have any plant species that could potentially cause accidents. **Figure 3-25** shows examples of trees that could potentially cause accidents.

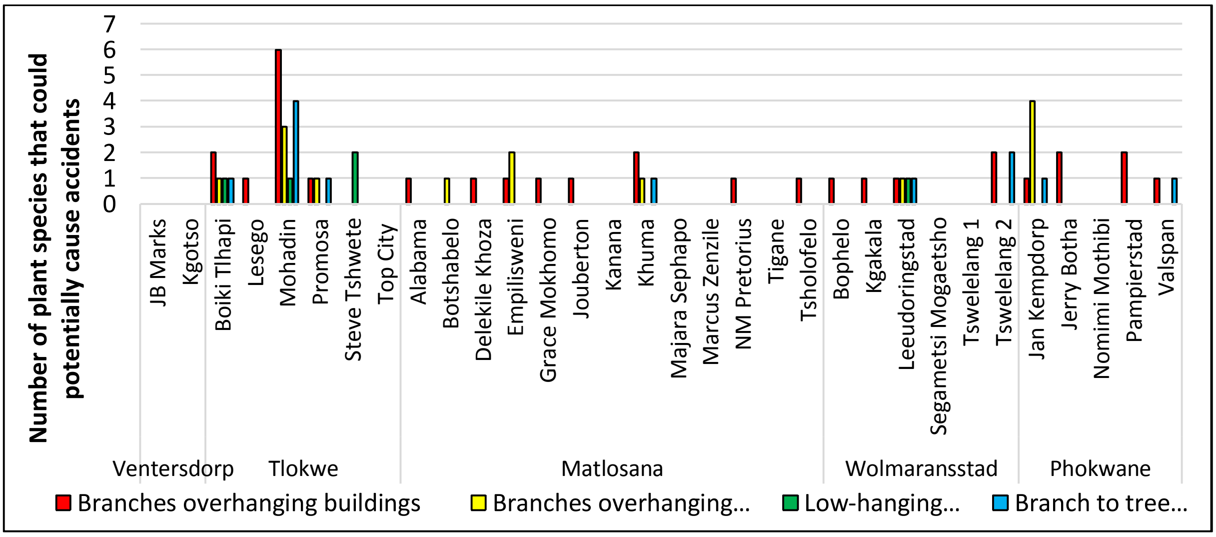


Figure 3-24: The number of species at each clinic that could potentially cause accidents.

Figure 3-25: A. A *Combretum erythrophyllum,* with a branch that had a 45° angle to the tree stem, at the Valspan clinic. B. A *Casuarina cunninghamiana* that was overhanging a building at the Empilisweni clinic. C. A *Vachellia karroo* that was overhanging a building at the Mohadin clinic.

3.3.5.3 Damage to buildings and other structures

The only clinic where root damage to buildings was noticed was Boiki Tlhapi with three species contributing to the damage, and the clinics where root damage to paving had been noticed were Boiki Tlhapi and Jouberton, both with two species contributing to the damage (**Figure 3-26**). There was only one clinic where branch damage to buildings was noticed, namely at Boiki Tlhapi where two species were contributing to the damage. The clinic with the most plant species that could potentially cause root damage to buildings was Mohadin (6 species). There were only two clinics where there were plant species that could potentially cause root damage to paving, namely Tsholofelo and Leeudoringstad both with one species that could cause the damage. The clinic with the most plant species that could potentially cause branch damage to buildings was Promosa (4 species). **Figure 3-27** shows examples of how tree roots had caused damage to paving at different clinics and of trees that could potentially cause damage in the future.

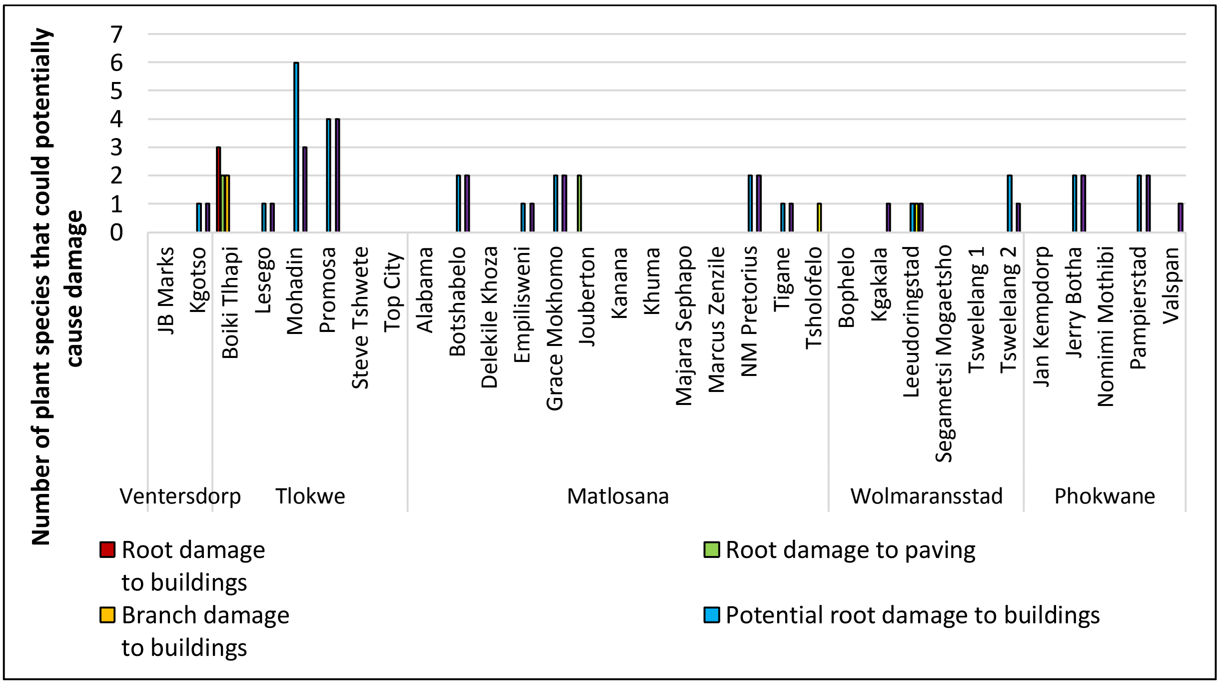


Figure 3-26: The number of species that had damaged buildings and/or other structures or that could potentially damage buildings and/or other structures.

Figure 3-27: A. A *Fraxinus velutina* that was causing root damage to the paving at the Boiki Tlhapi clinic. **B**. A *Brachychiton populneus* that had lifted paving stones with its roots at the Jouberton clinic. **C**. A *Celtis sinensis* that had lifted paving stones with its roots at the Jouberton clinic. **D**. A *Fraxinus velutina* that could lift paving in the future at the Leeudoringstad clinic. **E.** A *Casuarina cunninghamiana* that could potentially be causing or cause damage at the Empilisweni clinic.

3.3.6 Ratings of health clinic gardens

When concerning the economic value of ESs, the Tswelelang 1 clinic and the Mohadin clinic had the highest ratings (**Figure 3-28**). Segametsi Mogaetsho clinic had the lowest rating for economic value, namely 0. The sub-districts with the highest average economic value rating were Tlokwe (4.3) and Matlosana (4.1). There were 19 clinic gardens that had a higher rating for economic value than the average and median rating (4).

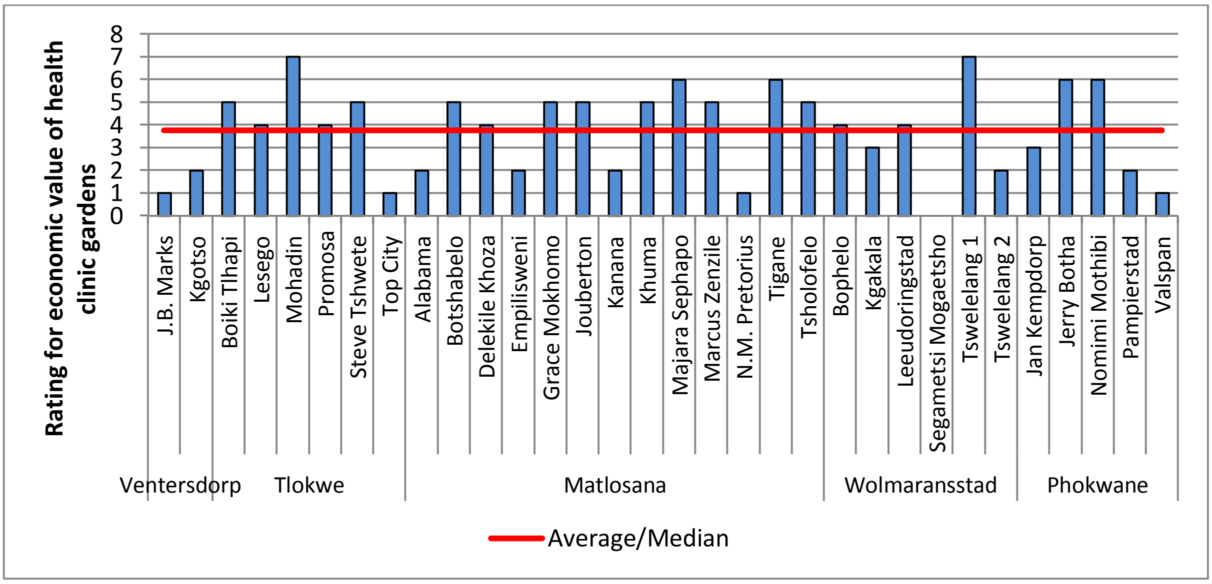


Figure 3-28: The ratings for economic value given to each clinic garden for the different ecosystem services.

When concerning the ecological value of ESs, the Jan Kempdorp CHC had the highest rating (**Figure 3-29**). The sub-district with the highest average ecological value rating was Phokwane (25), followed by Ventersdorp (24). There were 17 clinic gardens that had a higher ecological value rating than the average rating, while there were 16 clinics that had a higher ecological value rating than the median.

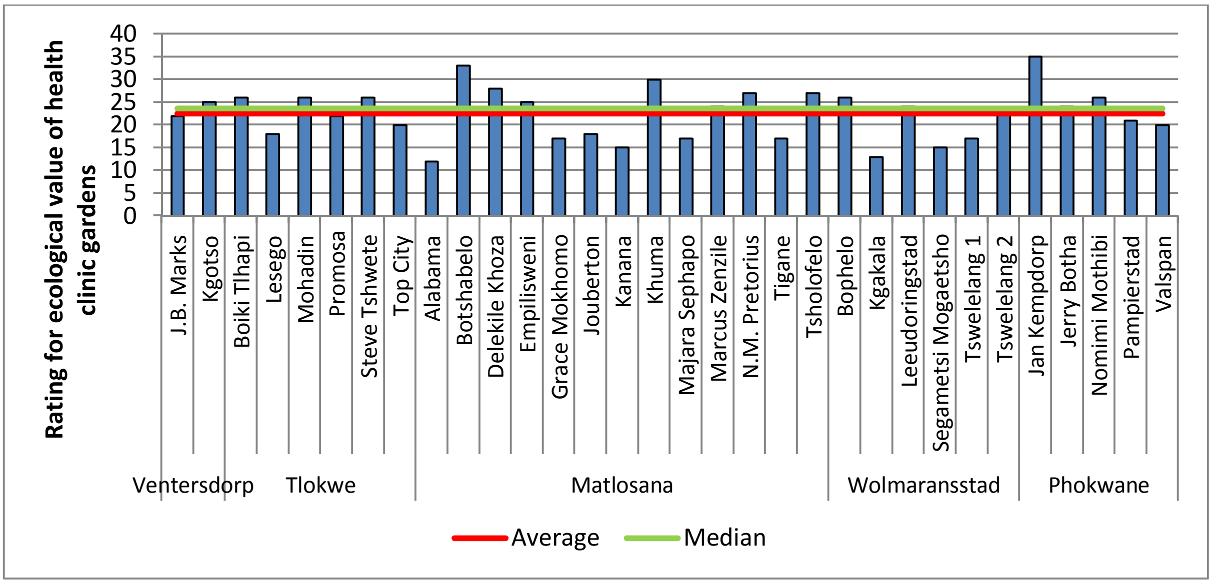


Figure 3-29: The ratings for ecological value given to each clinic garden for the different ecosystem services.

When concerning the socio-cultural value of ESs, the Jan Kempdorp CHC had the highest rating (**Figure 3-30**). The sub-district with the highest average socio-cultural value rating was Ventersdorp (17), followed by Phokwane (16). There were 13 clinic gardens that had a higher socio-cultural value rating than the average rating, and 17 that had an equal or higher rating than the median.

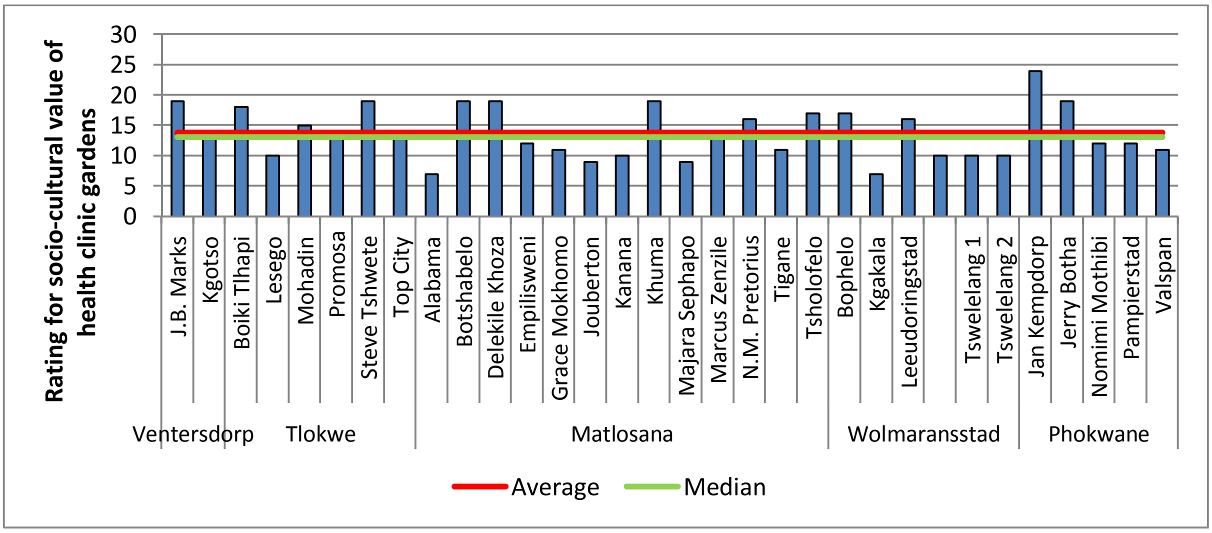


Figure 3-30: The ratings for socio-cultural value given to each clinic garden for the different ecosystem services.

3.4 Discussion

3.4.1 Provisioning ecosystem services

3.4.1.1 Number of potential food plant species

According to Hara *et al*. (2018), locally grown food plays an important role in improving food security, food safety, human health, the environment, and sustainability. There are many movements all over the world, such as Japan, the Philippines, Thailand, and New York City, where food is grown locally thus contributing to productive urban landscapes (Hara *et al*., 2018). Furthermore, Orsini *et al*. (2014) stated that food production sites should increase, especially near main consumption areas, as the rate of urbanisation is increasing.

There were five most frequently occurring potential food plant species that were the same as identified by Cornelius (2016) in health clinic gardens in Bojanala district municipality in the North West Province. These species are *Prunus persica* (also number two in list of Cornelius (2016)), *Urochloa mosambicensis* (number one in list of Cornelius (2016)), *Spinacia oleracea* (number six in list of Cornelius (2016)), *Bidens pilosa* (number four in list of Cornelius (2016)), and *Searsia lancea* (number seven in list of Cornelius (2016)). These similarities indicate that similar food plant species were preferred by communities in different areas of the North West Province and Northern Cape Province. The two most frequently occurring potential food plants, *Portulaca oleracea* and *Prunus persica*, were also the most frequently occurring food plants as identified by Molebatsi *et al*. (2010) in home gardens in the North West Province.

Most of the frequently occurring potential food plant species were leafy vegetables which is a similar result to that found by Cornelius (2016). Leafy vegetables include plant species of which the leaves, young succulent stems, flowers, and very young fruit are eaten (Jansen van Rensburg *et al*., 2007). Jansen van Rensburg *et al*. (2007) further state that many rural communities in South Africa are dependent on these leafy vegetables as a source of food. Leafy vegetables are frequently eaten by poorer households, those living through a drought or those that live in remote areas (Jansen van Rensburg *et al*., 2007). *Bidens pilosa* which was the tenth most frequently occurring food plant species is also one of the most widely used leafy vegetable species most often harvested from the wild (Jansen van Rensburg *et al*., 2007). Species are chosen based on a few factors; including the availability of the plant, ease of preparation, the taste of the vegetable, consistency and appearance (Jansen van Rensburg *et al*., 2007).

The size of the vegetable gardens seems to be related to the number of potential food species at the Steve Tshwete (910 m^2), Khuma (1052 m^2) and Jan Kempdorp (812 m^2) clinics. Kgakala clinic had no vegetable garden, and as a result, had the fewest number of potential food species. Other clinics with no vegetable gardens were Kanana, N.M. Pretorius, Segametsi Mogaetsho, and Tswelelang 2. These clinics do not necessarily have low numbers of potential food species, which could be explained by the fact that most of the potential food species were not traditional food species generally cultivated. Many of the species usually grow within other micro-gardens. As these were potential food species, many people may not know about the potential of consuming these species. Modi *et al*. (2006) support this by stating that poor utilisation of wild foods (especially vegetables) is often associated with a lack of knowledge about these foods, and how to get access to high quantities that can satisfy human requirements.

At all the clinics except Delekile Khoza, there were more exotic species than indigenous species that are potential food plants. Exotic species are usually more popular than indigenous species, even though there is evidence that wild vegetables are more nutritious (Modi *et al*., 2006). Jan Kempdorp had the highest number of indigenous plant species with the potential to be used as food, which was reflected by the fact that Jan Kempdorp had the largest naga (natural area) (9177 m^2), where indigenous species can grow. There were 16 clinics that had more potential food plant species than the median, indicating that only a few clinics had numerous potential food plant species when compared to the other clinics. The same was true for the potential exotic food plant species and potential indigenous food plant species; both had 14 clinics that had more species than the average.

It is important to note that the abundance (percentage cover) of food plant species would be a better measure of the extent of provisioning food. This is something that could be considered in future studies.

3.4.1.2 The market value of vegetables and fruit produced

In the North West Province, 13.4% of households were involved in agricultural activities in 2016 (STATS SA, 2018a). Households in the Dr Kenneth Kaunda district were involved with livestock production (22%), poultry production (32.3%), grain and food crops (4.5%), industrial crops (0.04%), fruit production (10.1%), vegetable production (30.5%) and other (0.6%) (STATS SA, 2018a). In the Northern Cape Province, 13.8% of households were involved in agricultural activities in 2016 (STATS SA, 2018b). Households in the Frances Baard district were involved with livestock production (8.6%), poultry production (13.7%), grain and food crops (22.7%), industrial crops (33.1%), fruit production (21.8%), vegetable production (21.5%) and other (18.4%) (STATS SA, 2018b).

There were 29.3% households in the Dr Kenneth Kaunda district that ran out of money to buy food in the 12 months before the 2016 community survey (STATS SA, 2018a). Additionally, there were 18.7% households that had to skip meals in the 12 months before the 2016 community survey (STATS SA, 2018a). There were 38.7% households in the Phokwane local municipality that ran out of money to buy food in the 12 months before the 2016 community survey (STATS SA, 2018b). Additionally, there were 22.3% households that had to skip meals in the 12 months before the 2016 community survey (STATS SA, 2018b).

Nomimi Mothibi had the highest vegetable and fruit market value (R 1653.81). The vegetable garden at Nomimi Mothibi was 250 m^2 and was relatively small when compared to some of the other clinics. However, this clinic had the highest variety of food plant species (9 species) when compared to the other clinics. These species were beetroot, cabbage, lemon, orange, tangerine-orange crossing, carrots, strawberries, tomatoes and spinach. The strawberries contributed a lot to the high market value as strawberries were R 85.81 per kilogram. Other clinics with high vegetable and fruit market values were Mohadin (R 11224.59), Marcus Zenzile (R 1167.93) and Tswelelang 1 (R 1031.19). Mohadin had six food species, Marcus

Zenzile had eight food species and Tswelelang 1 had four food species. Tswelelang 1 had only a few different species, but a high quantity of each of these species was grown and given away. For example, 160 head of cabbage were produced which amounts to a market value of R 831.17.

The clinic with the largest vegetable garden Marcus Zenzile (1185 m^2) had the second most food species (8 species) with a high food market value (R 1167.93). This clinic could, therefore, serve as a good example of a clinic that makes the most of the available space for food production.

The smallest vegetable garden (Tigane = 28 m^2) had a much larger yield of 1.5739 kg/m^2 than the largest vegetable garden (Khuma = 1052 m^2) with a yield of 0.0398 kg/m^2. The clinic with the largest yield was Tswelelang 1 with a yield of 2.9930 kg/m^2, while the Botshabelo clinic had the smallest yield (0.0163 kg/m^2). Thus, how effectively one uses the available space plays a role in the amount of food that will be obtained from the vegetable garden. It is, however, important to note that the type of vegetables planted will have an influence on the yield. Pourias *et al*. (2015) found that the average yield of community gardens in Montreal is 1.9 kg/m^2, family gardens in Paris is 1.2 kg/m^2, and shared gardens in Paris is 1.4 kg/m^2. The average for health clinic gardens was 0.5356 kg/m^2, the closest to family gardens in Paris. It could, therefore, be said that with the necessary resources and inputs the yield of health clinic gardens could improve.

Pourias *et al*. (2015) found that generally, the largest vegetable gardens produced the highest amount of food. At the health clinic gardens, this was not the case. The largest vegetable garden (1052 m^2) at Khuma clinic produced 41.852 kg while the smallest vegetable garden (28 m^2) at Tigane clinic produced 44.07 kg. The highest weight of food was produced in the Tswelelang 1 vegetable garden which was only 60 m^2. As Pourias *et al*. (2015) discovered in their study, there are other factors that play a role in the amount of food produced, such as the input of different gardeners. A larger garden will have a larger workload; therefore, gardeners may reduce the size of the vegetable garden to a more manageable size even if there is space for a large vegetable garden (Pourias *et al*., 2015). Other factors could also explain this difference in the amount of food produced, including soil and climatic conditions, harvesting systems, and the harvesting practices of different gardeners (Pourias *et al*., 2015). These factors were not determined but could be addressed in future studies.

The average yield for all the clinic gardens was R 4.36 per m^2 per growing season. When compared to the urban agriculture yield at Khayelitsha, South Africa, of R 1.60 per m^2 per year (Reuther & Dewar, 2006) the yield produced at the health clinic gardens was much higher. This low yield in Khayelitsha is however attributed to many challenges including the limited interest in the cultivation of vegetables and the lack of resources such as land and water (Reuther & Dewar, 2006).

3.4.1.3 Raw materials

Cynodon dactylon was the most frequently occurring potential raw material species and is used as fodder for animals (Mudau, 2006). Other potential fodder plant species that occurred mostly in the health clinic gardens were *Pennisetum clandestinum*, *Portulaca oleracea*, *Urochloa mosambicensis*, *Eragrostis tef*, *Sonchus oleraceus*, *Medicago lupulina*, *Eleusine indica*, and *Searsia lancea*. Of these species five were exotic. According to Molebatsi *et al.*, (2010) naga consists of natural areas where indigenous species grow and where naga could be used for grazing. It could be that the clinics introduced exotic plant species to increase the grazing capacity of the naga.

Jan Kempdorp had the highest number of potential raw material species (26 species) as it also had the largest garden (10359 m^2). Therefore, it could be said that the larger garden had more space to support more plant species. The other clinics with high numbers of potential raw material plant species were Steve Tshwete, Khuma and Leeudoringstad. Steve Tshwete had a garden size of 1758.5 m^2, Khuma 1775 m^2 and Leeudoringstad 658 m^2 which were also relatively large gardens. The clinics with low numbers of potential raw material plants had relatively small gardens when compared to the other clinics, the garden at Kgakala was 289.5 m^2, Grace Mokhomo was 97 m^2, Alabama was 50 m^2, and Jouberton was 558 m^2.

Most clinics had more exotic plant species than indigenous plant species that could be used as raw materials, which could indicate that these species were specifically planted to serve functions within the gardens. Only N.M. Pretorius, Segametsi Mogaetsho and Valspan had more indigenous species than exotic species.

The Phokwane sub-district had significantly more indigenous species that could potentially be used as raw materials. The average size of clinic gardens in the Phokwane sub-district was 2470.9 m^2, the second largest after the Ventersdorp sub-district which had an average garden size of 4488.5 m^2, which could be why Phokwane sub-district and Ventersdorp sub-district had the smallest effect size because they both had large average garden sizes which could support more plant species. When comparing the average size of naga of the two sub-districts, Phokwane sub-district had a larger average naga (1892 m^2) than Ventersdorp

(1470 m^2), which could be why Phokwane had the highest average number of indigenous species that could be used as raw materials.

3.4.1.4 Medicinal resources

Most of the species identified in the clinic gardens had the potential to be used as medicinal resources. Most plant species can be used in some or other way to address a variety of ailments, from small problems to more severe ailments. It is important to remember that these are potential uses and that these plants are not necessarily used for these purposes. According to Cilliers et al. (2013), there is a high demand for medicinal plant species in rural areas, and this is likely to increase in urban areas as rural communities migrate to cities. This high demand for medicinal plant species can contribute to the high diversity of medicinal plant species identified in the clinic gardens (Cornelius, 2016).

There were four most frequently occurring potential medicinal plant species that were the same as identified by Cornelius (2016). These species are *Tagetes minuta* (number three in the list of Cornelius (2016)), *Schkuhria pinnata* (number eight in the list of Cornelius (2016)), *Agapanthus* sp. (number one in the list of Cornelius (2016)), and *Tulbaghia simmleri* (number nine in the list of Cornelius (2016)). Similar medicinal plant species, therefore, seem to be preferred by communities in different areas of the North West and Northern Cape Provinces. There was only one potential medicinal plant species that occurred frequently in this study and in that of Molebatsi *et al*. (2010) in home gardens, namely *Schkuhria pinnata*.

The most frequently occurring potential medicinal plant was *Cynodon dactylon* which occurred at 23 clinics. *C. dactylon* is an indigenous species which occurs in most of South Africa (Van Oudtshoorn, 2012) and is used in traditional medicine to treat indigestion and wounds (Mudau, 2006). The second most frequently occurring potential medicinal plant was *Conyza bonariensis* which is an exotic species that supposedly has antimicrobial effects as well as antifungal properties (CABI, 2018).

J.B. Marks and Steve Tshwete both had 31 plant species with the potential to be used as medicinal resources. Medicinal plants play a considerable role in the daily lives of many people and make up an important part of the South African cultural heritage (Van Wyk *et al*., 2009). Neither of these clinics had a medicinal garden. Only Marcus Zenzile had a medicinal garden (2 m^2). It was found by Molebatsi *et al*. (2010) that medicinal plants are located throughout home gardens, but were most often grouped to form small ñtshingwanaò (micro-gardens). Even though medicinal gardens were reported as being present in home gardens, they were in most cases the least present type of micro-garden, especially in peri-urban and rural home gardens (Molebatsi *et al*., 2010; Lubbe *et al*. 2011). Medicinal gardens were included in the general garden layout despite having low frequencies of occurrence (Molebatsi *et al*., 2010). Furthermore, Molebatsi *et al*. (2010) found that medicinal species are often harvested from naga (natural areas), as it was found that there are more medicinal species in gardens with a higher indigenous species richness. Medicinal gardens are therefore not common in Tswana home gardens, or in health clinic gardens, as many medicinal plants are harvested from natural areas rather than gardens (Molebatsi *et al*., 2010; Matavele & Habib, 2000).

Steve Tshwete and J.B. Marks also had the highest number of exotic species with the potential to be used as a medicinal resource. Exotic species may be chosen to cultivate as these species usually adapt well, grow faster than indigenous species, and can grow with minimal human input (Semenya & Potgieter, 2014).

Ventersdorp was the sub-district with the highest average number of potential medicinal plant species as well as the highest average number of potential exotic medicinal plant species, which could be because Ventersdorp sub-district had an average garden size of 4488.5 m^2 which was the largest average size when compared to the other sub-districts. Therefore, it could be said that larger gardens had a greater potential of providing habitat for medicinal plant species to be grown; these species can, however, include exotic species. It is therefore important to think what the use of the plant species in the garden will be. If exotic species are planted mainly for their medicinal value, they need to be well controlled.

3.4.2 Regulating ecosystem services

3.4.2.1 Carbon sequestration by trees

The clinic gardens that store the most carbon were Jan Kempdorp and Botshabelo as they had the largest gardens, 10359 m^2 and 3836 m^2 respectively, and therefore had enough space for trees. Jan Kempdorp garden had 120 trees of which 117 were used to determine the amount of carbon sequestered. Botshabelo garden had 41 trees of which 39 were used to determine the amount of carbon sequestered. The trees that were not taken into consideration were not high enough, as trees were measured at a height of 1.3 m. The average stem circumference of the trees at Jan Kempdorp was 149.375 cm and at Botshabelo 151.31 cm. Other clinics where the average stem circumference was high were Alabama (308.5 cm), Jouberton (146.67 cm), Empilisweni (152.46 cm), Kgakala (260 cm) and Tswelelang 2 (148.4 cm) but they had fewer species than in the Jan Kempdorp and Botshabelo clinic gardens. It is important to note that the amount of carbon stored in urban gardens will be less when compared to urban and peri-urban forests (Langemeyer *et al*., 2016).

The two trees in the Segametsi Mogaetsho clinic garden were still very small (less than 1.3 m) and could not be used in carbon sequestration calculations. The small size of the trees does not mean that these trees do not sequester any carbon; the amount of carbon sequestered will only have a small value while the trees are so small. According to Stoffberg *et al*. (2010) when trees are young, the carbon stock is not significant. Trees do however grow and become larger, increasing the biomass and consequently the carbon stock (Stoffberg *et al*., 2010).

Since the amount of carbon stored (kg) was used to determine the value of the stored carbon, the trends between the amount of carbon stored and the value of the carbon were very similar. A *Melia azedarach* tree in the Jan Kempdorp clinic garden had a stem diameter at breast height of 279.79 cm and had sequestered carbon worth R 14601.61, which was the most óvaluableôtree. *M. azedarach* is a category 3 declared invader species which are not allowed to be planted or traded, and spreading of existing plants should be prevented (Henderson, 2001). Gaertner *et al*. (2016) have developed a framework in which species can be positioned according to its benefits and negative impacts. This framework helps one to determine whether a species should be tolerated or not, which is in most cases highly context-specific. Therefore *M. azedarach* may be tolerated as it provides important benefits. In the Botshabelo clinic garden, a *Schinus molle* tree had a stem diameter at breast height of 125.10 cm and had sequestered carbon worth R 2236.46. Older trees, with a larger diameter at breast height, were found to have the largest values of above-ground biomass (Lembani, 2015). Lembani (2015) concluded that the ability of trees to sequester atmospheric carbon dioxide, therefore, increases with age.

Lembani (2015) estimated that 414 individual trees (indigenous and exotic) in one Sowetan park had total carbon stocks of 3.35 tonnes with a value of R 1 475.34. In another park, 294 individual trees had total carbon stocks of 92.59 tonnes with a value of R 40 776.64. In this study, 505 individual indigenous and exotic trees in all the health clinic gardens store 354.04 tonnes carbon which was worth R 155 778.26, which was considerably more than that found by Lembani (2015). This combined size of the two parks surveyed by Lembani (2015) is 12.62 hectares, while the combined size of all the health clinic gardens was 7.99 hectares. The health clinic gardens had 63.24 trees/ha compared to 44.56 trees/ha as found by Lembani (2015). The existing space is, therefore, better used in the clinic gardens in terms of sequestering carbon than in the parks studied by Lembani (2015).

Stoffberg *et al*. (2010) determined that a selection of street trees in Tshwane, South Africa sequestered carbon valued at US$ 3 006 435 at a rate of US$ 15 tonnes CO_2. The health clinic gardens had sequestered carbon valued at US$ 10 649.57 (US$ 1 = R 14.6284 on 19 September 2018). Stoffberg *et al*. (2010) used 115 200 street trees in their study, while for this study only 505 individual trees where used. By using a ratio of 228.1188119 the value of 115 200 health clinic garden trees in all the health clinic gardens could be US$ 2 429 367.26 that is relatively similar to the value obtained for the street trees in Tshwane, South Africa.

According to Turpie *et al*. (2017), the annual carbon sequestration value for South Africa is R 40.7 billion. Additionally, they concluded that carbon storage is among the ESs with the highest economic value. Through estimating the carbon sequestration value of health clinic gardens, it is clear that trees contribute a great deal to this annual carbon sequestration value.

3.4.2.2 Local climate regulation

Trees have many uses, including providing shade, providing food, acting as windbreaks, aesthetic appeal, and providing cooler and wetter areas for other smaller plants to grow (Semenya & Potgieter, 2014). Bowler *et al*. (2010) found that day air temperatures beneath individual trees and clusters of trees are lower than day temperatures in open areas. The trees at the health clinic gardens, therefore, have many potential benefits to provide people working at and visiting the clinics.

The clinic with the most potential to regulate the local climate was Jan Kempdorp clinic which had the most trees (120 trees) and a total tree cover of 9620.8 m^2. Botshabelo clinic had the second most trees (41 trees) and a total tree cover of 2536.9 m^2. Segametsi Mogaetsho had the lowest total tree cover at 0.27 m^2, but not the least number of trees (two trees). There were two other clinics, Kgakala and Tswelelang 1, which only had one tree each. These trees were however much larger than the trees at Segametsi Mogaetsho. Therefore, it could be said that the number, as well as the size of the trees, influence the total tree cover, a higher number of trees which are relatively larger will provide more local climate regulation.

3.4.3 Supporting ecosystem services

3.4.3.1 Habitat diversity (micro-gardens)

Dunnett and Qasim (2000) found that in urban gardens larger gardens were associated more with the growing of vegetables and fruit, while smaller gardens prioritised ornamental and recreational functions. In this study, the larger gardens mostly had vegetable and ornamental gardens with smaller gardens either having both vegetable and ornamental gardens or only vegetable or ornamental gardens. There were 27 clinics that had vegetable gardens and 26 clinics that had ornamental gardens. The size of the gardens did not seem to influence the kind of garden(s) present. Preference seems to be given to vegetable gardens in the health clinic gardens as the establishment and maintenance of these gardens could enhance community nutrition (Robinson, 2015).

The micro-gardens are a mixture of the traditional *tshimo* gardens (naga) and colonial or western gardens (lawn and ornamental) (Davoren *et al*., 2016). This combination of traditional meets colonial is described by Davoren *et al*. (2016) as Westernised Batswana gardens.

Davoren *et al*. (2016) classified home gardens as Tswana tshimo if lebala and naga were dominant, and as colonial, if ornamental and lawn micro-gardens were dominant. If this is considered for this study, Jan Kempdorp, Nomimi Mothibi, Tswelelang 2, Botshabelo, Delekile Khoza, Jouberton, and Khuma will be the only clinics that had a dominant Tswana tshimo garden layout providing more potential habitat for a variety of species. The other clinics have been influenced by the colonial garden layout style to create Westernised Batswana gardens (Davoren *et al*., 2016).

The naga was the largest micro-garden in the Jan Kempdorp CHC garden, and this clinic had the largest garden overall. Natural vegetation is allowed to grow in the clinic gardens, as the natural areas usually contain traditional useful plant species (Molebatsi *et al*., 2010; Cornelius, 2016). Furthermore, large gardens or more gardens likely have more value to wildlife than small or few gardens according to Dunnett and Qasim (2000).

Marcus Zenzile clinic was the only clinic where a medicinal garden (herb garden) was found. This micro-garden was $2\ m^2$ and made up 0.092% of the entire garden, which was the smallest micro-garden at Marcus Zenzile clinic. As it was a medical centre, there could be used for medicinal plants, but patients are also supplied with medication from the clinic. Therefore, there may not be as big a need for medicinal plants from the garden, as it could be risky to provide patients with plants instead of scientifically tested medication. As previously mentioned, Molebatsi *et al*. (2010) found that medicinal plants are located throughout home gardens, but were most often grouped to form small ñtshingwanaò (micro-gardens). Even though medicinal gardens were reported as being present in home gardens, they were in most cases the least present type of micro-garden, especially in peri-urban and rural home gardens (Molebatsi *et al*., 2010; Lubbe *et al*. 2011). Medicinal gardens were included in the general garden layout despite having low frequencies of occurrence (Molebatsi *et al*., 2010). Furthermore, Molebatsi *et al*. (2010) found that medicinal species are often harvested from naga (natural areas), as it was found that there are more medicinal species in gardens with a higher indigenous species richness. Medicinal gardens are therefore not common in Tswana home gardens, or in health clinic gardens, as many medicinal plants are harvested from natural areas rather than gardens (Molebatsi *et al*., 2010; Matavele & Habib, 2000).

Promosa clinic was the only clinic where a hedge was found. A hedge can serve multiple purposes; it provides habitat for other organisms while also creating a fence. Molebatsi *et al*. (2010) have found that plants with structural purposes are more frequently found in areas with lower financial means preventing the replacement of hedges with concrete walls. Cornelius (2016) found in clinic gardens in the Bojanala District Municipality that hedges were not very common and that very few species were used to create hedges.

Most clinics had areas in the yard that were paved (96.88%), while the least number of clinics had medicinal and hedge micro-gardens (3.13% each), which was similar to the findings of Molebatsi *et al*. (2010). There was also a high percentage of clinics that had vegetable gardens (84.38%), which could indicate that the clinics know how important growing food is to the community. Molebatsi *et al*. (2010) have found that more urbanised areas have limited food production. People, therefore, tend to value biodiversity much more in rural areas where plant diversity is conserved through being useful (Molebatsi *et al*., 2010; Das & Das, 2005).

Of the clinics that only had one micro-garden, two had vegetable gardens, and one had a lawn. Molebatsi *et al*. (2010) have found that Tswana communities, especially in more rural areas, prefer to cultivate more useful, indigenous species in home gardens. Lubbe *et al*. (2011) state poorer communities are therefore dependent on these types of gardens for their livelihoods

There seems not to be a very strong relationship between the size of the garden that could serve as habitat and the percentage that makes out of the entire garden. For example, Marcus Zenzile clinic had a relatively small habitable garden (2178 m^2), but it makes out 100% of the garden. Therefore, the size and presence of lebala and paving play a big role. With an increase in lebala or paving size, there was less habitable space left to support fauna and flora. It is important to remember that even though a man-made environment could provide a habitat for different species, it would not necessarily provide all the functions of a natural system (Chee, 2004). Langemeyer *et al*. (2016) contradicted this slightly by stating that urban gardens offer a variety of habitats for both fauna and flora which is very important for the maintenance of biodiversity. Even though these health clinic gardens may not act as natural systems, they have been found to support many different species (Cornelius, 2016).

Ventersdorp sub-district had the largest average total garden size (including lebala and paving). In the Ventersdorp sub-district, only two clinics were visited, one clinic had a very large yard (second largest) while the other had a relatively small yard. If more clinics were visited in the Ventersdorp sub-district, a more accurate average garden size might have been obtained. The Tlokwe sub-district had the smallest average garden size, therefore a large effect size. The areas visited in the Tlokwe sub-district are described as peri-urban (Davoren *et al*., 2016; Lubbe *et al*., 2011) while many of the other clinics are in more rural areas, which could explain why the yards are generally smaller; they have less space as they were built in more urban (less rural) areas.

3.4.3.2 Plant species diversity

Turpie *et al*. (2017) determined that the existence value of the biodiversity of South Africa is about R 6.45 billion per annum. The biodiversity supported in public parks and gardens provide an important contact point between humans and the natural world (Barbosa *et al*., 2007). According to Langemeyer *et al*. (2016), most urban gardens contain both natural plant species and cultivars. This variety of different plant species play a role in conserving genetic diversity (Langemeyer *et al*., 2016). Urban gardens can support and enhance urban biodiversity, therefore if they are designed with this in mind high levels of biodiversity and ESs can be supported (Lin & Egerer, 2018). There was one clinic from each sub-district that had among the highest number of species. In every sub-district, there seem to be clinics with high, intermediate and low numbers of species. As could be expected the clinics with the most plant species also had large gardens.

Most health clinic gardens had more exotic plant species than indigenous plant species, which was similar to that found by Molebatsi *et al*. (2010) for home gardens. Lubbe *et al*. (2011) also found that more exotic than indigenous species were cultivated in domestic gardens since many exotic species are hardier and aesthetically pleasing exotic species can easily be imported from anywhere in the world.

All three of the clinics that had the highest number of indigenous plant species had naga. Naga is usually small patches containing natural occurring vegetation (Molebatsi *et al*., 2010).

There was only one rare plant species that was identified at the health clinic gardens, namely *Dietes bicolor*. All the other plant species were of least concern. Lubbe *et al*. (2011) stated that even though gardens support only a few rare species, the contribution of a few gardens may aid the protection of these species. The inclusion of these species in gardens is not always done with conservation in mind, but rather considering the possible uses of the species (Lubbe *et al*., 2011). Gardens could, however, be places where rare or endangered species could be conserved ex situ (Langemeyer *et al*., 2016; Lubbe *et al*., 2011). The expansion of human-built areas is not necessarily a threat to local biodiversity as urban areas are also ecosystems which could house many species (Langemeyer & Gómez-Baggethun, 2018).

According to Tibane (2017) R 6.5 billion worth of ESs is lost each year due to invasive species in South Africa, which is of great concern and should be acknowledged by the clinics with the highest number of invasive species as these species have the potential of escaping garden cultivation (Lubbe *et al*., 2011). The clinics that do not have any invasive species should be seen as good examples of what gardens could contain in terms of plant species. Lubbe *et al*. (2011) supported this by stating that information on the presence and abundance of invasive species in gardens can be used to create preventative measures and eradication of plans. There were a few clinics that had invasive species that should according to legislation be removed. It is possible that the personnel at the clinics do not have the knowledge and/or equipment to remove these species. The importance of the removal of these species should be communicated to the clinics so that necessary steps can be taken to remove them as many people do not fully understand the issues relating to invasive species (Gaertner *et al*., 2016). These clinics could be important examples to the wider community of which species are acceptable and which should be removed. Clinics could provide information on invasive species, why they should be removed and how to go about removing them successfully. It is, however, important to note that some invasive species may be tolerated due to a combination of social and practical reasons (Gaertner *et al*., 2016).

The Ventersdorp sub-district had the highest average number of invasive species, with Wolmaransstad-Maquassie Hills having the least average number of invasive species. It could be that the clinics in the Wolmaransstad-Maquassie Hills sub-district were more informed about invasive species or that more intensive steps had been taken to remove them, however, there was no proof of this.

The Ventersdorp sub-district had the highest average number of category 2 invasive species, with Tlokwe and Wolmaransstad-Maquassie Hills sub-districts having no category 2 invasive species. These sub-districts could have started the process of removing these invasive species.

According to Hochuli and Threlfall (2018), there are certain measures that could promote biodiversity in urban landscapes, which includes limited mowing and planting native species; adding or retaining habitat structures such as logs, leaf litter and rocks; adding flowering plants for food and shelter; planting perennial vegetation; and adding artificial nesting habitats such as nesting boxes. This information should be communicated to the health clinic gardens as it can promote biodiversity not only in the clinic gardens, but when communicated to the community can also improve home-garden biodiversity.

3.4.3.3 Habitat for birds

Birds are aesthetically pleasing to many people; they are also good environmental indicators, as their presence indicates the garden quality (Johnson & Johnson, 1993). Johnson and Johnson (1993) further stated that all gardens attract birds, the numbers and diversity of birds are however dependent on the quality of the garden. All bird species have their own unique habitat which provides resources such as nest sites, cover and food (Johnson & Johnson, 1993). Many of these habitats overlap so that at a given place there will be a community of different bird species (Johnson & Johnson, 1993). A shortage of nesting sites is the main limiting factor for bird presence, followed by a shortage of food and cover (Johnson & Johnson, 1993).

Many bird species were observed in clinics that were found to have only one recorded bird attracting plant species. Therefore, birds may prefer species that have not yet been noted as bird plant species. Within urban environments, there are ample possibilities to find food in the diverse gardens created by humans, especially since many people intentionally feed birds (Johnson & Johnson, 1993). The bird species could also be influenced by the number of humans that visit the clinic, and the distance of the plants to areas where humans are often located.

The clinic gardens where the most bird species were observed and the clinic gardens with the most nests were not the same. Birds do not necessarily forage where they nest, as birds are specialised in their choice of nesting site (Johnson & Johnson, 1993). Birds make nests where they feel safe and forage in the nearby area. Johnson and Johnson (1993) have found that even though there are many bird species in the garden for example 50, only two or three of these species will actually nest in the garden.

Andersson *et al*. (2007) found that the total number of bird species increase when there are different types of green areas, which was not the case in this study. The clinics where the most bird species were observed had two to three different micro-gardens, while those clinics with four different micro-gardens generally had few bird species. In this case, the types of green areas are different from those identified by Andersson *et al*. (2007). Therefore, it could be said that more different types of green spaces are beneficial to bird species, but these green spaces have to meet the needs of the bird species.

Humans have changed natural environments a great deal in the process of making way for growing cities, which has resulted in there being few places for indigenous birds to breed and find food (Berruti & Newman, 1986; Sinclair & Mendelsohn, 1984). Consequently, many indigenous birds have vanished from built-up areas while other introduced species replace them, including the House sparrow, Indian Myna, European Starling and Feral Pigeon (Berruti & Newman, 1986). These birds thrive in human-created areas partly since they do not have specialised feeding habits and they can make use of buildings as nesting sites (Berruti & Newman, 1986). These city birds are also often aggressive and not easily disturbed by humans or pets (Berruti & Newman, 1986). The most common occurring bird species in the clinic gardens was the House Sparrow. House sparrow nests were also the most commonly found at health clinic gardens. House Sparrows were introduced to Durban from India and to East London from Britain and spreading throughout southern Africa from there (Berruti & Newman, 1986). Bird species can adapt to many different environments and thrive in urban environments as it is traditionally associated with human habitation (Shaw *et al*., 2008). Furthermore, House Sparrows are seed eaters feeding their young with insects (Berruti & Newman, 1986), as well as feeding on kitchen waste and grain), which has led to almost complete dependence on humans for survival (Sinclair & Mendelsohn, 1984).

The Rock Pigeon is a cliff-nesting species which now nest on buildings (Berruti & Newman, 1986; Sinclair & Mendelsohn, 1984). Rock pigeons, however, often find food outside of cities in the farmlands (Berruti & Newman, 1986), except when they are intentionally fed by humans (Sinclair & Mendelsohn, 1984). The Masked Weaver usually nests in trees above water, but have been found to nest further away from water in the suburbs (Sinclair, 1985). The Laughing Dove is not afraid of humans and can often be observed in parks and gardens (Sinclair & Mendelsohn, 1984). Another commonly occurring bird species observed in clinic gardens was the Indian Myna. These birds were first introduced to Durban by the Indians and have successfully adapted to living in human-made areas (Berruti & Newman, 1986), and spread inland (Sinclair & Mendelsohn, 1984). They cause significant disturbances to city dwellers with their noise and messy droppings (Berruti & Newman, 1986). The Red Bishop usually lives along reed beds, but are known to fly farther afield to feed on grain (Berruti & Newman, 1986). The Cape Canary prefers mountainous terrain but has been found in suburban gardens (Sinclair *et al*., 1993). The Pied Barbet is related to woodpeckers and makes nests in trees (Berruti & Newman, 1986). They have been found to make nests in exotic trees that often have soft enough wood that can be excavated by these birds (Berruti & Newman, 1986). The Olive Thrush usually prefers thick undergrowth in forests but has adapted well to gardens and parks (Sinclair & Mendelsohn, 1984). Worms and snails are a favourite of these birds often found in gardens and parks (Sinclair & Mendelsohn, 1984). The Cape Turtle Doves are recorded to occur in every type of habitat (Sinclair *et al*., 1993). These could be some of the reasons for these bird species to occur in the health clinic gardens.

The most commonly occurring potential bird plant species was *Celtis sinensis*, an exotic tree, which is common in urban environments (Henderson, 2001). This tree produces fruit that is enjoyed by birds, and the branches make great locations to build nests (Johnson & Johnson, 1993).

The clinics with the highest number of potential bird plant species had relatively large gardens, therefore having much space to support different plant species which might attract a variety of birds.

The Phokwane sub-district had the highest average number of potential bird plant species as well as the highest number of potential indigenous bird plant species. In contrast, the Ventersdorp sub-district had the lowest average number of potential bird plant species and the average number of potential indigenous bird plant species. The Phokwane sub-district had an average of 4.4 potential bird plant species per clinic while the Ventersdorp sub-district only had an average of 1.0 potential bird plant species per clinic. This was interesting as the Ventersdorp sub-district had the largest average garden size that could potentially serve as habitat as well as the largest percentage of the gardens that could serve as habitat. Therefore, the size of the gardens was not necessarily a predictor of a bird attracting garden but rather the plant species present in the garden.

3.4.4 Cultural ecosystem services

3.4.4.1 Recreation

It is generally accepted that people do not come specifically to the clinic for recreational purposes but rather for medical attention (Cullinan, 2006). However, patients that are at the clinic for their health do make use of garden benches and/or shade for relaxation while waiting. The clinic personnel were also observed to relax on garden benches or in the shade especially during lunch breaks. According to Langemeyer *et al*. (2016), urban gardens can provide important recreational benefits such as the reduction of stress. Most of the clinic gardens had the potential of providing recreation opportunities to patients and clinic personnel; this does not, however, mean that it was used for this.

Some clinics had provided the opportunity for play. No children were, however, seen playing in these areas on the day of visiting the clinic as it was raining, but there was, however, the potential for play. Providing areas for children to play in the garden may be very beneficial to parents that have to wait in long queues.

3.4.4.2 Aesthetic appreciation

It is important to note that the ornamental plants have the potential to be aesthetically pleasing to the stakeholders, but that was however not determined.

The clinic with the most potential to be aesthetically pleasing was Jan Kempdorp CHC as it had the most potential ornamental species. Jan Kempdorp CHC had the largest garden, and therefore much space for a variety of plant species. Alabama clinic had the smallest garden as well as the least number of potential ornamental plant species. Jan Kempdorp CHC had a large ornamental garden while Alabama clinic had no ornamental garden. The largest ornamental garden was located at the Jerry Botha clinic which had the highest number of potential indigenous ornamental plant species. The Tswana culture has been altered by European influences when concerning the use of ornamental plant species in the home and clinic gardens which could attribute to the higher diversity of ornamental plant species in the clinic gardens (Molebatsi *et al*., 2010; Cornelius, 2016; Davoren *et al*., 2015).

According to Langemeyer *et al*. (2016), the presence of ornamental plants in urban gardens is very important. These plants, however, have a low economic value and have therefore not been extensively studied (Langemeyer *et al*., 2016). Ornamental plants are often chosen to include in gardens as they need less maintenance than food plants, and some hardy species can last for many years in a garden (Langemeyer *et al*., 2016).

There were six clinics that had no ornamental gardens; even so, these clinics had potential ornamental plant species, which indicates that the clinic gardens could have aesthetic value even if there are no dedicated ornamental gardens.

The most frequent occurring potential ornamental plant was *Pennisetum clandestinum* an exotic grass species often used as ornamental and lawn species (Van Oudtshoorn, 2012).

The most frequent occurring potential ornamental tree was the exotic *Celtis sinensis* which is often found in urban open spaces and along riverbanks (Henderson, 2001).

A study conducted by Goodness (2018) in Cape Town on plant traits important in the selection of plants for a garden, identified that the aesthetic value of plants is very important. People tend to select plants based on their pleasing appearance, the colour of the plant, and noticeable flowering among others. Another aspect that received attention was the smell of plants (olfactory appeal).

3.4.4.3 Spiritual or cultural value

It is important to note that the plants with spiritual or cultural importance are only potentially of spiritual or cultural value to the stakeholders, but that was however not determined.

According to literature, there are very few plant species with the potential to have spiritual or cultural value. Because there are a lot of cultures and religions in the study areas (STATS 2018a, b), it might not be possible to know exactly which plant species are spiritually or culturally valuable to all the people.

The most commonly occurring potential spiritual or cultural plant species was the indigenous tree, *Celtis africana*. This tree is thought to have magical properties (Mbambezeli & Notten, 2008). People mix the wood of the tree with crocodile fat which is then used as a charm against lightning, a peg made of the wood is also believed to keep witches away when it is driven into the ground thus having power over evil (Mbambezeli & Notten, 2008). It is not known if the clinic personnel or visiting patients are aware of these rituals.

3.4.5 Ecosystem disservices

3.4.5.1 Allergies

The larger clinic gardens with more species had more plant species with the potential to cause allergies. People differ from each other, and some may be negatively affected by a specific plant species while someone else will not be affected at all. Some allergies may only be experienced externally while others may be internal (Zuidmeer *et al*., 2008). These illnesses and incidents are also often difficult to prevent (Delshammar *et al*., 2015). Pampierstad clinic may serve as an example of a clinic garden with very few plant species that could cause allergies.

Cynodon dactylon was the most commonly occurring plant species with the potential to cause allergies as this grass species is pollinated by wind (Mudau, 2006) and the pollen could cause allergies. Nine other species in the top 13 most frequently occurring species were also grasses and were, therefore, wind pollinated.

It is important to note that there are several factors that affect allergic reactions, including airflow, rainfall, air temperature, and the proximity to allergy-causing plant(s) (Speak *et al*., 2018; Sikora *et al*., 2013). Additionally, Dobbs *et al*. (2014) stated that a tree with a high allergen potential could cause more allergy attacks. Thus, to fully understand the allergic reactions caused by the plants in the clinic gardens these factors have to be considered.

The number of plant species alone is however not a good measure of allergic potential, as the richness will also have an effect, for example, a garden which is full of only two allergenic species could be worse than a garden containing many different allergenic plant species.

3.4.5.2 Accidents

There were only 22 clinics where there was a risk for accidents, and this risk was generally small. The clinic with the greatest risk of accidents seems to be Mohadin, where there were 14 trees that pose a risk of causing harm. These may be older trees, as older trees, reaching the end of their useful life expectancy have a higher potential of causing accidents (Dobbs *et al*., 2014). Overall it seems that the clinics take care of potentially threatening branches by cutting or pruning when and where necessary. Lyytimäki and Sipilä (2009) have found that traffic accidents could be caused by plants obstructing visibility, which was, however, not a risk at the health clinics as trees are generally located in the garden away from traffic. Lyytimäki (2014) found that the growth and ageing of vegetation could have a risk of falling on and hurting people.

3.4.5.3 Damage to buildings and other structures

Plants could damage buildings or other man-made structures (Lyytimäki & Sipilä, 2009) by blocking stormwater drains with leaves or by roots that damage pavement (Shackleton *et al*., 2016). Only 18 clinics had experienced some damage or had the potential to experience damage. This indicates that overall the clinics are well maintained, and the plants are monitored for potential damage. There were only two clinics where damage was noted; this indicates that in general the plants that could cause damage were pruned so that they reduce the potential of causing damage. Some problems, on the other hand, may be difficult to observe and may not be realised until it is affecting the infrastructure (Delshammar *et al*., 2015). There were a few instances where the plants could potentially cause damage in the future, but if the plants are well-looked after and cut when necessary, there might never be a problem. It is important to remember that with age trees sometimes cause problems with infrastructure (Delshammar *et al*., 2015). These conflicts can be avoided in future if the positioning of trees is better planned (Delshammar *et al*., 2015; Vogt *et al*., 2015). For example, choosing trees that do not grow too high or too wide to plant in areas where space is limited will reduce conflicts between plants and infrastructure (Delshammar *et al*., 2015).

3.4.6 Rating of health clinic gardens

It is important to note that by rating the clinics, it does not imply that all the ESs are equal it only provides means to compare the different clinics to each other in terms of the value of ESs (economic, ecological and socio-cultural).

There were three ESs that potentially had economic value, namely the market value of food, food rand value per m^2 and value of stored carbon. The maximum rating for economic value was thus nine. The highest-ranking clinics when concerning economic value was Tswelelang 1 and Mohadin both with a ranking total of seven. Even though these clinics could be described as the clinics having the highest economic value, it could not be considered as ideal clinics concerning economic value, as it did not have the maximum rating. There is thus room for improvement, especially concerning the value of stored carbon.

There were 15 ESs that potentially had ecological value, namely number of food plant species (total and indigenous), total yield, amount of carbon stored, local climate regulation, number of micro-gardens, size of habitat, percentage of garden habitable, number of plant species (total and indigenous), rare species, birds observed, nests observed, and bird attracting plant species (total and indigenous). The maximum rating for ecological value was thus 45. The highest-ranking clinic concerning ecological value was Jan Kempdorp CHC with 35. Even though this clinic could be described as the clinic having the highest ecological value, it could not be considered as the ideal clinic concerning ecological value, as it did not have the maximum rating. There is thus room for improvement, especially concerning the total yield of food, the number of micro-gardens, the percentage of the habitable garden, the number of rare species, and the number of birds present.

There were nine ESs that potentially had socio-cultural value, namely number of food plant species (total and indigenous), raw materials (total and indigenous), medicinal resources (total and indigenous), number of ornamental species (total and indigenous), and plants with spiritual or cultural value. The maximum rating for socio-cultural value was thus 27. The highest-ranking clinic concerning socio-cultural value was Jan Kempdorp CHC with 24. Even though this clinic could be described as the clinic having the highest socio-cultural value, it could not be considered as the ideal clinic concerning socio-cultural value, as it did not have the maximum rating. There is thus room for improvement, especially concerning the medicinal resources present, and the number of species with spiritual or cultural value.

When concerning the different sub-districts, the Tlokwe sub-district had the highest economic value, the Phokwane sub-district had the highest ecological value, and the Ventersdorp sub-district had the highest socio-cultural value. There was thus not one sub-district that had the highest rating for all the values. The Ventersdorp sub-district has to improve the economic value most of all the sub-districts. The J.B. Marks CHC had the second largest garden and therefore has the potential to increase the amount of food produced as well as the amount of carbon sequestered.

The Wolmaransstad-Maquassie Hills sub-district has to improve the ecological value and socio-cultural value the most. Only three clinics in this sub-district had naga (Molebatsi *et al*., 2010). These naga micro-gardens support many different species, especially indigenous species which could contribute to the ecological value of clinic gardens. Additionally, only 67% of the clinics in this sub-district had ornamental micro-gardens. Ornamental species contribute to the aesthetic value of the health clinic gardens. In order for this sub-district to increase ecological and socio-cultural value more plant species could be included in the clinic gardens, especially those that serve as habitat for species and has spiritual or cultural significance.

The Jan Kempdorp CHC could serve as the best example of a clinic with high ecological and socio-cultural value. There is potential for this clinic to have a high economic value as well as sufficient space in the clinic garden to cultivate vegetables and fruit.

3.5 Conclusion

Clinic gardens were generally made up of a variety of different species influenced both by western and traditional practices (Cornelius, 2016; Davoren et al., 2015; Lubbe et al., 2011; Molebatsi et al., 2013). Health clinic gardens also had a variety of different micro-gardens (Molebatsi *et al*., 2010; Cornelius, 2016) that support a variety of different plant species contributing to the provisioning of ESs. These ESs had different values.

When concerning the provisioning ESs, food had economic value as it has a monetary value. Raw materials had cultural value as it is used differently by different people and cultures (Van Wyk & Gericke, 2000). Medicinal resources are also used differently by different cultures (Semenya & Potgieter, 2014; Van Wyk *et al*., 2009), and therefore it could be said that it has cultural value. According to Van Wyk *et al*. (2009), each culture has developed solutions for various health aspects “that resonate in harmony with the worldview of that cultureö Semenya and Potgieter (2014) further stated that the practice of growing medicinal plant species in gardens may in the long term sustain the plant species and the indigenous knowledge about the species together with the cultural identity.

When concerning regulating ESs, carbon had a monetary value, therefore, carbon sequestration and storage could be said to have economic value. Carbon sequestration also had ecological value as trees contribute to the removal of pollutants, such as ozone and nitrogen dioxide from the air which makes the atmosphere cleaner (Stewart *et al*., 2001). Stewart *et al*. (2001) also state that trees have social, physical and health-related values as they are an integral part of an urban environment. Local climate regulation had ecological value as it plays a role in reducing the temperature of the environment at a local scale, which will only be confirmed when temperatures are measured in green and non-green urban areas and compared (Bowler *et al*., 2010).

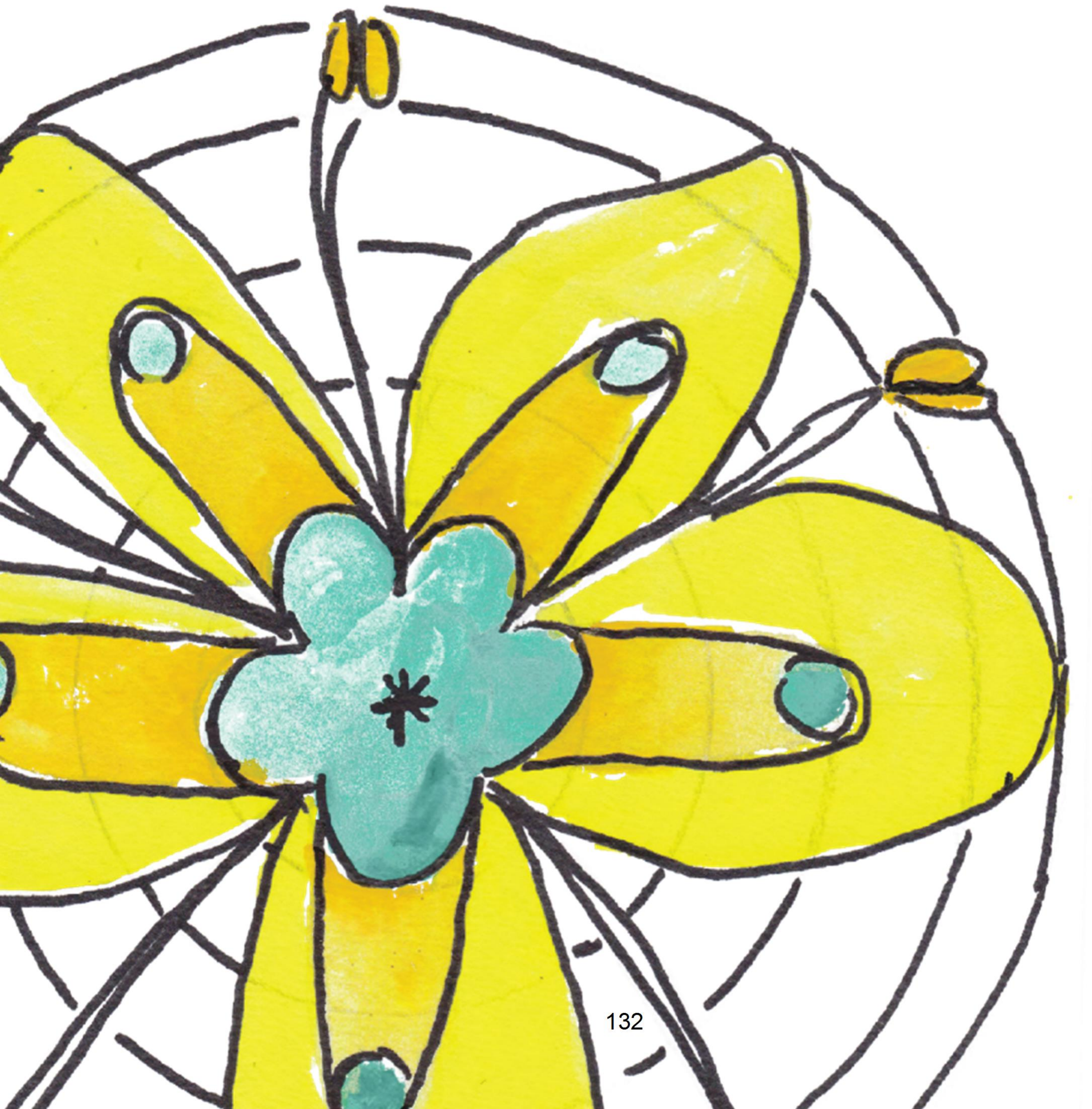
When concerning supporting ESs, the habitat provisioning service had an ecological value as it supports much different fauna and flora within different micro-gardens at the health clinics. The species diversity (maintenance of genetic diversity) ES had an ecological value as the gardens support a variety of different species. Jansson and Polasky (2010) support this by stating that biodiversity supplies species with different traits that are needed to maintain functions in order for ESs to be generated. They further stated that this important function of biodiversity should not be taken for granted as a decline in biodiversity can lead to a decline in the generation of ESs. The habitat provisioning for birds ES had an ecological value as habitat is created for different bird species.

When concerning cultural ESs, the clinic gardens had social and cultural value due to recreational opportunities for patients and clinic personnel. The aesthetically pleasing nature of clinic gardens could also be said to have social and cultural value. The plants having spiritual or cultural significance to people is of cultural value, as different cultures view plants differently (Van Wyk & Gericke, 2000).

Even though there were some EDSs present in the health clinic gardens, the benefits of the gardens seem to outweigh the disadvantages. It is however important that these EDSs should be acknowledged and managed so that they do not become bigger challenges in the future.

The aim of this chapter, to conduct an ecological survey to determine the social, cultural, economic and ecological value of a variety of ESs and EDSs, was reached.

Chapter 4: Perceived presence and values of stakeholders on ecosystem services (ESs) and disservices (EDSs) provided by health clinic gardens



CHAPTER 4 – PERCEIVED PRESENCE AND VALUES OF STAKEHOLDERS ON ECOSYSTEM SERVICES (ESs) AND DISSERVICES (EDSs) PROVIDED BY HEALTH CLINIC GARDENS

4.1 Introduction

Turpie *et al*. (2017) stated that the ecosystem service (ES) concept was introduced to make people aware of the fact that nature is important and should be recognised as “a valuable form of capital that contributes to economic production and human well-being”. Most people are however not aware of the importance of ESs and how dependent they are of them, probably due to the fact that ESs are generally “not properly valued, priced or paid for, and their contributions to the formal economy, although vital, are not acknowledged” (Le Maitre *et al*., 2007). Many of the ESs, such as regulating services and cultural services, are ‘free’ and can therefore not be marketed, or are difficult to market (Bunse *et al*., 2015). It is also stated by Bunse *et al*. (1015) that it is quite difficult to incorporate these types of ESs into “financial institutions focused on monetary values and cost-benefit analysis”.

Ecosystem disservices (EDSs) on the other hand refer to natural or anthropogenic-impacted ecosystem functions negatively affecting human well-being (Davids *et al*., 2016; Lyytimäki & Sipilä, 2009; Von Döhren & Haase, 2015). Examples of EDSs include allergic reactions due to pollen, leaves blocking stormwater drains, roots damaging pavement, fear of increased crime, diseases such as bilharzia or malaria, pests, weeds and increased leaching of soil nutrients (Shackleton *et al*., 2016). Lyytimäki and Sipilä (2009) stated that to manage urban environments successfully one has to know what advantages and disadvantages are provided by the ecosystems. One of the best ways to assess EDSs is by making use of local knowledge “since the valuation of ecosystem functions is largely based on personal values and perceptions” (Lyytimäki & Sipilä, 2009).

It has been noted by DEFRA (2007) that there are two ways in which ESs contribute to economic prosperity. Firstly, by generating income and contributing to well-being; and secondly, by preventing costly damages. The second way indicates the value of ESs in providing insurance, regulation and resilience functions (DEFRA, 2007). Values for ESs are useful in guiding decisions about conservation or restoration actions (Howarth & Farber, 2002). It is, however, important to remember that ecosystems and species already have an “intrinsic” value, regardless of whether it is valued by humans or not (Pearson, 2016), for example, despite not being compensated, plant roots continuously act as filter systems (García-Orcoyen, 2008).

The connections between people and nature are complex, and they are viewed differently by different people (Haines-Young & Potschin, 2012). Some acknowledge the economic value of ESs while others are more concerned about the impact human activities have on the capacity of ecosystems to deliver services (Haines-Young & Potschin, 2012). Even so, Hein *et al*. (2006) stated that human perceptions are required to value ESs especially the cultural services of an ecosystem.

Hein *et al*. (2006) defined a stakeholder in the valuation of ecosystems as ñany group or individual who can affect or is affected by the ecosystemõs servicesò. According to Hein et al. (2006) ñthe services supplied by an ecosystem determine the relevant stakeholders, and the stakeholders determine relevant ESsò. Many different stakeholders can be involved with the health clinic gardens, including facility managers, groundskeepers (paid gardeners), caregivers (stipend paid by the Department of Health), Community Works Program (CWP ï stipend paid by the Department of Works), NGOõs, community volunteers, Community Health Workers (CHW ï stipend paid by the Department of Health) and other clinic personnel (Cilliers *et al*., 2018; Cornelius, 2016). Facility managers are generally not directly involved in the clinic gardens, but play mostly a facilitating role (Cornelius, 2016). Groundskeepers are in charge of the maintenance of the gardens, especially the food and ornamental gardens, of the health clinics (Cornelius, 2016).

In order for the clinic gardens to be successful, these different stakeholders have to engage and share their knowledge and skills to develop the garden further and solve problems regarding water availability, seed and equipment availability, as well as other issues concerning nutrition and distribution of food produced (Cornelius, 2016). This could contribute to the creation of pockets of social-ecological memory that is places that have ñcaptured, stored, and transmittedò knowledge and experience concerning the management of local ecosystems and ESs, and continuously maintaining them despite severe changes in surrounding environments (Barthel *et al*., 2010; Reyes-Garcóa *et al*., 2014). The exchange of knowledge between a diversity of knowledge systems can lead to the generating of new knowledge, which could improve the capacity to react to conditions, change, responses, and in some cases fundamental relationships in the dynamics of socio-ecological systems (Tengö *et al*., 2014). This exchange of knowledge is known as the co-production of knowledge (Tengö *et al*., 2014). In gardens, the transmission of social-ecological memory could be in the form of gardening skills, cultural traditions, or the physical exchange of plants, seeds and recipes (Barthel *et al*., 2010). There are many cases where shared knowledge across different knowledge systems have improved the understanding and management of ecosystems, threatened natural resources, and biodiversity (Tengö *et al*., 2014).

It could also be used to determine or predict future trajectories or pathways (Tengö *et al*., 2014). Clinic gardens can thus be seen as pockets of social-ecological innovation (Cilliers *et al*., 2018). There are many cases where shared knowledge across different knowledge systems have improved the understanding and management of ecosystems, threatened natural resources, and biodiversity (Tengö *et al*., 2014).

Social surveys using questionnaires provide an objective means of gathering information concerning people's beliefs, knowledge, behaviour, and attitudes (Boynton & Greenhalgh, 2004; White *et al*., 2005). In social-ecological studies, questionnaires are used to obtain information from a specific human target population in order to test research hypotheses (White *et al*., 2005). Questionnaires are especially useful when addressing stakeholder perceptions in interdisciplinary studies (White *et al*., 2005). Questionnaires are often used when ecological data and socio-economic or political data are to be integrated (White *et al*., 2005). Questionnaires can be used to determine actual- or hypothetical behaviour such as the case where economic valuation studies are undertaken (White *et al*., 2005).

This study comprises a multiple method in which quantitative (this chapter) and qualitative (chapter 5) approaches will be followed. Quantitative research concerns explanation, controlled measurement, and exploration of reality from the perspective of an outsider (Fouché & Schurink, 2011). Qualitative research concerns understanding, naturalistic observation, and subjective exploration of reality from the perspective of an insider (Fouché & Schurink, 2011). In quantitative research, the design determines the researcher's choices and actions, while in qualitative research the researcher's choices and actions determine the design or strategy (Fouché & Schurink, 2011).

A questionnaire was designed and tested in the researcher's honours project in 2016, titled: Development and refinement of a questionnaire to study the presence and value of ecosystem services at health clinic gardens in South Africa.

This chapter will address objective 2, namely to develop and conduct a social survey to determine the social, cultural, economic and ecological value of a variety of ESs and EDSs as perceived by different stakeholders. The different sub-districts were compared to each other, as well as the three core stakeholder groups, namely facility managers, groundskeepers and other community members. Because there were between one and four stakeholders interviewed at the different health clinics, it would not provide reliable information to compare the clinics to each other as was done in chapter 3 with the actual values.

4.2 Materials and methods

As interviews were conducted with the stakeholders of the health clinic gardens, ethical clearance from the North-West University (NWU) had to be obtained (Ethics number: NWU-00092-17-S1).

4.2.1 Population and sampling

Voluntary stakeholders of the health clinic gardens were interviewed. Health personnel (facility manager), garden personnel (groundskeeper), traditional health practitioners, caregivers, NGO's, Community Works Programme (CWP) and the local community were identified as stakeholders actively present at health clinic gardens (Cilliers *et al*., 2018). The number of stakeholders interviewed at the health clinic gardens can be seen in **Table 4-1**. These stakeholders were grouped to form three core stakeholder groups, namely facility managers, groundskeepers and other (CWP, Community Health Workers (CHW), other community members, clinic committee, nurses, mentors, counsellors, nutritionists, and general assistants). The stakeholders interviewed were adults of any gender, race and religiosity.

Table 4-1: The number of the different stakeholders interviewed at the health clinic gardens.

Stakeholders	Number interviewed
Facility manager	19
Acting facility manager	7
Groundskeeper	26
Community health worker (CHW)	3
Community health worker (CHW) and on clinic committee	2
Community Works Program (CWP)	2
Nurse/Profesional nurse	4
Clinic committee	1
Community member/Volunteer	3
Mentor and counsellor	1
Nutritionist	1
General assistant	1

The Dr Kenneth Kaunda District Municipality of the North-West Province and the Phokwane local municipality (**Figure 1-1**) acted as the larger group (population) from which samples were drawn. The Dr Kenneth Kaunda district municipality had a population of 742 821 in 2016 increasing by a rate of 1.48 from 2011 (STATS SA, 2018a). The Phokwane local municipality had a population of 60 168 in 2016 decreasing by a rate of 1.0 from 2011 (STATS SA, 2018b). A total of 32 clinics were surveyed of which 27 in the Kenneth Kaunda

District Municipality and five in the Phokwane sub-district. At each health clinic 2-3 different stakeholders, to a total of 70, were interviewed, if they were active at a specific health clinic garden.

4.2.2 Recruitment of participants

Community entry was secured by first obtaining the consent of the health departments of the North West and Northern Cape Provinces, which includes the local health clinics, and by informing the relevant district and local municipality managers. Each clinic was visited beforehand to schedule a date and time most suitable for the interviews and ecological surveys. On the specified day our research team, which includes an interpreter, travelled to the clinic and collected the necessary data.

4.2.3 Process of obtaining informed consent

Participants were approached at the health clinics by the interpreter first to get informed consent and secure an appointment for an interview within the following days in order to give them time to think. The project was explained orally following the informed consent form. Any questions were answered. The interpreter obtained informed consent, and the researcher explained the project further if necessary.

4.2.4 Questionnaire administration

At each clinic, a questionnaire (Appendix B) was used to determine the perceived value the participants attach to provisioning, regulating, habitat and cultural ESs found in the clinic garden. Prior to starting, each participant was given a brief project description and an assurance of anonymity. Signed informed consent was obtained from each voluntary participant before the interview began by the interpreter, who was the mediator and familiar with the Tswana culture. All members of the study team ensured that participants weren't exploited and that informed consent was voluntary and genuine.

The questionnaires were administered orally, face-to-face to 70 stakeholders. The questionnaire took approximately 13-54 minute's (average time was 30.47 min) time to complete depending on the answers of the participant. The participant had the option to withdraw from the questionnaire at any time, but nobody did. The questionnaires were administered by the researcher (Marlize Muller) in a quiet room or area of the garden where the interview could not be influenced or interrupted by other people. The interpreter, who spoke Setswana and English, was used to improve communication between the researcher and the participants.

The questionnaire began with demographic questions. The participantõs age, gender, home language, level of education, occupational role, religion, health, political orientation, economic status and connectedness to nature were obtained. According to Cottrell (2003), literature indicated that socio-demographic variables, such as age, income, education, and political ideology, are often used as predictors of behaviour.

Schultz (2002) described connectedness to nature as ñthe extent to which an individual includes nature within his/her cognitive representation of selfò. The ñinclusion of nature in the self (INS)ò scale was used (Schultz, 2001). The INS scale consists of seven pairs of circles, one circle of the pair is labelled ómeô (I, me, myself, mine, self) and the other circle of the pair is labelled ónatureô (animals, birds, plants, trees) (Mayer & Frantz, 2004; Milfont, 2007). These pairs of circles are arranged so that on one side of the gradient the circles are barely touching, and on the other side of the gradient, they overlap almost completely (Mayer & Frantz, 2004). Respondents used in the study were asked to choose the pair of circles that best describe their connection to nature (Mayer & Frantz, 2004).

Provisioning ESs that were valuated through the questionnaire included: food, raw materials, medicinal plants and freshwater. Regulating ESs that were determined concerned the local climate and air quality regulation, carbon sequestration and storage, moderation of extreme events, wastewater treatment, erosion prevention and maintenance of soil fertility, pollination, and biological control. The provision of habitat for species and the maintenance of genetic diversity through supporting ESs were also determined. Cultural ESs that were investigated include recreational, mental and physical health, spiritual experience, aesthetical appreciation and inspiration for culture, art and design.

An illustration was made to represent each ES (see Appendix C1). According to Tahvanainen *et al*. (2001) how a landscape is perceived depends greatly on sight, therefore by using visual representations of the landscape is important. The illustrations were shown to the participants and questions asked about the ESs. The participants were asked whether he/she perceives the ESs to be present and to what extent (limited, common or abundant). The participant was then asked to indicate which values (economic, ecological, social, and/or cultural ï also shown with illustrations) (see Appendix C3) he/she perceives those ESs have that was perceived to be present, and also to indicate the valueõs importance by organising the values from most important to least important (the participant was allowed to place the illustrations in this order). Finally, the participant was asked if he/she was willing to pay (WTP) for the ESs perceived to be present and if they were what was the amount they were willing to pay for each ES. The participants were ensured that there will not be any stigma or pressure to pay anything and that a zero response is acceptable (Shackleton *et* *al.*, 2018). WTP options were given, namely R 5, R 10, R 20, R 35, R 50, R 75, R 100, R 150, R 200, R 250, R 300, R 350, R 400, R 450, R 500 and the stakeholders were given the option to provide WTP amounts higher if they wanted to.

The four values were based on the five types of capital used in the sustainable livelihood approach, namely natural capital, human capital, economic or financial capital, physical capital and social capital (Morse & McNamara, 2013). In the questionnaire four of these capitals are used, namely natural capital (ecological value), human capital (cultural value), economic or financial capital (economic value) and social capital (social value). The physical capital was not taken into consideration because it comprises of human-made assets and does not necessarily have a value when concerning ESs or EDSs.

Questions on EDSs were asked, for example, ňdo you think any of the plants in the garden can make you sick, ill or allergic?ò (Cornelius, 2016). Illustrations were also made to represent each EDS (see Appendix C2).

4.2.5 Key for social data

The results obtained from the interviews, using a questionnaire (Appendix B), were coded so that it could be used for statistical analysis (**Table 4-2**, **Table 4-3**, **Table 4-4**). The responses of the stakeholders to the open-ended questions were analysed and grouped according to the most frequent answers (**Table 4-2**).

Table 4-2: The codes used for the demographic questions.

Demographic questions		**Code**
Occupational role	Groundskeeper	1
	Caregiver	2
	Facility manager	3
	Patient	4
	Traditional Health Practitioner	5
	CWP	6
	Volunteers	7
	Other	8
Gender	Male	1
	Female	2
Home language	English	1
	Afrikaans	2
	Setswana	3
	isiZulu	4
	isiXhosa	5
	Sesotho	6
	Other	7
Highest level of education (Literacy	None	1
	Some primary	2

level)	Completed primary (Grade 1 ï 7)	3
	Some secondary	4
	Completed secondary (Grade 8 ï 12)	5
	Post-school qualification (diploma, trade, etc.)	6
	University degree	7
	Other	8
Do you belong to a church?	No	0
	Yes	1
How often meet/go to church	Once a week	1
	Two times a week	2
	Three times a week	3
	Four times a week	4
	Five times a week	5
	Six times a week	6
	Every day	7
	Other: few times a month	8
How involved at church	Sunday services only	1
	Sunday services and one or more other activities including choir, Sunday school teacher, youth leader, prayer meetings, visiting sick, attending conferences, menõs fellowship, womanõs forum, secretary, financial committee	2
	Preacher or spouse of preacher	3
	Other: scout, helping other, youth activist	4
How often visits clinic for health	Never	0
	Once a year	1
	Two times a year	2
	Three times a year	3
	Four times a year	4
	Every few weeks or once a month	5
	Every few days	6
	Other: staff members receive a general checkup sometimes, treats oneself, almost every day, goes to private doctor and not clinic	7
Role of clinic	Personal gain, i.e. source of income, benefits own health	1
	Helps community and him/herself personally	2
	Helps the community with their health by providing health care services	3
	Health care and education	4
	Assists people with health in the immediate area (people that live near clinics)	5
	Provides patients with health and provides them with vegetables	6
	Helps people who cannot afford private services	7
	Other: changes lives, be clean and nice	8
Politics interest	No response	0
	Not sure, does not follow politics, not involved	1
	Does not mean anything or means very little, not interested or dislikes politics	2
	They are a nuisance, are jeopardising country, are for personal gain	3
	Are needed ï they rule the country	4
	They provide information and services	5
	Very interested in politics, means a lot	6
	Other: means people, shapes the world, neutral but interested,	7

	provides curriculums, causes a lot of stress, different parties.	
Income source	No income	1
	Department of health/Government	2
	Other: NGO, CWP, Marang, own business, Agang	3
Receives social grant	No	0
	Yes	1
Connectedness to nature (based on circles)	Self and nature apart	1
	Self and nature very little connected	2
	Self and nature somewhat connected	3
	Self and nature about half connected	4
	Self and nature very connected	5
	Self and nature one	6

Table 4-3: The codes used for the questions concerning ecosystem services.

Ecosystem services		**Code**
Presence	No	0
	Don't know	1
	Not sufficient (not enough)	2
	Sufficient (enough)	3
Values (Economic, ecological, social and cultural)	Least important	1
	Most important	4
Willingness to pay	No	0
	Yes	1

Table 4-4: The codes used for the questions concerning ecosystem disservices.

Ecosystem disservices		**Code**
Presence	No	0
	Don't know	1
	Average	2
	Abundant	3

4.2.6 Statistical analysis

The Cronbach's coefficient alpha allows one to sum all interrelated items in order to obtain an overall score for each participant, as the Cronbach's coefficient alpha "estimates the reliability of this type of scale by determining the internal consistency of the test or the average correlation of items within the test" (SAS, 2013). The initial data amounted to 123 items (results of the questionnaire) that had to be analysed. The Cronbach's Coefficient Alpha was used to decrease it to 71 items that were used in the final analysis. For example, the presence of the four provisioning ESs were combined to give an overall score for the presence of provisioning ESs.

Cramér's V is an association measure for nominal random variables (Bergsma, 2013), derived from the Pearson chi-square statistic in two-way frequency tables (SAS, 2013). The

Cramér's V is designed in such a way that the attainable upper bound is always 1 (SAS, 2013). Cramér's V of 0.1 was regarded as small, of 0.3 as medium and of 0.8 as large. The Cramér's V test was used for the demographic questions, which included occupational role, gender, home language, highest level of education, belong to a church, how often meet/go to church, how involved at church, health: how often visit clinic, role of clinic, interest in politics, income, social grant and connectedness to nature.

SPSS Version 25 was used for hierarchical linear models where the sub-districts were used as the subject to compare demographic groups (in other words the sub-districts were compared to each other concerning all the ES questions). The p-values were determined. A small *p*-value (< 0.05) is accepted as adequate evidence that the results are statistically significant (Ellis & Steyn, 2003).

The effect size was determined between the five sub-districts and between the three main occupational groups (facility managers, groundskeepers and community members) because the effect size is independent of the sample size and is a measure of practical significance (Ellis & Steyn, 2003). Practical significance, according to Ellis and Steyn (2003) refers to a difference being large enough that it could have an effect in practice. An effect size of 0.2 was regarded as small, an effect size of 0.5 was medium, and an effect size of 0.8 was large.

The plots indicated no deviation of normality, meaning that the data was normally distributed so that means could be used.

4.3 Results

4.3.1 Demographics

Cramer's V values for the demographic questions of the interview schedule can be seen in **Table 4-5**. All the Cramer's V values were around 0.3 which was of medium significance. Home language had the highest Cramer's V value (0.384), while income had the smallest Cramer's V value (0.203).

Table 4-5: The Cramer's V values for the demographic questions answered by the stakeholders at the health clinics.

	Cramer's V		Cramer's V
Occupational role	0.306	Health: how often visit clinic	0.321
Gender	0.303	Role of clinic	0.361

Home language	0.384	Interest in politics	0.322
Highest level of education	0.267	Income	0.203
Belong to a church	0.312	Social grant	0.210
How often meet/go to church	0.305	Connectedness to nature	0.259
How involved at church	0.265		

4.3.1.1 Occupational role

Only groundskeepers and facility managers were interviewed in all the sub-districts (**Figure 4-1**). There were equal numbers of groundskeepers and facility managers interviewed at all the sub-districts (37.1%) (**Figure 4-1**). The least amount of stakeholder belonged to the CWP group (2.9%). In none of the sub-districts, all five stakeholder groups were interviewed.

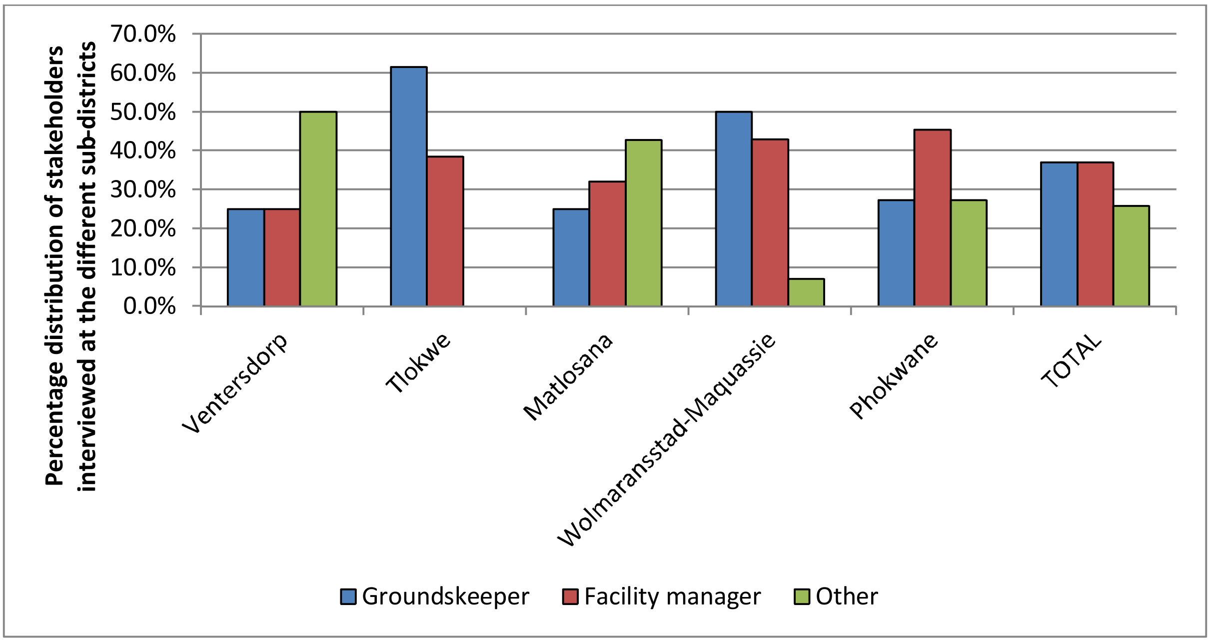


Figure 4-1: The percentage distribution of stakeholders interviewed at different sub-districts.

4.3.1.2 Age

The p-value for age when comparing the different sub-districts was 0.053 which could be considered to be statistically significant. **Table 4-6** indicates the average age of stakeholders in each sub-district. Stakeholders in the Phokwane sub-district were on average the oldest (50.27), while stakeholders from the Wolmaransstad-Maquassie Hills sub-district were the youngest (38.86). There was a significant effect size between the ages of the facility managers and the groundskeepers (0.54) (**Table 4-7**). When comparing the mean age for each stakeholder type, it was noted that the average age for facility managers was 46.96 and for groundskeepers 41.35 indicating that in general groundskeepers were younger than facility managers.

Table 4-6: The average age of interviewed stakeholders in each sub-district.

Sub-district	Number of stakeholders interviewed in each sub-district	Average age
Wolmaransstad-Maquassie Hills	14	38.86
Tlokwe	13	42.54
Ventersdorp	4	44.75
Matlosana	28	46.71
Phokwane	11	50.27

Table 4-7: The average age of the different stakeholder groups, and their effect sizes. Shaded cells are statistically significant.

	N	Average age	Std. Deviation	Effect sizes	
				Groundskeeper	Facility manager
Groundskeeper	26	41.35	9.907		
Facility manager	26	46.96	10.348	0.54	
Other	13	45.23	8.368	0.39	0.17

4.3.1.3 Gender

The total distribution of male and female of all interviewed stakeholders were relatively equal, with 48.6% male and 51.4% female but not in the different sub-districts (**Figure 4-2**). It was only in the Matlosana sub-district and to a lesser extent Phokwane sub-district where more females were interviewed than males (**Figure 4-2**).

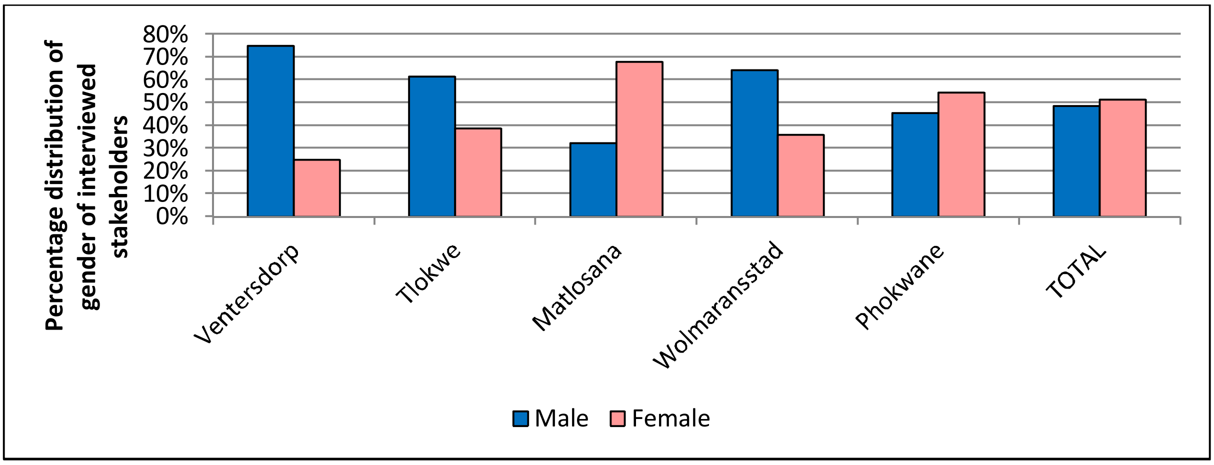


Figure 4-2: The percentage distribution of males and females interviewed at different sub-districts.

4.3.1.4 Home language

Most stakeholders interviewed spoke Setswana (55.7%) at home (**Figure 4-3**). In all the sub-districts, except in the Matlosana sub-district, the most spoken home language was Setswana. In the Matlosana sub-district, the most spoken home language was Sesotho and not Setswana as in the other sub-districts. Furthermore, Matlosana had the most different home languages, when compared to the other sub-districts that had only three home languages.

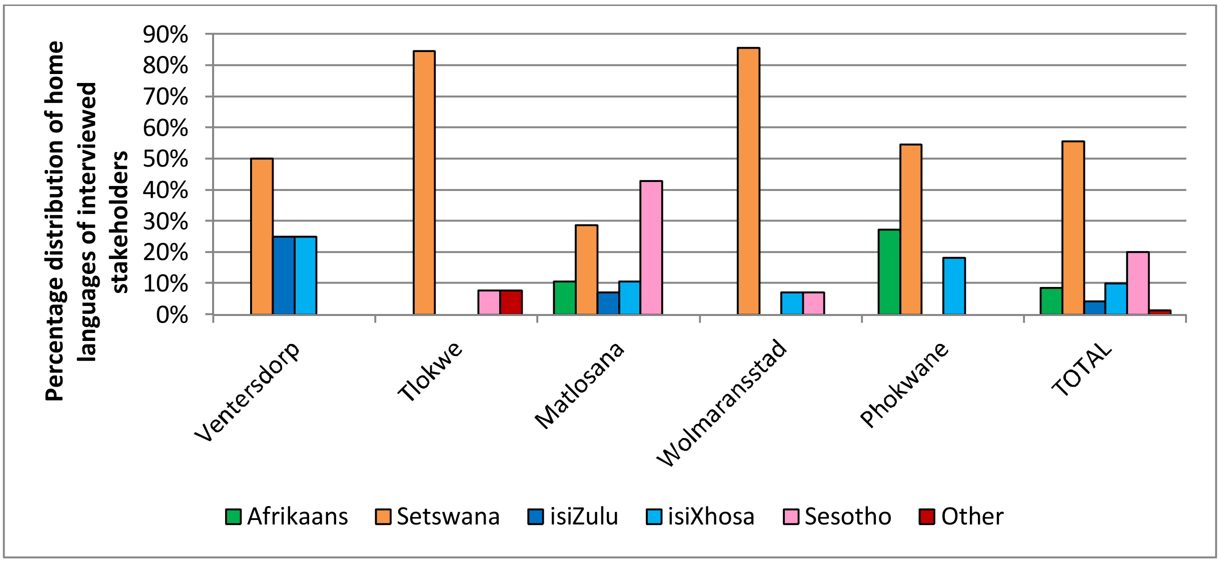


Figure 4-3: The percentage distribution of home languages of the interviewed stakeholders at the different sub-districts.

4.3.1.5 Highest level of education

A high percentage of interviewed stakeholders completed secondary education (27.1%) (**Figure 4-4**). In total there were equal amounts of stakeholders that had some secondary education (24.3%) and a post-school qualification (24.3%) as their highest level of education. There were 18.6% with a University degree and 5.7% who only had primary school education as their highest level of education. Only Matlosana and Phokwane sub-districts had participants of all five education groups.

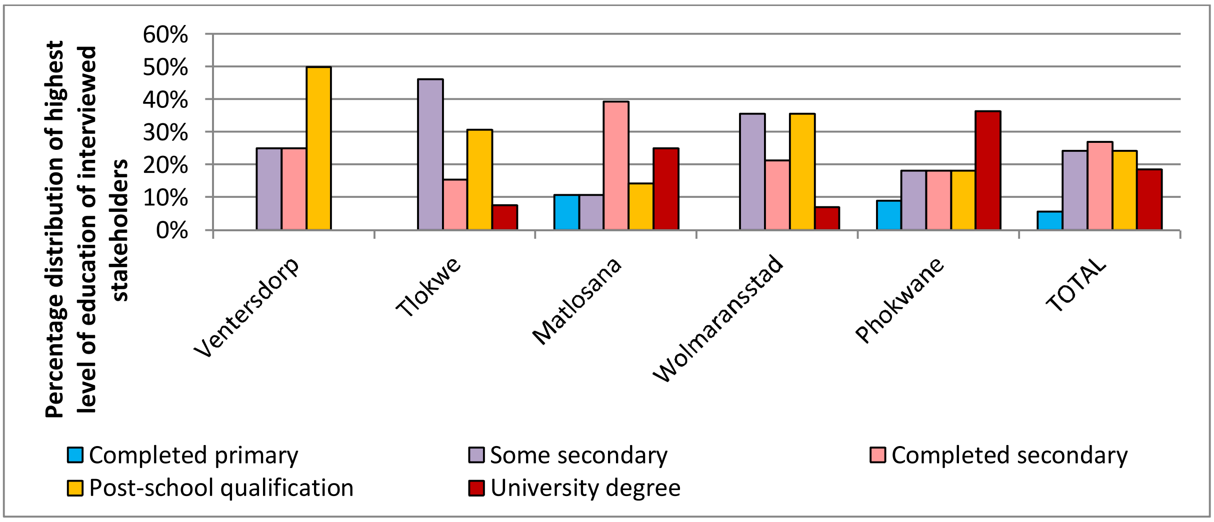


Figure 4-4: The percentage distribution of highest level of education of interviewed stakeholders at the different sub-districts.

4.3.1.6 Religion

Of all stakeholders interviewed 91.4% belong to a church while 8.6% do not belong to a church (**Figure 4-5**). In all the sub-districts most or all stakeholders belong to a church. Most stakeholders were involved with church activities once a week (38.6%), followed by twice a week (27.1%) (**Figure 4-6**). Most stakeholders were involved with Sunday services and other activities (42.9%), 41.4% only attend Sunday services, 8.6% were not involved, 4.3% were the preacher or spouse of the preacher, and 2.9% were involved in other ways (**Figure 4-7**).

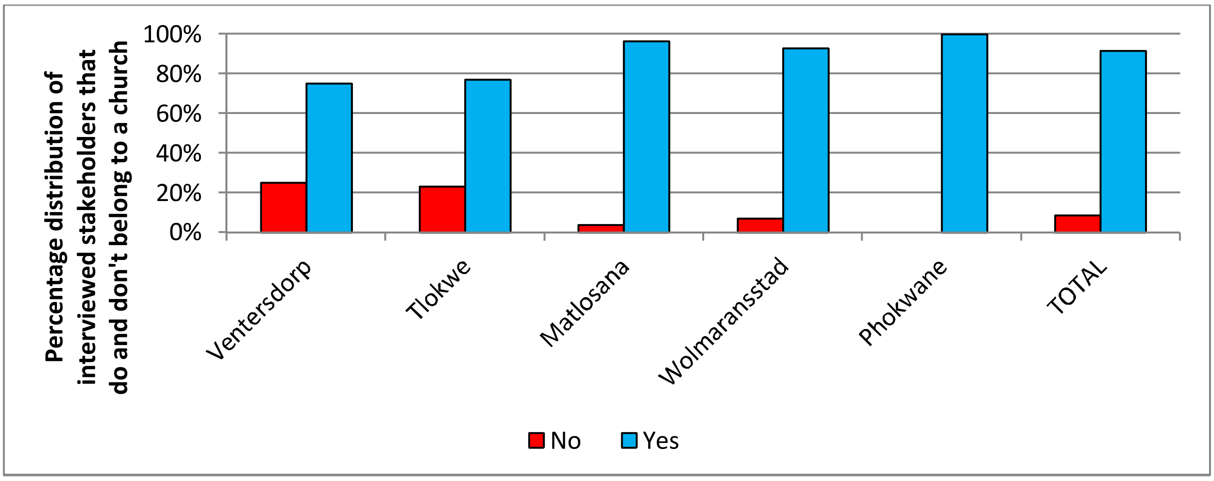


Figure 4-5: The percentage distribution of interviewed stakeholders that belong to a church in the different sub-districts.

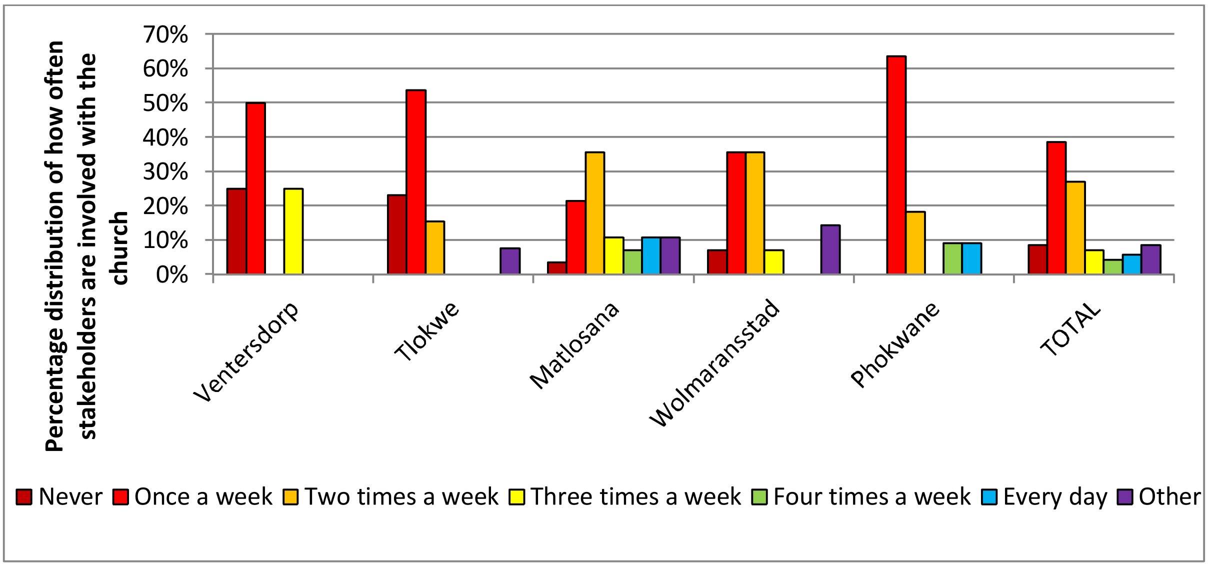


Figure 4-6: The percentage distribution of frequency of visiting the church or meeting for church-related activities by the interviewed stakeholders in the different sub-districts.

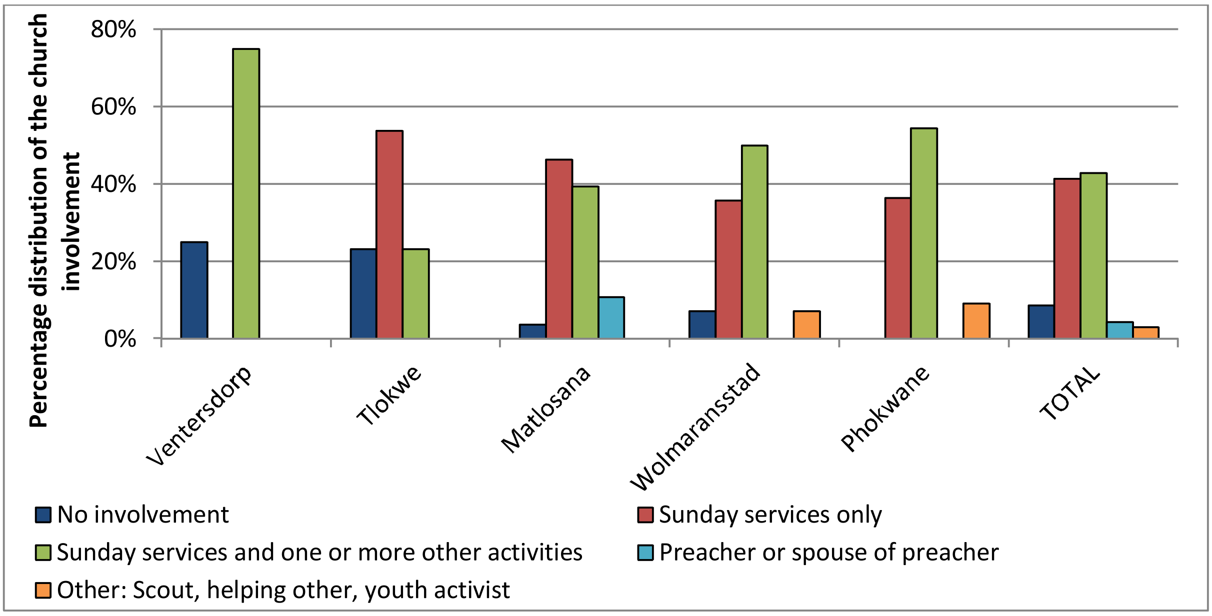


Figure 4-7: The percentage distribution of involvement at the church by the interviewed stakeholders of the different sub-districts.

4.3.1.7 Health

When concerning the stakeholdersô health, during the interviews each stakeholder was asked how often he/she visits the clinic for their health. Of all the stakeholders 32.9% visit a clinic every few weeks, 15.7% never visits a clinic, and 14.3% visits a clinic once a year (**Figure 4-8**). The high total for ñevery few weeks or once a monthò was due to it being the most stated by stakeholders in the Tlokwe and Wolmaransstad-Maquassie Hills sub-districts.

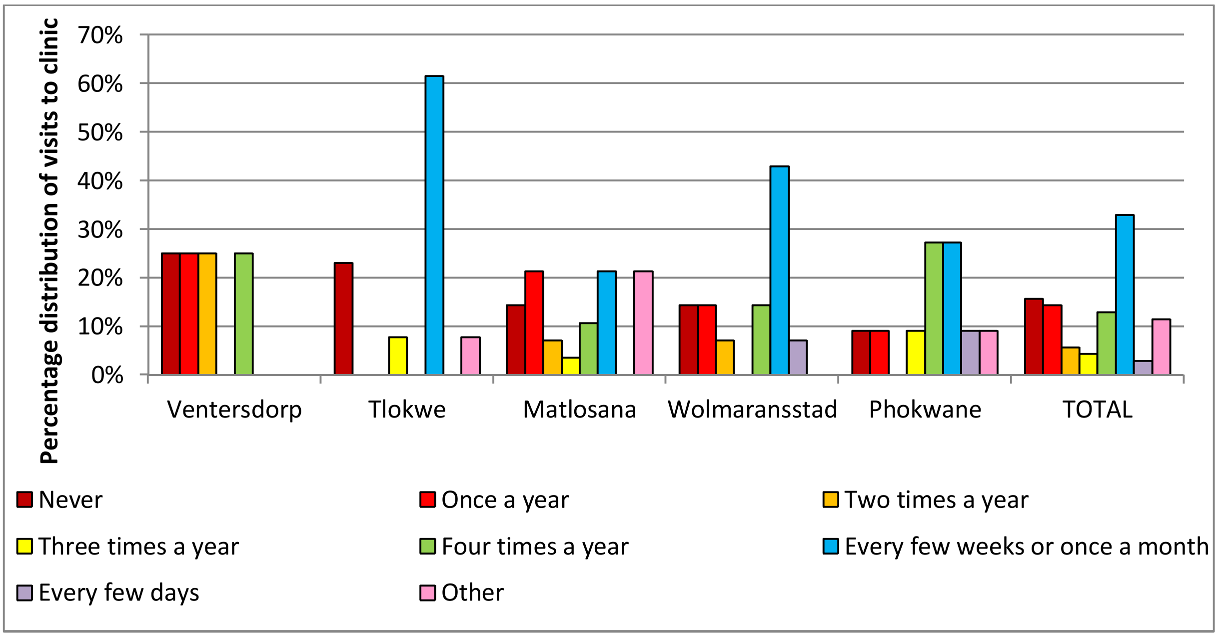


Figure 4-8: The percentage distribution of frequency of visiting the clinic for own health by interviewed stakeholders of the different sub-districts.

4.3.1.8 Role of the clinic

Most stakeholders perceived the role of the clinic to be helping the community with their health (58.6%), as seen in **Table 4-8**. In all the sub-districts most of the stakeholders perceived the role of the clinic to be helping the community with their health by providing health care services.

Table 4-8: The percentage distribution of the perceived role of the clinic by the interviewed stakeholders in the different sub-districts.

	Ventersdorp	**Tlokwe**	**Matlosana**	**Wolmaransstad**	**Phokwane**	**TOTAL**
Personal gain, i.e. source of income, benefits own health	25.0%	7.7%	0.0%	7.1%	18.2%	7.1%
Helps community and him/herself personally	0.0%	7.7%	14.3%	28.6%	9.1%	14.3%
Helps the community with their health by providing health care services	50.0%	61.5%	71.4%	35.7%	54.5%	58.6%
Health care and education	25.0%	0.0%	0.0%	14.3%	18.2%	7.1%
Assists people with health in the immediate area (people that live near clinics)	0.0%	15.4%	3.6%	0.0%	0.0%	4.3%
Provides patients with health and provides them with vegetables	0.0%	7.7%	3.6%	0.0%	0.0%	2.9%
Helps people who cannot afford private services	0.0%	0.0%	7.1%	0.0%	0.0%	2.9%
Other: changes lives, be clean and nice	0.0%	0.0%	0.0%	14.3%	0.0%	2.9%

4.3.1.9 Politics

Of the stakeholders, 50% perceived politics to mean nothing, or very little, which was also the view of most of the respondents in all the sub-districts (**Figure 4-9**). The category õotherö includes statements by the interviewed stakeholders of their views that could not be placed in the other categories. õOtherö statements include õpolitics means peopleö, õpolitics shapes the worldö, õI am neutral but very interestedö, õthey provide curriculumsö, õthey cause a lot of stressö and õpolitics represents different partiesö.

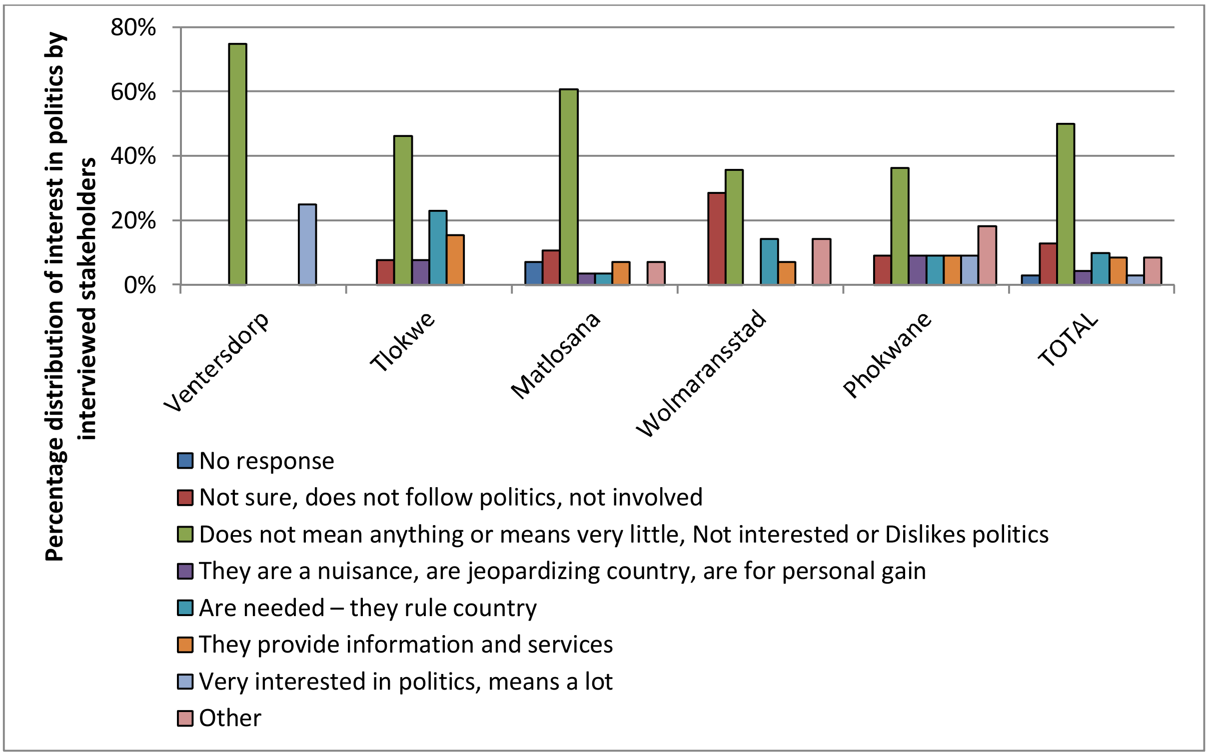


Figure 4-9: The percentage distribution of the interest in politics of the interviewed stakeholders in the different sub-districts.

4.3.1.10 Income

In total the most stakeholders received their income from the department of health (85.7%), while 11.4% receive their income from other sources, and 2.9% had no income (**Figure 4-10**). Of all the interviewed stakeholders only 2.9% receive a social grant. These stakeholders were only in the Matlosana sub-district (7.1%).

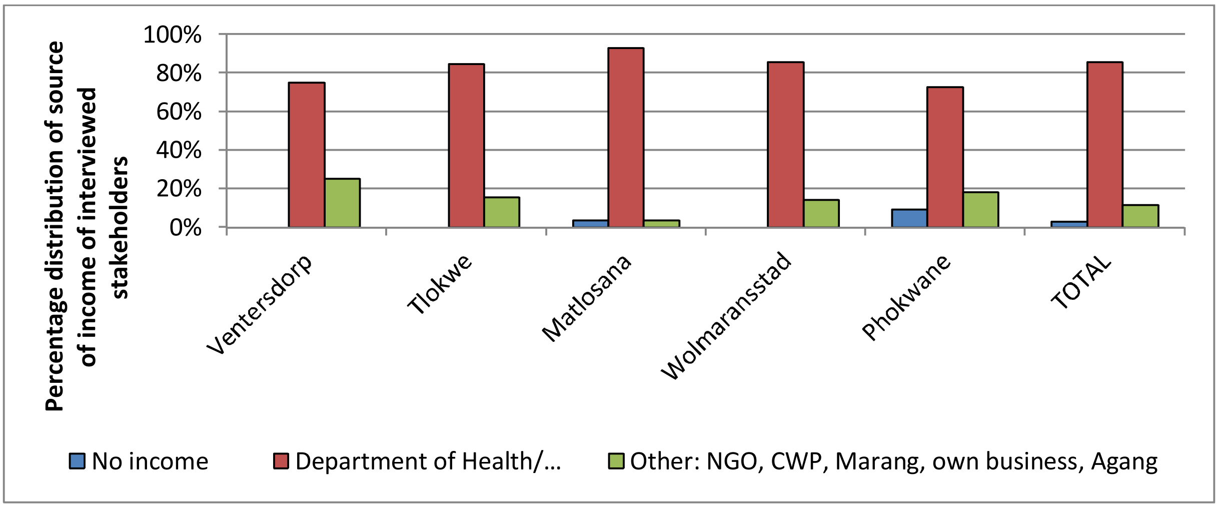


Figure 4-10: The percentage distribution of the income source of the interviewed stakeholders in the different sub-districts.

4.3.1.11 Connectedness to nature

The most interviewed stakeholders perceived themselves to be completely connected to nature (44.3%) (**Figure 4-11**). In two of the sub-districts (Tlokwe and Wolmaransstad-Maquassie Hills) between 15 and 21% of the stakeholders regarded themselves to be very little connected to nature.

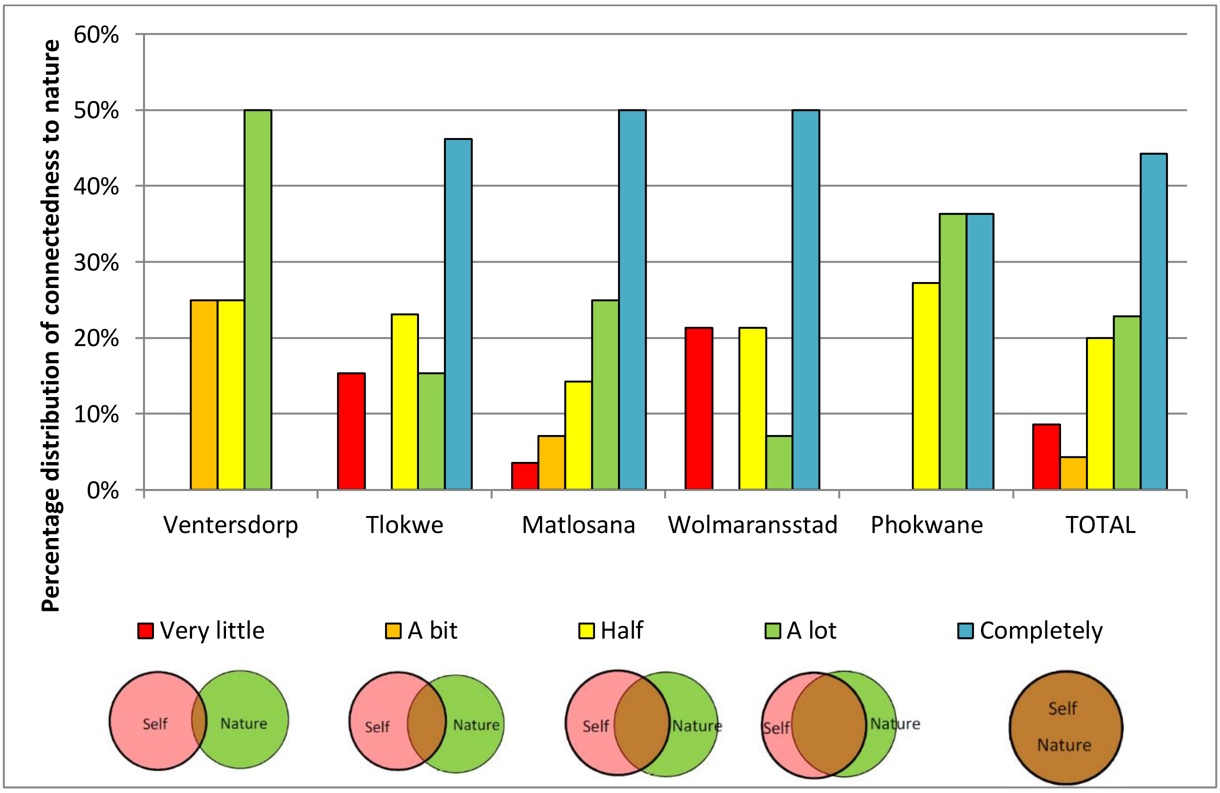


Figure 4-11: The percentage destitution of the interviewed stakeholdersôperception of their connectedness to nature in the different sub-districts.

4.3.2 Presence of ecosystem services

Although the measuring scale for presence data consists only of a 4-point Likert scale, each subcategory, e.g. provisioning ESs, consist of the mean of a number of Likert scale questions and thus forming a truly continuous variable for which the analysis done was sufficient.

Concerning the perceived presence of ESs in the clinic gardens, there was no statistical significance found between the different sub-districts (**Table 4-9**). When comparing the perceived presence of ESs between the different stakeholder groups two ESs were statistically significant (**Table 4-10**).

Table 4-9: The mean, standard deviation and ANOVA p-values for the total of the presence of different ESs between the sub-districts.

Ecosystem services	Sub-district	Mean	Std. Deviation	ANOVA p-value*
Provisioning ESs	Ventersdorp	0.81	0.24	0.595
	Tlokwe	1.08	0.77	
	Matlosana	0.91	0.62	
	Wolmaransstad-Maquassie Hills	0.79	0.69	
	Phokwane	1.18	0.80	
Regulating ESs	Ventersdorp	1.29	0.48	0.292
	Tlokwe	1.60	0.77	
	Matlosana	1.79	0.57	
	Wolmaransstad-Maquassie Hills	1.64	0.75	
	Phokwane	2.00	0.38	
Habitats for species	Ventersdorp	1.00	1.15	0.861
	Tlokwe	1.23	1.42	
	Matlosana	1.14	1.27	
	Wolmaransstad-Maquassie Hills	1.36	1.45	
	Phokwane	1.64	1.36	
Maintenance of genetic diversity	Ventersdorp	2.25	0.50	0.967
	Tlokwe	2.15	0.80	
	Matlosana	2.21	0.42	
	Wolmaransstad-Maquassie Hills	2.14	0.36	
	Phokwane	2.27	0.47	
Recreation	Ventersdorp	0.75	1.50	0.408
	Tlokwe	1.54	1.33	
	Matlosana	1.32	1.31	
	Wolmaransstad-Maquassie Hills	1.79	1.25	
	Phokwane	2.00	1.34	
Health and well-being	Ventersdorp	2.50	0.58	0.257
	Tlokwe	1.85	1.14	
	Matlosana	2.25	0.80	
	Wolmaransstad-Maquassie Hills	2.57	0.51	
	Phokwane	2.27	0.90	
Aesthetic appreciation	Ventersdorp	1.75	1.26	0.892
	Tlokwe	1.15	1.34	
	Matlosana	1.07	1.21	
	Wolmaransstad-Maquassie Hills	1.07	1.33	
	Phokwane	1.09	1.04	
Inspiration for culture, art and design	Ventersdorp	2.50	0.58	0.170
	Tlokwe	1.46	1.45	
	Matlosana	1.75	1.21	
	Wolmaransstad-Maquassie Hills	2.14	0.77	
	Phokwane	2.36	0.50	
Spiritual experience	Ventersdorp	2.00	1.41	0.428

and sense of place	Tlokwe	0.92	1.26	
	Matlosana	1.57	1.26	
	Wolmaransstad-Maquassie Hills	1.57	1.45	
	Phokwane	1.82	1.25	

*Since there was no statistical significance there is no distinction made between the averages of the different sub-districts.

Table 4-10: The ANOVA p-values for the total presence of different ESs as perceived by different stakeholders. (Shaded cells are statistically significant).

Ecosystem services	ANOVA p-value*
Provisioning ESs	0.787
Regulating ESs	0.551
Habitats for species	0.034
Maintenance of genetic diversity	0.780
Recreation	0.040
Health and well-being	0.266
Aesthetic appreciation	0.774
Inspiration for culture, art and design	0.314
Spiritual experience and sense of place	0.226

*Since there was no statistical significance there is no distinction made between the averages of the different stakeholders.

The presence of habitats for species had a p-value of 0.034 when stakeholder responses were compared (**Table 4-10**). For the presence questions 0 represented no, 1 represented don't know, 2 represented not sufficient, and 3 represented sufficient. The presence of habitat for species as perceived by the other stakeholders will then be between "no" and "don't know" (**Table 4-11**). The presence of habitat for species as perceived by facility managers and groundskeepers will be between "don't know" and "not sufficient" which were similar to each other but different from the 'other' group (**Table 4-11**).

Table 4-11: The number of stakeholders that perceived habitats for species to be present in the health clinic garden and the average presence value given to this ES by the different stakeholders.

Stakeholders	Number of stakeholders that perceived ES to be present	Average presence value given to ES	
		1	2
Other	13	0.46	
Facility manager	26		1.42
Groundskeeper	26		1.58

The presence of recreation in the health clinic gardens had a p-value of 0.040 (**Table 4-10**). Even so, there were no significant effect sizes for the presence of recreation (**Table 4-12**). For the presence questions 0 represented no, 1 represented don't know, 2 represented not sufficient, and 3 represented sufficient. The presence of recreation as perceived by other stakeholders and facility managers were between "don't know" and "not sufficient" (**Table 4-**

12). The presence of recreation as perceived by groundskeepers was between ñnot sufficientò and ñsufficientò (**Table 4-12**).

Table 4-12: The number of stakeholders that perceived recreation to be present in the health clinic garden and the average presence value given to this ES by the different stakeholders.

Stakeholders	Number of stakeholders that perceived ES to be present	Average presence value given to ES
Other	13	1.08
Facility manager	26	1.31
Groundskeeper	26	2.04

For most ESs there were not significant effect sizes between the presence perceptions of different stakeholders (**Table 4-13**). When concerning habitats for species, the other stakeholders had different perceptions concerning the presence (**Table 4-13**). For recreation, the groundskeepers had different perceptions than the facility managers and other stakeholders (**Table 4-13**).

Table 4-13: The mean, standard deviation and significant effect sizes of ESs as perceived by different stakeholders. (Shaded cells are statistically significant).

		N	Mean	Std. Deviation	Effect sizes	
					Groundskeeper	Facility manager
Provisioning ESs	Groundskeeper	26	0.9712	0.71529		
	Facility manager	26	0.8462	0.73170	0.17	

	Other	13	0.9423	0.35581	0.04	0.13
Regulating ESs	Groundskeeper	26	1.7912	0.6691		
	Facility manager	26	1.6538	0.5913	0.21	
	Other	13	1.5714	0.6415	0.33	0.13
Habitats for species	Groundskeeper	26	1.58	1.419		
	Facility manager	26	1.42	1.301	0.11	
	Other	13	0.46	0.776	0.79	0.74
Maintenance of genetic diversity	Groundskeeper	26	2.19	0.634		
	Facility manager	26	2.15	0.368	0.06	
	Other	13	2.08	0.277	0.18	0.21
Recreation	Groundskeeper	26	2.04	1.216		
	Facility manager	26	1.31	1.289	0.57	
	Other	13	1.08	1.256	0.77	0.18
Health and well-being	Groundskeeper	26	2.38	0.852		
	Facility manager	26	2.00	0.849	0.45	
	Other	13	2.23	0.832	0.18	0.27
Aesthetic appreciation	Groundskeeper	26	1.12	1.275		
	Facility manager	26	1.12	1.177	0.00	
	Other	13	0.85	1.144	0.21	0.23
Inspiration for culture, art and design	Groundskeeper	26	2.08	1.129		
	Facility manager	26	1.62	1.061	0.41	
	Other	13	1.77	1.092	0.27	0.14
Spiritual experience and sense of place	Groundskeeper	26	1.73	1.343		
	Facility manager	26	1.15	1.223	0.43	
	Other	13	1.69	1.251	0.03	0.43

ESs were stated by the stakeholders as either being absent, not sufficient (not enough) or sufficient (enough); there was also an option of "don't know" if the stakeholders did not know anything about a specific ES (**Table 4-3**). The average presence values given by all the interviewed stakeholders can be seen in **Figure 4-12**. The ESs perceived to be the most present was erosion prevention and the maintenance of soil fertility (2.26) as well as health and well-being (2.26). These were closely followed by the maintenance of genetic diversity (2.20) and carbon sequestration (2.14).

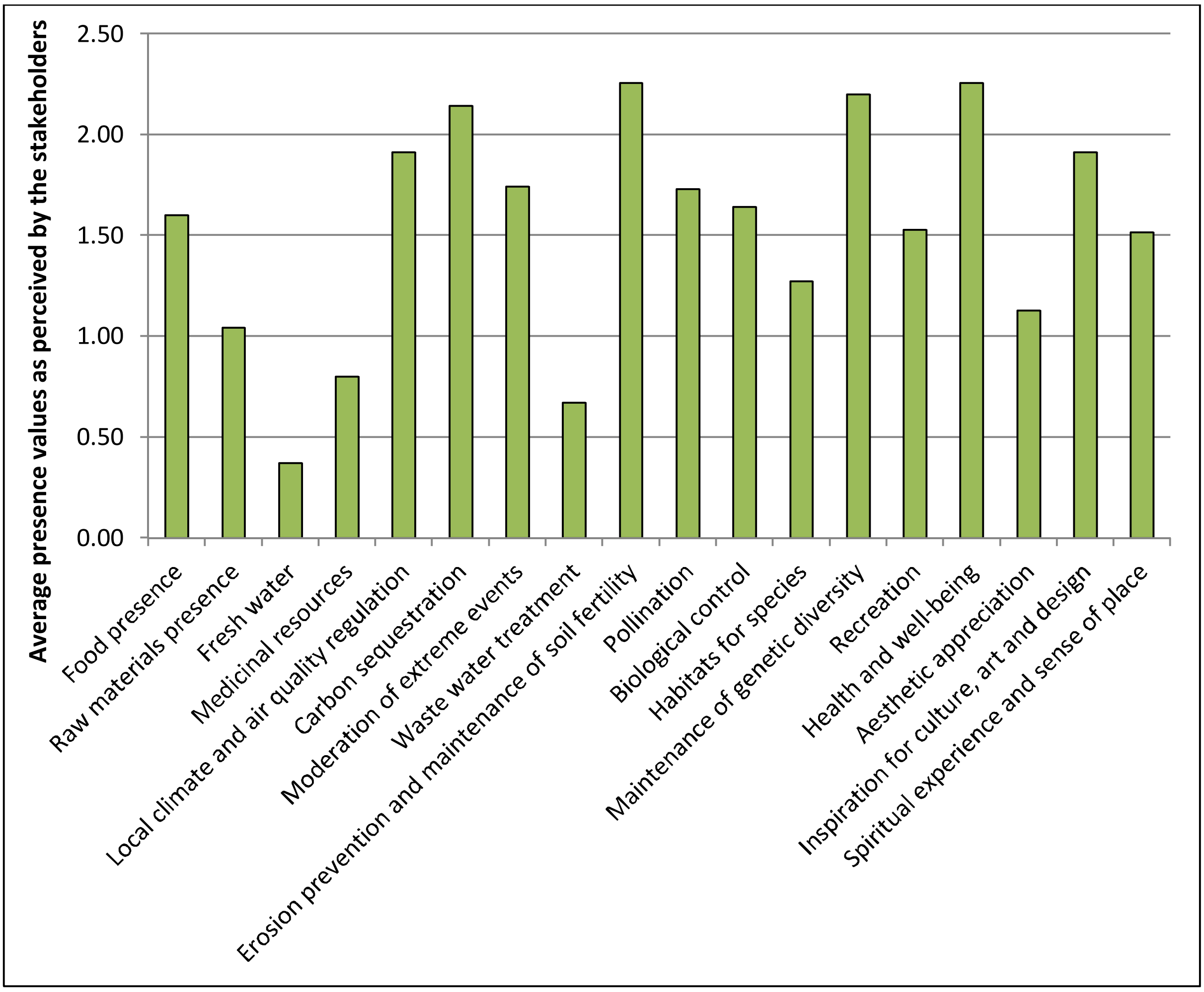


Figure 4-12: The average presence values for each ES as perceived by the stakeholders of all the health clinic gardens visited.

Stakeholders mostly stated that the ESs were not sufficient followed by not present (**Figure 4-13**). Most of the interviewed stakeholders did not perceive freshwater to be present in the health clinic gardens (**Figure 4-13**). The biological control ES was the ES that most interviewed stakeholders did not know. The ES that was perceived to be the most insufficient in the health clinic gardens was the maintenance of genetic diversity. The most sufficient ES as perceived by the stakeholders were erosion prevention and maintenance of soil fertility and health and well-being (**Figure 4-14**). Overall there were few ESs that the stakeholders did not know. There was, however, at all the clinics a percentage of the stakeholders that perceived the ESs not to be present.

A box and whisker diagram was created of the presence perceptions of the stakeholders interviewed that perceived the ecosystem groups (provisioning, regulating, supporting and cultural) to be sufficiently present (**Figure 4-15**). The provisioning services were considerably less chosen to be sufficiently present by the stakeholders than the other ES groups. The ñwhiskersò indicate the maximum and minimum points (not outliers), the top line of the box indicates the Q_3, the middle line in the box indicates the median and the bottom line of the box indicates the Q_1 (Swanepoel *et al*., 2011) (**Figure 4-15**). The dot that is not connected to the box or whisker is an outlier. A data point is considered an outlier if it exceeds a distance of 1.5 times the interquartile range ($IQR = Q_3 – Q_1$) below the 1st quartile or above the 3rd quartile (Swanepoel *et al*., 2011). Therefore, for the regulating services there was an outlier as it was below 17 ($Q_1 – 1.5*IQR = 29 – 1.5*8 = 17$) (**Figure 4-15**).

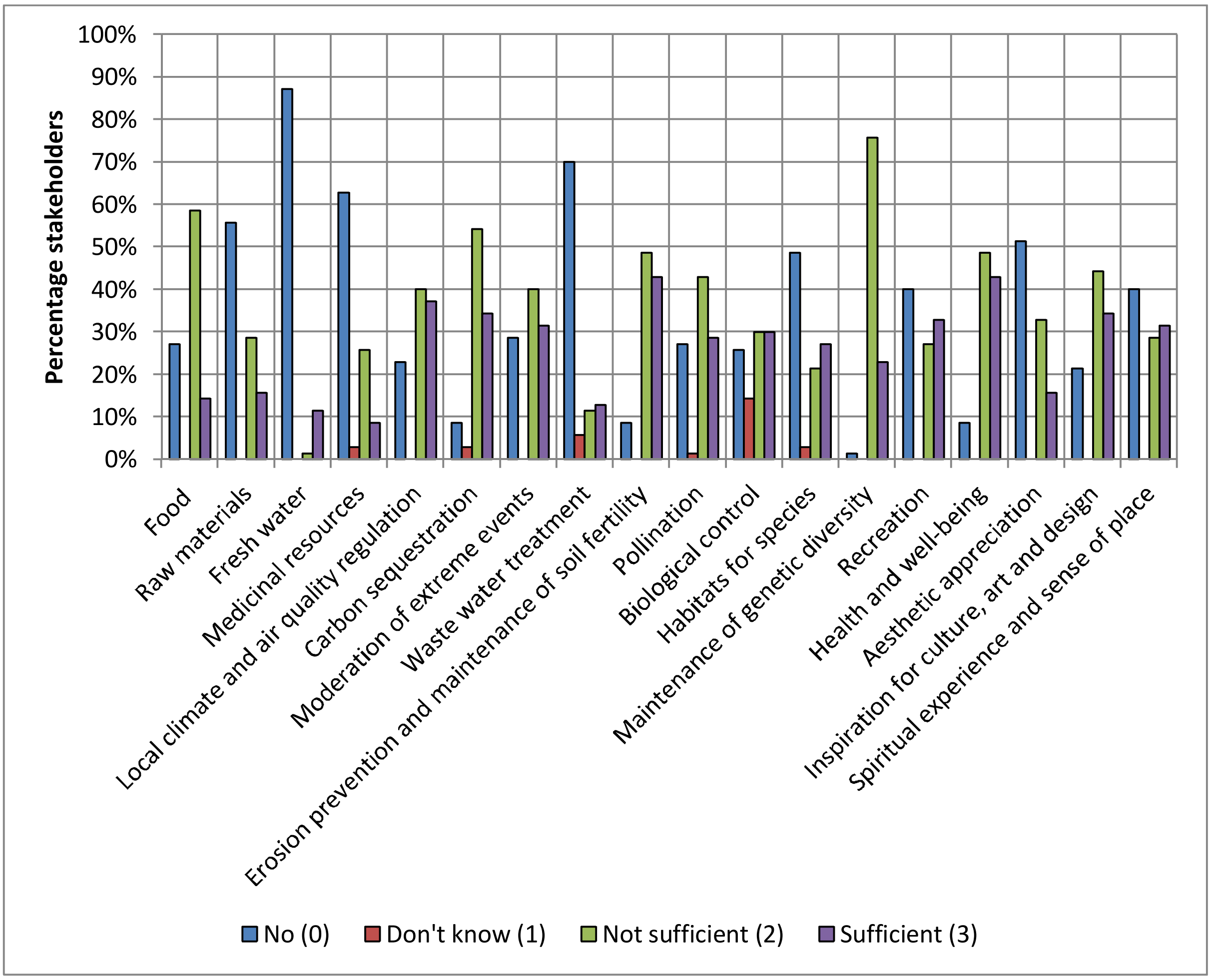


Figure 4-13: The percentage of stakeholders that perceived the ESs to be present at health clinic gardens.

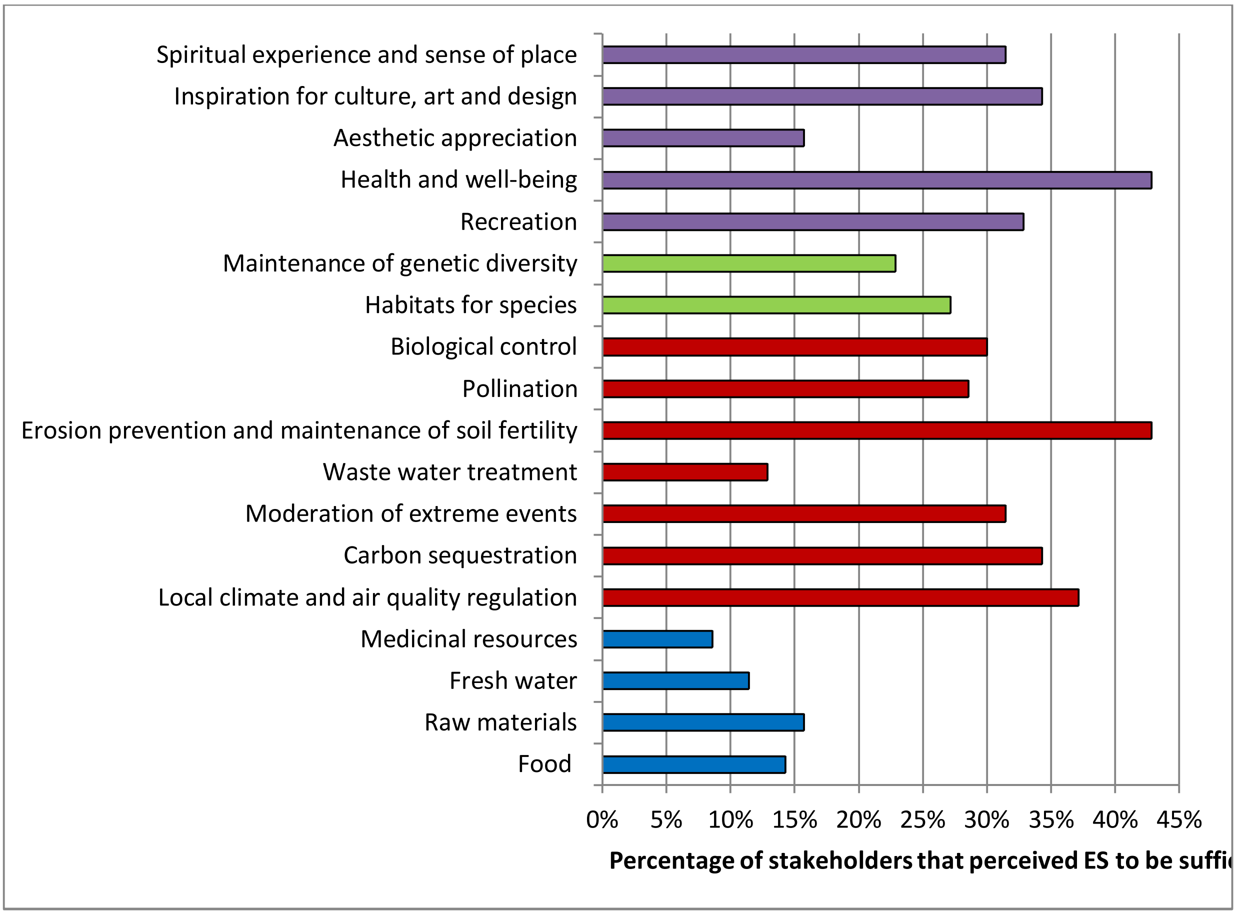


Figure 4-14: The percentage of stakeholders that perceived the ESs to be sufficiently present in the health clinic gardens.

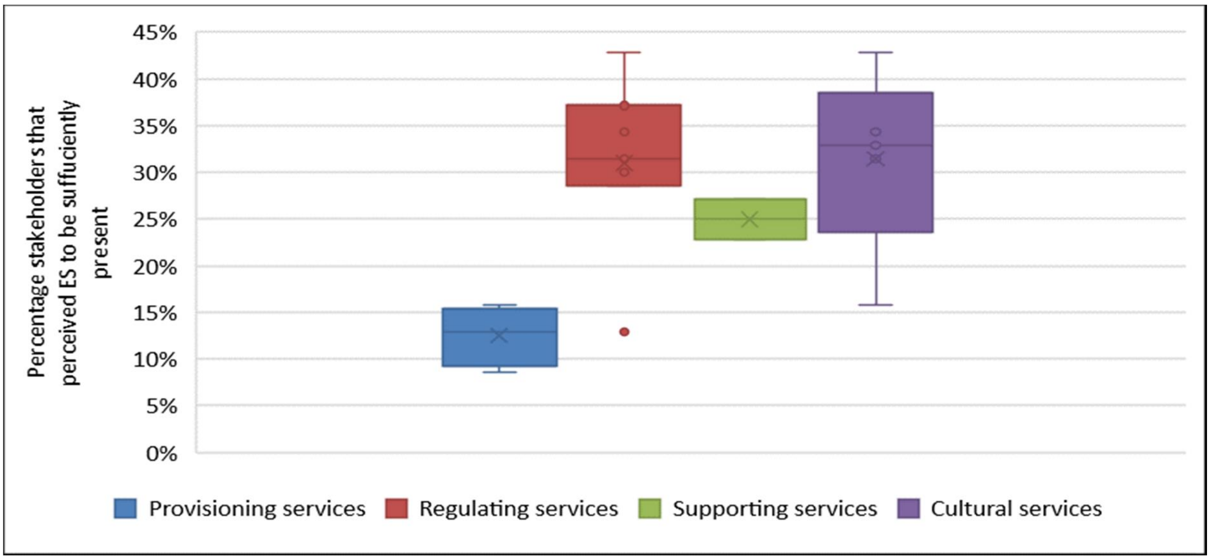


Figure 4-15: A box and whisker diagram of the percentage of stakeholders that perceived the four different ecosystem groups to be sufficiently present in the health clinic gardens.

4.3.3 Values of ecosystem services

The stakeholders had the option of assigning four values to each ES. These values were based on the four types of capital used in the sustainable livelihood approach, namely natural capital (ecological value), human capital (cultural value), economic or financial capital (economic value) and social capital (social value) (Morse & McNamara, 2013).

When concerning the perceived values of ESs in the clinic gardens, there were no statistically significant differences found between the different sub-districts (**Table 4-14**). There were only statistically significant differences between the economic value perceptions of biological control and cultural ESs and for the ecological value of pollination between the different stakeholder groups (**Table 4-15**).

For most ESs there were not significant effect sizes between the value perceptions of different stakeholders (**Table 4-16**). There were eight ESs where the perceptions on the value between the groundskeepers and facility managers were statistically significant. While there were four ESs were the perceptions of the other stakeholders differ statistically from the groundskeepers and facility managers. It is important to note that for some ESs there were very few stakeholders that answered the questions concerning the value of ESs, and these may therefore not be statistically significant even if they had high effect sizes. For example, for the ecological value of freshwater, only one other stakeholder and two facility managers perceived this ES to have ecological value.

Table 4-14: The mean, standard deviation and ANOVA p-values for the total of the values of different ESs between the sub-districts.

Ecosystem services	Sub-district	Mean	Std. Deviation	ANOVA p-value*
Provisioning - Economic	Ventersdorp	0.19	0.38	0.664
	Tlokwe	0.56	0.96	
	Matlosana	0.55	0.57	
	Wolmaransstad-Maquassie Hills	0.38	0.58	
	Phokwane	0.68	0.67	
Provisioning - Social	Ventersdorp	1.19	0.55	0.327
	Tlokwe	1.31	0.89	
	Matlosana	0.98	0.88	
	Wolmaransstad-Maquassie Hills	0.66	0.79	
	Phokwane	1.20	0.86	
Provisioning - Cultural	Ventersdorp	0.00	0.00	0.723
	Tlokwe	0.56	0.80	
	Matlosana	0.49	0.87	
	Wolmaransstad-Maquassie Hills	0.36	0.59	

	Phokwane	0.58	0.92	
Food ecological	Ventersdorp	4.00		0.467
	Tlokwe	3.11	0.78	
	Matlosana	2.94	0.87	
	Wolmaransstad-Maquassie Hills	3.50	0.58	
	Phokwane	3.40	0.55	
Food cultural	Ventersdorp			0.294
	Tlokwe	2.80	1.30	
	Matlosana	2.15	1.07	
	Wolmaransstad-Maquassie Hills	3.00	1.00	
	Phokwane	4.00		
Raw materials ecological	Ventersdorp	3.00		0.594
	Tlokwe	3.75	0.50	
	Matlosana	3.71	0.49	
	Wolmaransstad-Maquassie Hills	4.00	0.00	
	Phokwane	3.67	0.58	
Freshwater ecological	Ventersdorp	3.50	0.71	0.798
	Tlokwe	3.00	1.41	
	Matlosana	4.00	0.00	
	Wolmaransstad-Maquassie Hills			
	Phokwane	3.33	1.15	
Medicinal resources ecological	Ventersdorp			0.761
	Tlokwe	2.67	1.53	
	Matlosana	2.67	1.15	
	Wolmaransstad-Maquassie Hills	4.00		
	Phokwane	3.00	0.82	
Regulating - Ecological	Ventersdorp	1.79	0.32	0.738
	Tlokwe	2.05	1.06	
	Matlosana	2.15	0.97	
	Wolmaransstad-Maquassie Hills	1.83	1.10	
	Phokwane	2.33	1.10	
Regulating - Social	Ventersdorp	1.11	0.29	0.063
	Tlokwe	1.20	1.10	
	Matlosana	1.81	0.86	
	Wolmaransstad-Maquassie Hills	1.49	0.76	
	Phokwane	2.04	0.55	
Regulating - Cultural	Ventersdorp	0.07	0.14	0.173
	Tlokwe	0.38	0.54	
	Matlosana	0.29	0.45	
	Wolmaransstad-Maquassie Hills	0.24	0.38	
	Phokwane	0.73	1.02	
Local climate and air quality regulation economic	Ventersdorp			0.148
	Tlokwe	2.50	1.00	
	Matlosana	1.67	0.58	

	Wolmaransstad-Maquassie Hills			
	Phokwane	4.00		
Carbon sequestration economic	Ventersdorp	2.00		0.173
	Tlokwe	3.00		
	Matlosana	2.75	0.96	
	Wolmaransstad-Maquassie Hills	4.00	0.00	
	Phokwane	2.00	0.82	
Moderation of extreme events economic	Ventersdorp			0.237
	Tlokwe	2.67	1.53	
	Matlosana	3.00	1.15	
	Wolmaransstad-Maquassie Hills			
	Phokwane	1.75	0.50	
Wastewater treatment economic	Ventersdorp			0.974
	Tlokwe	2.00		
	Matlosana	2.25	1.26	
	Wolmaransstad-Maquassie Hills			
	Phokwane	2.00		
Erosion prevention and maintenance of soil fertility economic	Ventersdorp			0.535
	Tlokwe	2.00	0.00	
	Matlosana	3.09	1.04	
	Wolmaransstad-Maquassie Hills	2.00		
	Phokwane	2.60	1.52	
Pollination economic	Ventersdorp	4.00		0.253
	Tlokwe			
	Matlosana	3.00	1.07	
	Wolmaransstad-Maquassie Hills	4.00		
	Phokwane	2.00	1.15	
Biological control economic	Ventersdorp			0.062
	Tlokwe			
	Matlosana	2.00	1.10	
	Wolmaransstad-Maquassie Hills	1.00	0.00	
	Phokwane	3.25	0.96	
Pollination ecological	Ventersdorp	3.67	0.58	0.698
	Tlokwe	4.00	0.00	
	Matlosana	3.72	0.57	
	Wolmaransstad-Maquassie Hills	3.78	0.44	
	Phokwane	3.75	0.71	
Supporting - Social	Ventersdorp	1.63	1.25	0.983
	Tlokwe	1.54	1.18	
	Matlosana	1.68	1.07	
	Wolmaransstad-Maquassie Hills	1.50	1.11	
	Phokwane	1.73	1.33	
Supporting - Cultural	Ventersdorp	0.38	0.75	0.672
	Tlokwe	0.46	0.75	
	Matlosana	0.50	0.84	

	Wolmaransstad-Maquassie Hills	0.25	0.58	
	Phokwane	0.73	0.93	
Habitats for species economic	Ventersdorp			0.712
	Tlokwe	3.00		
	Matlosana	2.00	1.15	
	Wolmaransstad-Maquassie Hills			
	Phokwane	2.00	1.00	
Habitats for species ecological	Ventersdorp	4.00	0.00	0.754
	Tlokwe	3.83	0.41	
	Matlosana	3.91	0.30	
	Wolmaransstad-Maquassie Hills	3.75	0.50	
	Phokwane	4.00	0.00	
Maintenance of genetic diversity economic	Ventersdorp	3.00	1.41	0.258
	Tlokwe	3.00	1.00	
	Matlosana	3.65	0.79	
	Wolmaransstad-Maquassie Hills	3.63	0.74	
	Phokwane	2.83	1.17	
Maintenance of genetic diversity ecological	Ventersdorp	4.00	0.00	0.096
	Tlokwe	3.71	0.49	
	Matlosana	2.93	0.96	
	Wolmaransstad-Maquassie Hills	3.67	0.71	
	Phokwane	3.38	0.74	
Cultural - Economic	Ventersdorp	0.50	0.66	0.882
	Tlokwe	0.34	0.92	
	Matlosana	0.52	0.70	
	Wolmaransstad-Maquassie Hills	0.50	0.79	
	Phokwane	0.69	0.93	
Cultural - Ecological	Ventersdorp	1.80	1.15	0.936
	Tlokwe	1.68	1.31	
	Matlosana	1.78	1.16	
	Wolmaransstad-Maquassie Hills	1.77	1.20	
	Phokwane	2.07	0.59	
Cultural - Social	Ventersdorp	1.75	1.12	0.850
	Tlokwe	1.63	1.17	
	Matlosana	1.57	1.09	
	Wolmaransstad-Maquassie Hills	1.74	0.91	
	Phokwane	2.00	1.04	
Cultural - Cultural	Ventersdorp	0.80	0.75	0.213
	Tlokwe	0.34	0.61	
	Matlosana	0.75	0.74	
	Wolmaransstad-Maquassie Hills	0.44	0.64	
	Phokwane	0.98	1.05	

*Since there were no statistically significant differences there is no distinction made between the averages of the different sub-districts.

Table 4-15: The ANOVA p-values for the total value of different ESs as perceived by different stakeholders. (Shaded cells are statistically significant).

Ecosystem services	ANOVA p-value*
Provisioning - Economic	0.712
Provisioning - Social	0.645
Provisioning - Cultural	0.733
Food ecological	0.742
Food cultural	0.251
Raw materials ecological	0.966
Freshwater ecological	0.382
Medicinal resources ecological	0.723
Regulating - Ecological	0.722
Regulating - Social	0.580
Regulating - Cultural	0.816
Local climate and air quality regulation economic	0.366
Carbon sequestration economic	0.108
Moderation of extreme events economic	0.532
Wastewater treatment economic	0.876
Erosion prevention and maintenance of soil fertility economic	0.262
Pollination economic	0.783
Biological control economic	0.021
Pollination ecological	0.000
Supporting - Social	0.486
Supporting - Cultural	0.412
Habitats for species economic	0.258
Habitats for species ecological	0.912
Maintenance of genetic diversity economic	0.206
Maintenance of genetic diversity ecological	0.145
Cultural - Economic	0.042
Cultural - Ecological	0.628
Cultural - Social	0.554
Cultural - Cultural	0.736

*Since there were no statistically significant differences for most ES there is no distinction made between the averages of the different stakeholders.

Table 4-16: The mean, standard deviation and significant effect sizes of ESs as perceived by different stakeholders. (Shaded cells are statistically significant).

		N	Mean	Std. Deviation	Effect sizes	
					Grounds keeper	Facility manager
Provisioning - Economic	Groundskeeper	26	0.433	0.740		
	Facility manager	26	0.529	0.645	0.13	
	Other	13	0.615	0.574	0.25	0.13
Provisioning - Social	Groundskeeper	26	0.913	0.889		
	Facility manager	26	0.904	0.872	0.01	
	Other	13	1.154	0.658	0.27	0.29
Provisioning - Cultural	Groundskeeper	26	0.576	0.745		
	Facility manager	26	0.436	0.836	0.17	
	Other	13	0.385	0.881	0.22	0.06
Food ecological	Groundskeeper	12	3.33	0.651		
	Facility manager	15	3.13	0.743	0.27	
	Other	8	3.13	0.835	0.25	0.01
Food cultural	Groundskeeper	10	2.90	1.101		
	Facility manager	4	1.75	1.500	0.77	
	Other	7	2.43	0.976	0.43	0.45
Raw materials ecological	Groundskeeper	6	3.67	0.516		
	Facility manager	7	3.71	0.488	0.09	
	Other	4	3.75	0.500	0.16	0.07
Freshwater ecological	Groundskeeper	5	3.00	1.000		
	Facility manager	2	4.00	0.000	1.00	
	Other	1	4.00		1.00	
Medicinal resources ecological	Groundskeeper	4	2.75	1.500		
	Facility manager	5	3.00	0.707	0.17	
	Other	1	2.00		0.50	1.41
Regulating - Ecological	Groundskeeper	26	1.923	1.012		
	Facility manager	26	2.147	1.040	0.22	
	Other	13	2.089	1.001	0.16	0.06
Regulating - Social	Groundskeeper	26	1.593	0.833		
	Facility manager	26	1.544	0.954	0.05	
	Other	13	1.846	0.752	0.30	0.32
Regulating - Cultural	Groundskeeper	26	0.313	0.463		
	Facility manager	26	0.407	0.644	0.15	
	Other	13	0.418	0.750	0.14	0.01
Local climate and air quality regulation economic	Groundskeeper	3	2.33	1.155		
	Facility manager	3	2.00	1.000	0.29	
	Other	1	4.00		1.44	2.00
Carbon sequestration economic	Groundskeeper	2	3.50	0.707		
	Facility manager	8	2.75	0.886	0.85	
	Other	2	1.50	0.707	2.83	1.41
Moderation of	Groundskeeper	3	2.00	1.000		

extreme events economic	Facility manager	8	2.88	1.126	0.78	
	Other	3	2.33	1.528	0.22	0.35
Wastewater treatment economic	Groundskeeper	1	2.00			
	Facility manager	5	2.20	1.095	0.18	
	Other	0				2.01
Erosion prevention and maintenance of soil fertility economic	Groundskeeper	3	2.67	1.155		
	Facility manager	12	3.08	0.996	0.36	
	Other	4	2.00	1.414	0.47	0.77
Pollination economic	Groundskeeper	0				
	Facility manager	6	2.67	1.033	2.58	
	Other	7	2.86	1.345	2.12	0.14
Biological control economic	Groundskeeper	2	1.00	0.000		
	Facility manager	8	2.13	0.991	1.14	
	Other	2	4.00	0.000		1.89
Pollination ecological	Groundskeeper	20	3.95	0.224		
	Facility manager	17	3.88	0.332	0.20	
	Other	9	3.22	0.833	0.87	0.79
Supporting - Social	Groundskeeper	26	1.558	1.2355		
	Facility manager	26	1.827	1.1484	0.22	
	Other	13	1.385	0.9388	0.14	0.39
Supporting - Cultural	Groundskeeper	26	0.327	0.7063		
	Facility manager	26	0.615	0.8867	0.33	
	Other	13	0.538	0.7489	0.28	0.09
Habitats for species economic	Groundskeeper	2	3.00	0.000		
	Facility manager	5	2.00	1.000	1.00	
	Other	1	1.00			1.00
Habitats for species ecological	Groundskeeper	11	3.91	0.302		
	Facility manager	14	3.93	0.267	0.06	
	Other	2	4.00	0.000	0.30	0.27
Maintenance of genetic diversity economic	Groundskeeper	9	3.67	0.707		
	Facility manager	16	3.06	0.998	0.61	
	Other	10	3.60	0.966	0.07	0.54
Maintenance of genetic diversity ecological	Groundskeeper	17	3.59	0.712		
	Facility manager	16	3.31	0.946	0.29	
	Other	7	2.86	0.690	1.03	0.48
Cultural - Economic	Groundskeeper	26	0.323	0.7044		
	Facility manager	26	0.492	0.7488	0.23	
	Other	13	1.000	0.9557	0.71	0.53
Cultural - Ecological	Groundskeeper	26	1.946	1.0904		
	Facility manager	26	1.692	1.1499	0.22	
	Other	13	1.985	0.9780	0.04	0.25
Cultural - Social	Groundskeeper	26	1.692	1.1555		
	Facility manager	26	1.785	0.9748	0.08	
	Other	13	1.400	0.9381	0.25	0.39

Cultural - Cultural	Groundskeeper	26	0.585	0.7775		
	Facility manager	26	0.746	0.8719	0.19	
	Other	13	0.600	0.6164	0.02	0.17

For each of the different values (economic, ecological, social, cultural) results will be given on the percentage of stakeholders that perceived each of the ESs to have that specific value, what percentage of the stakeholders perceived the specific value to be the most important and whether there are statistically significant differences between the perceptions of the different stakeholders (groundskeeper, facility manager and other).

4.3.3.1 Economic value

The ESs that were perceived to have economic value by most of the stakeholders were the maintenance of genetic diversity (54.29%), food (38.57%), health and well-being (28.57%) and erosion prevention and maintenance of soil fertility (27.14%) (**Figure 4-16**). Freshwater was perceived as the ES with the least economic value (2.86%).

Economic value was perceived to be the most important value for food (17.14%), raw materials (7.14%), medicinal resources (4.29%), erosion prevention and maintenance of soil fertility (10%), maintenance of genetic diversity (34.29%), health and well-being (11.43%), and inspiration for culture, art and design (11.43%) (**Figure 4-17**).

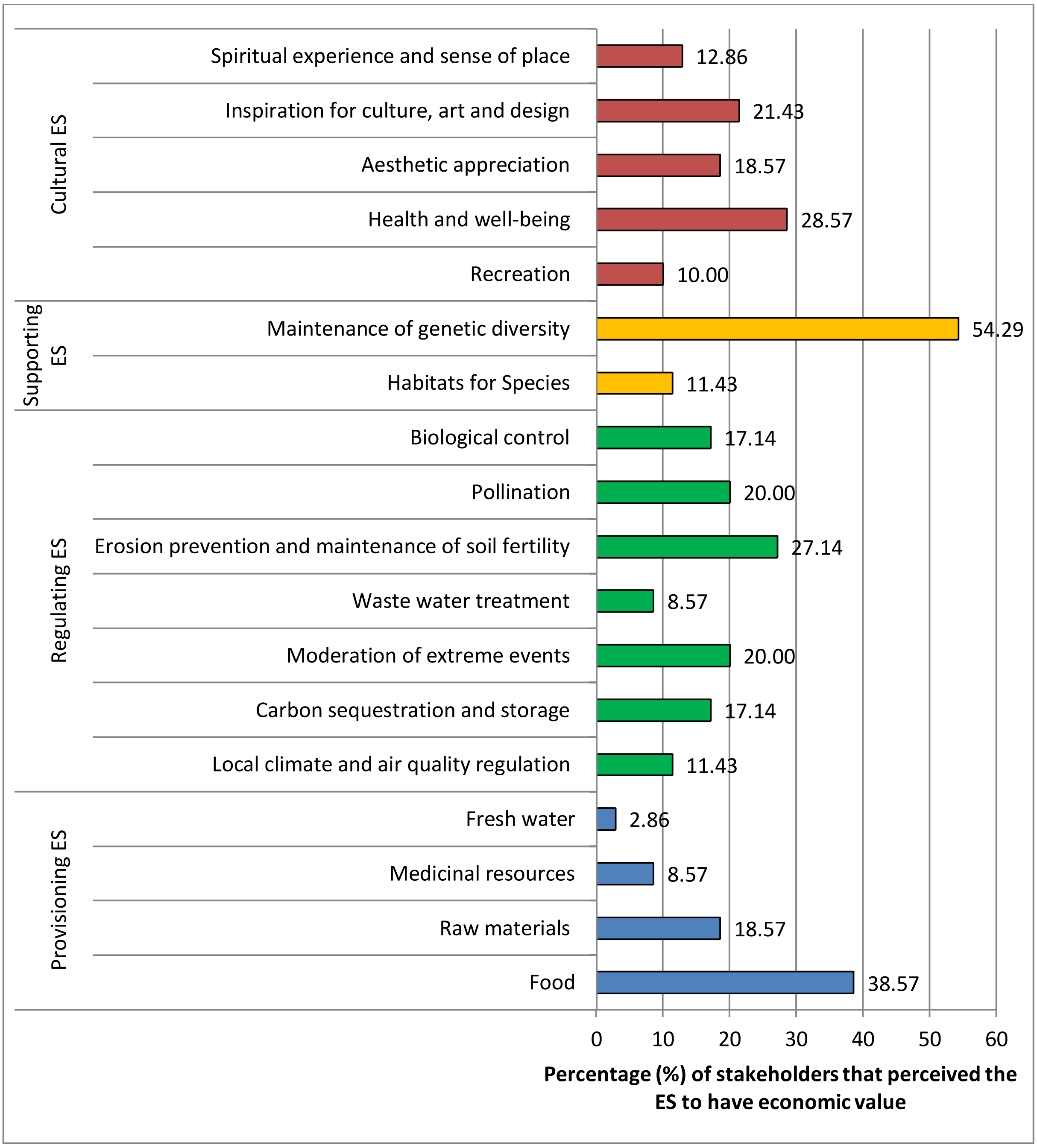


Figure 4-16: The percentage of stakeholders that perceived the ESs at health clinic gardens to have economic value.

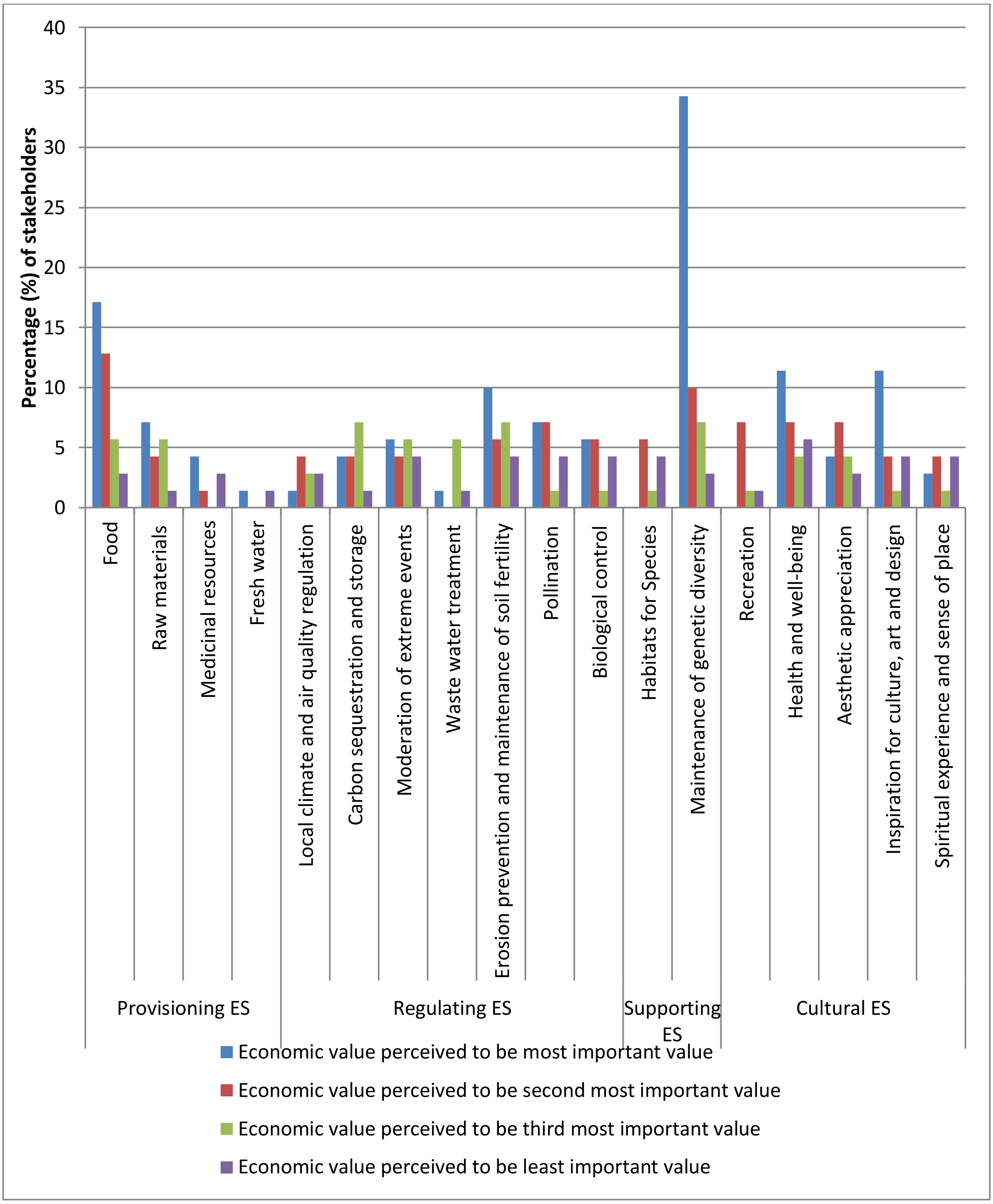


Figure 4-17: The percentage of stakeholders that perceived the economic value of ESs at health clinic gardens to be the most important, second most important, third most important and the least important value.

4.3.3.1.1 Biological control ï economic value

The economic value for biological control had a p-value of 0.021 when comparing the perceptions of different stakeholders (**Table 4-15**). Values were given to rate the importance of the value by the stakeholders. A value of 1 was least important while a value of 4 was most important. Groundskeepers perceived biological control to have economic value, but it was on average the least important value (**Table 4-17**). Facility managers perceived biological control to have an average economic value. Other stakeholders perceived economic value to be the most important value for biological control. The largest statistical differences were thus between groundskeepers and other stakeholders.

Table 4-17: The number of stakeholders that perceived biological control to have an economic value and the average economic value given by each group of stakeholders.

Stakeholders	Number of stakeholders that perceived ES to be present	Average economic value given to ES	
		1	2
Groundskeeper	2	1.00	
Facility manager	8	2.13	2.13
Other	2		4.00

4.3.3.1.2 Economic value of cultural ecosystem services

The cultural ESs had a combined p-value of 0.042 when concerning the economic value given to the ESs by the different stakeholders (**Table 4-15**). A value of 1 was least important while a value of 4 was most important. Groundskeepers and facility managers perceived the cultural ESs to have very low economic value (**Table 4-18**). The other stakeholders perceived the economic value to be the least important value for the cultural ESs. The largest statistical differences were between that of groundskeepers and other stakeholders.

Table 4-18: The number of stakeholders that perceived cultural ES to have an economic value and the average economic value given by each group of stakeholders.

Stakeholders	Number of stakeholders that perceived ESs to be present	Average economic value given to cultural ESs	
		1	2
Groundskeeper	26	0.323	
Facility manager	26	0.492	0.492
Other	13		1.000

4.3.3.2 Ecological value

The ESs that were perceived to have ecological value by most of the stakeholders were erosion prevention and maintenance of soil fertility (81.43%), carbon sequestration and storage (75.71%), health and well-being (74.29), and pollination (68.57%) (**Figure 4-18**). Freshwater was perceived as the ES with the least ecological value (12.86%).

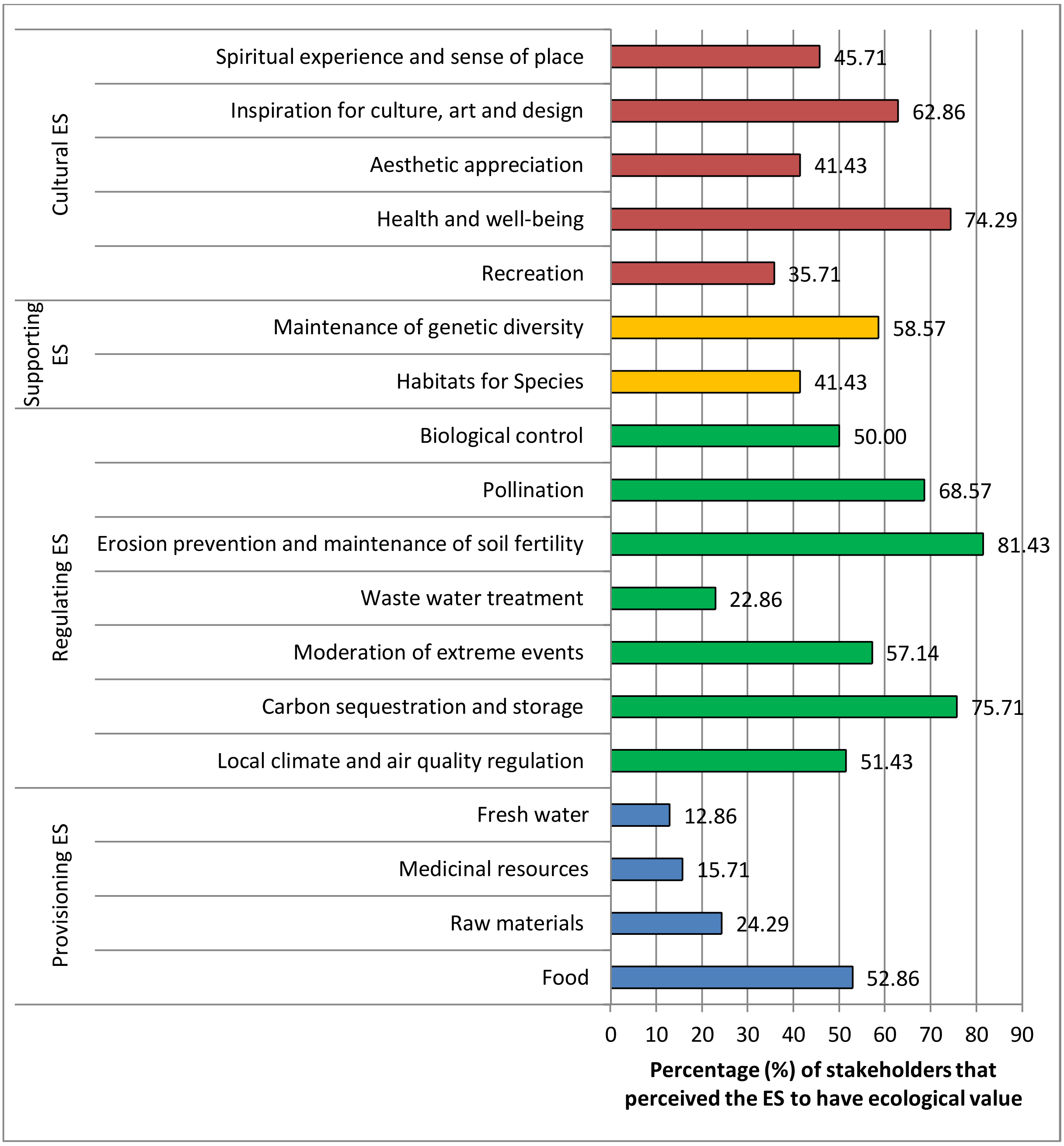


Figure 4-18: The percentage of stakeholders that perceived the ESs at health clinic gardens to have ecological value.

Ecological value was perceived to be the most important value for raw materials (17.4%), medicinal resources (5.71%), freshwater (8.57%), local climate and air quality regulation (32.86%), carbon sequestration and storage (58.57%), moderation of extreme events (40%), wastewater treatment (15.71%), erosion prevention and maintenance of soil fertility (61.43%), pollination (57.14%), biological control (44.29%), habitats for species (37.14%), maintenance of genetic diversity (32.86%), health and well-being (38.57%), aesthetic appreciation (35.71%), inspiration for culture, art and design (34.29%), and spiritual experience and sense of place (24.29%) (**Figure 4-19**).

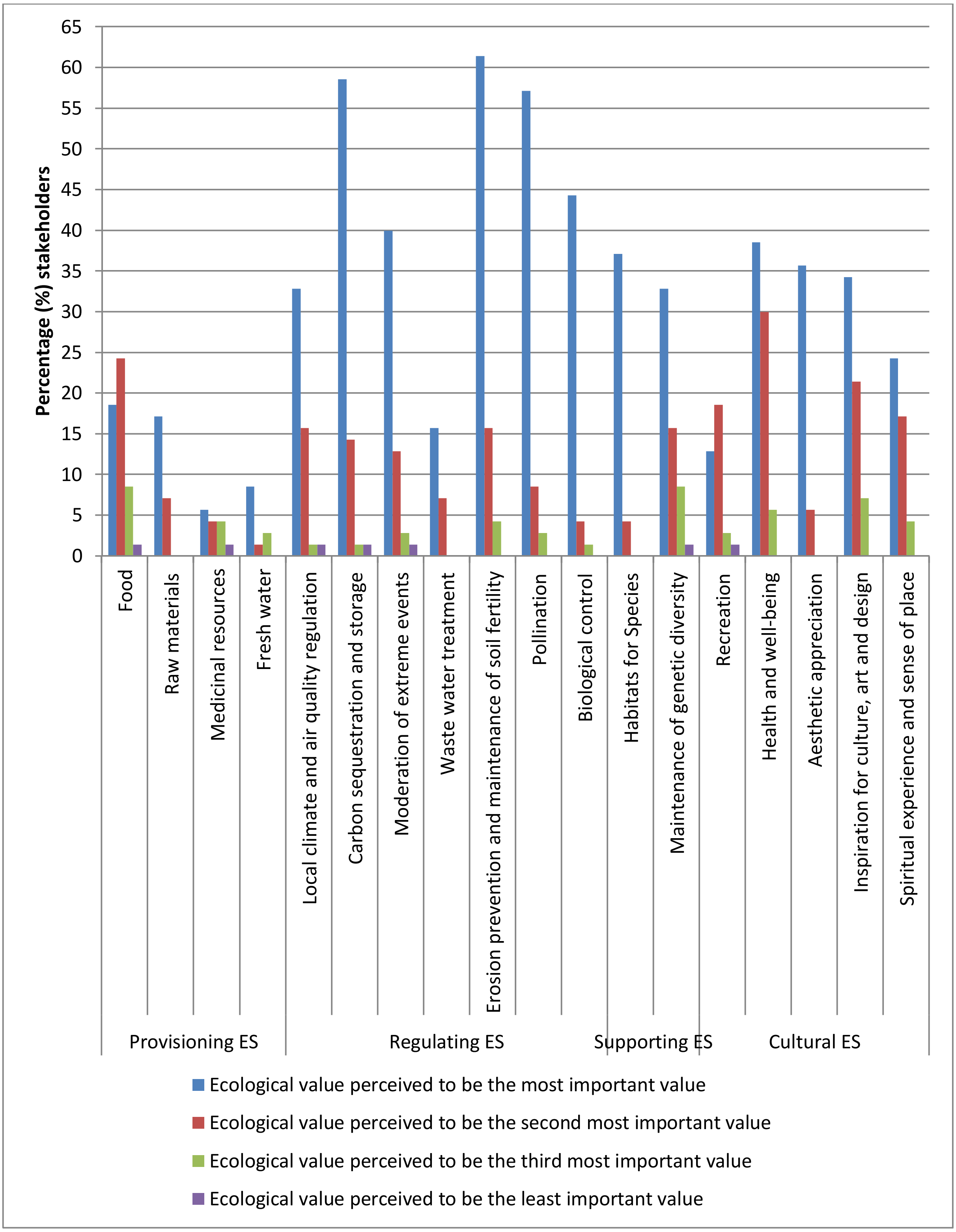


Figure 4-19: The percentage of stakeholders that perceived the ecological value of ESs at health clinic gardens to be the most important, second most important, third most important and the least important value.

4.3.3.2.1 Pollination ï ecological value

The pollination ES had a p-value of 0.000 when concerning the ecological value given to the ESs by the different stakeholders (**Table 4-15**). A value of 1 was least important while a value of 4 was most important. Groundskeepers and facility managers perceived pollination to have a similar value which differs from that as perceived by the other stakeholders (**Table 4-19**).

Table 4-19: The number of stakeholders that perceived pollination to have an ecological value and the average economic value given by each group of stakeholders.

Stakeholders	Number of stakeholders that perceived ES to be present	Average ecological value given to ES	
		1	2
Other	9	3.22	
Facility manager	17		3.88
Groundskeeper	20		3.95

4.3.3.3 Social value

The ESs that were perceived to have social value by most of the stakeholders were carbon sequestration and storage (74.29%), local climate and air quality regulation (72.86%), maintenance of genetic diversity (70%), and health and well-being (67.14%) (**Figure 4-20**). Freshwater was perceived as the ES with the least social value (10%).

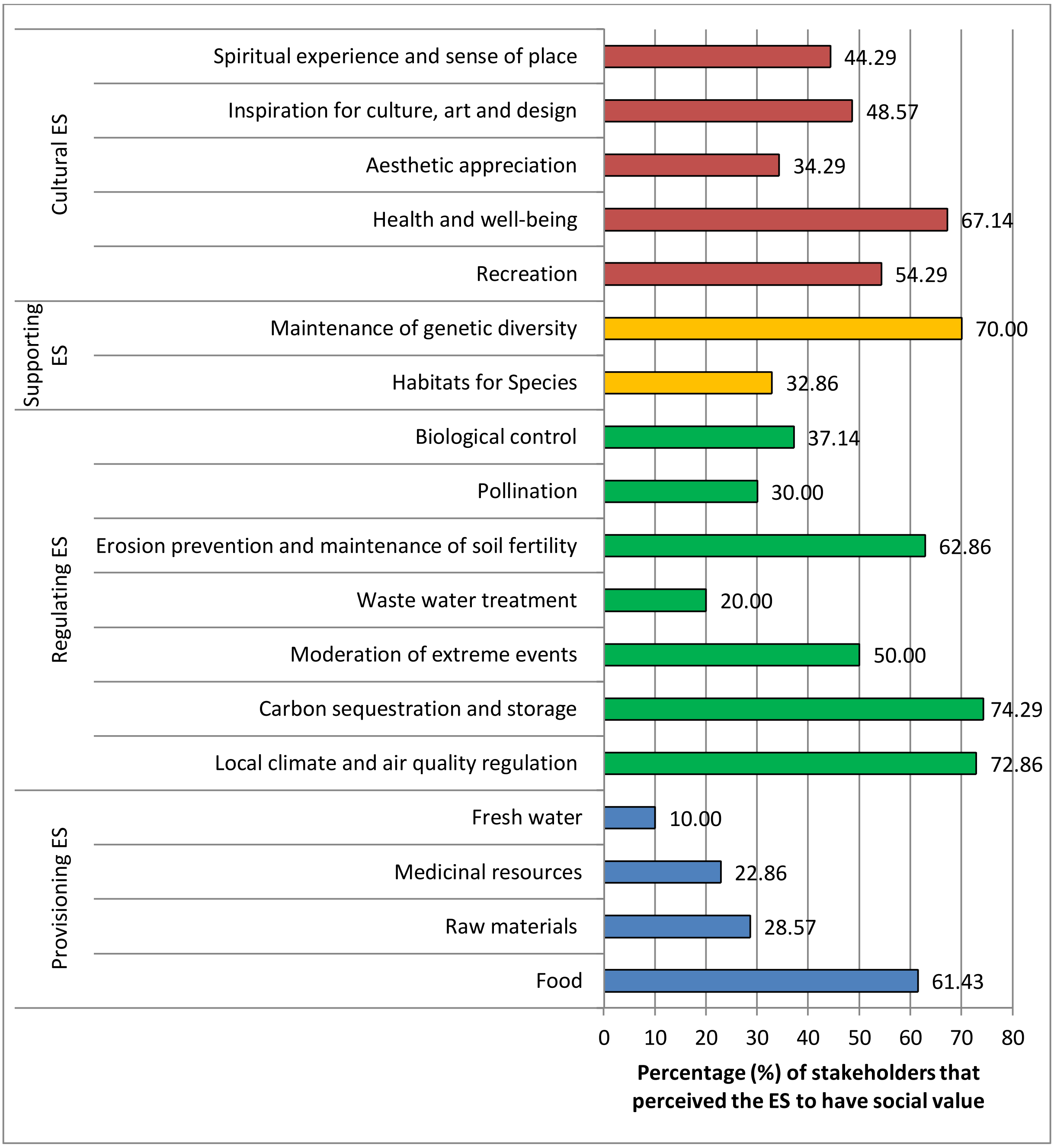


Figure 4-20: The percentage of stakeholders that perceived the ESs at health clinic gardens to have social value.

Social value was perceived to be the most important value for food (30%), medicinal resources (12.86%), local climate and air quality regulation (41.43%), moderation of extreme events (24.29%), recreation (45.71%), health and well-being (37.14%), and spiritual experience and sense of place (25.71%) (**Figure 4-21**).

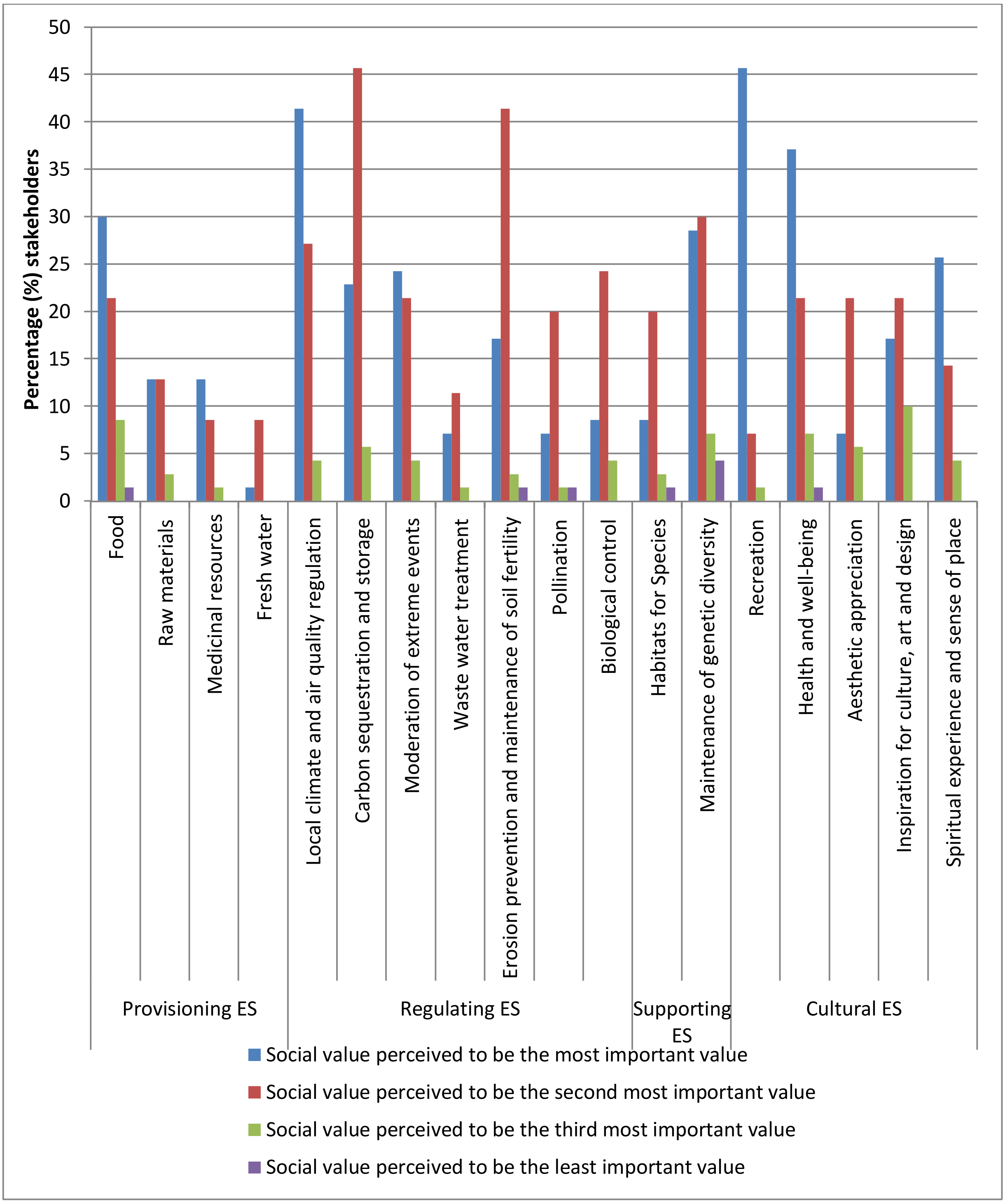


Figure 4-21: The percentage of stakeholders that perceived the social value of ESs at health clinic gardens to be the most important, second most important, third most important and the least important value.

4.3.3.4 Cultural value

The ESs that were perceived to have cultural value by most of the stakeholders were an inspiration for culture, art and design (34.29%), food (31.43%), and health and well-being

(27.14%) (**Figure 4-22**), but with much lower percentages than the other three values. Freshwater was perceived as the ES with the least cultural value (4.29%).

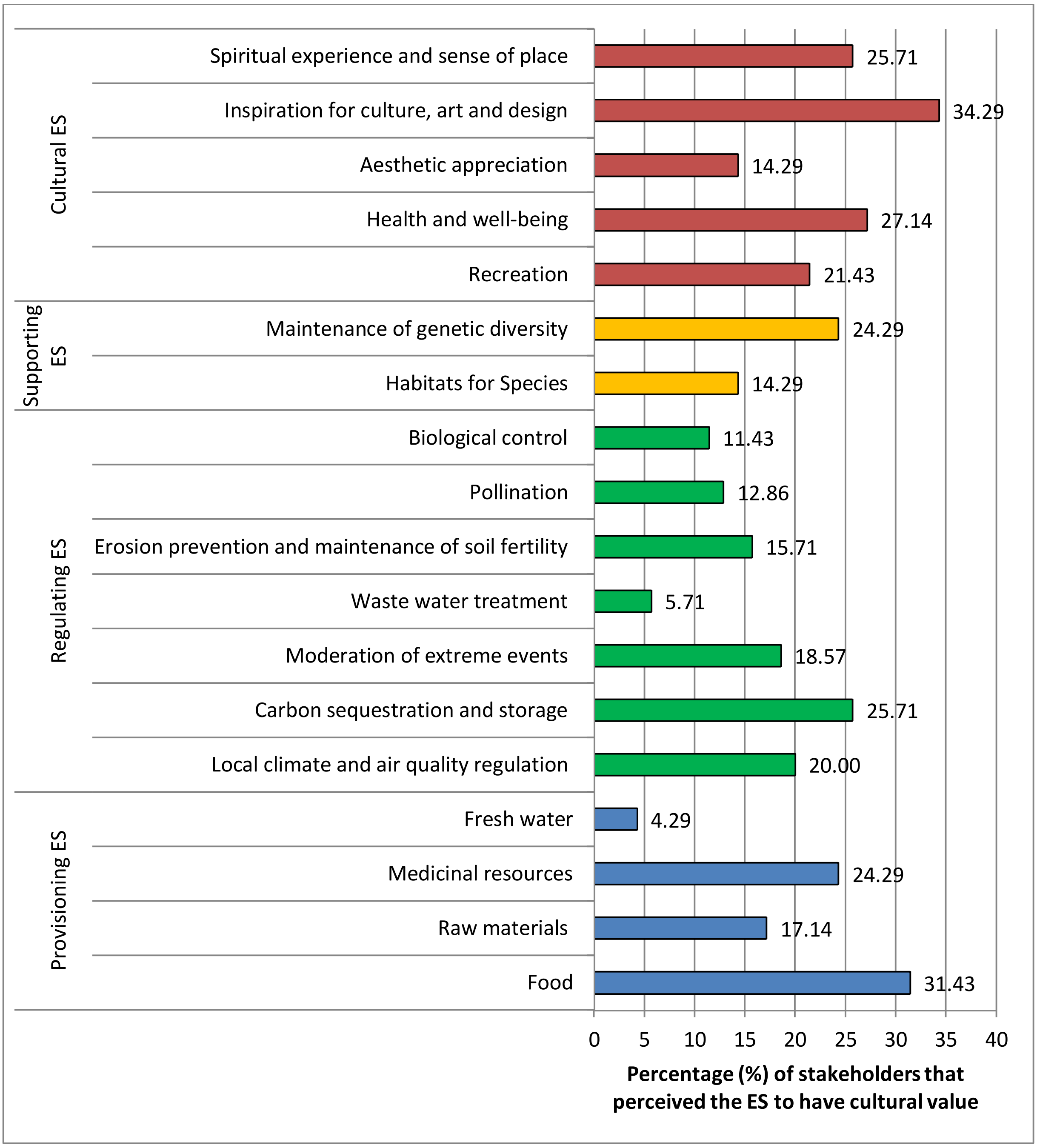


Figure 4-22: The percentage of stakeholders that perceived the ESs at health clinic gardens to have cultural value.

Cultural value was perceived to be the most important value for only medicinal resources (11.43%) and inspiration for culture, art and design (15.71%) (**Figure 4-23**).

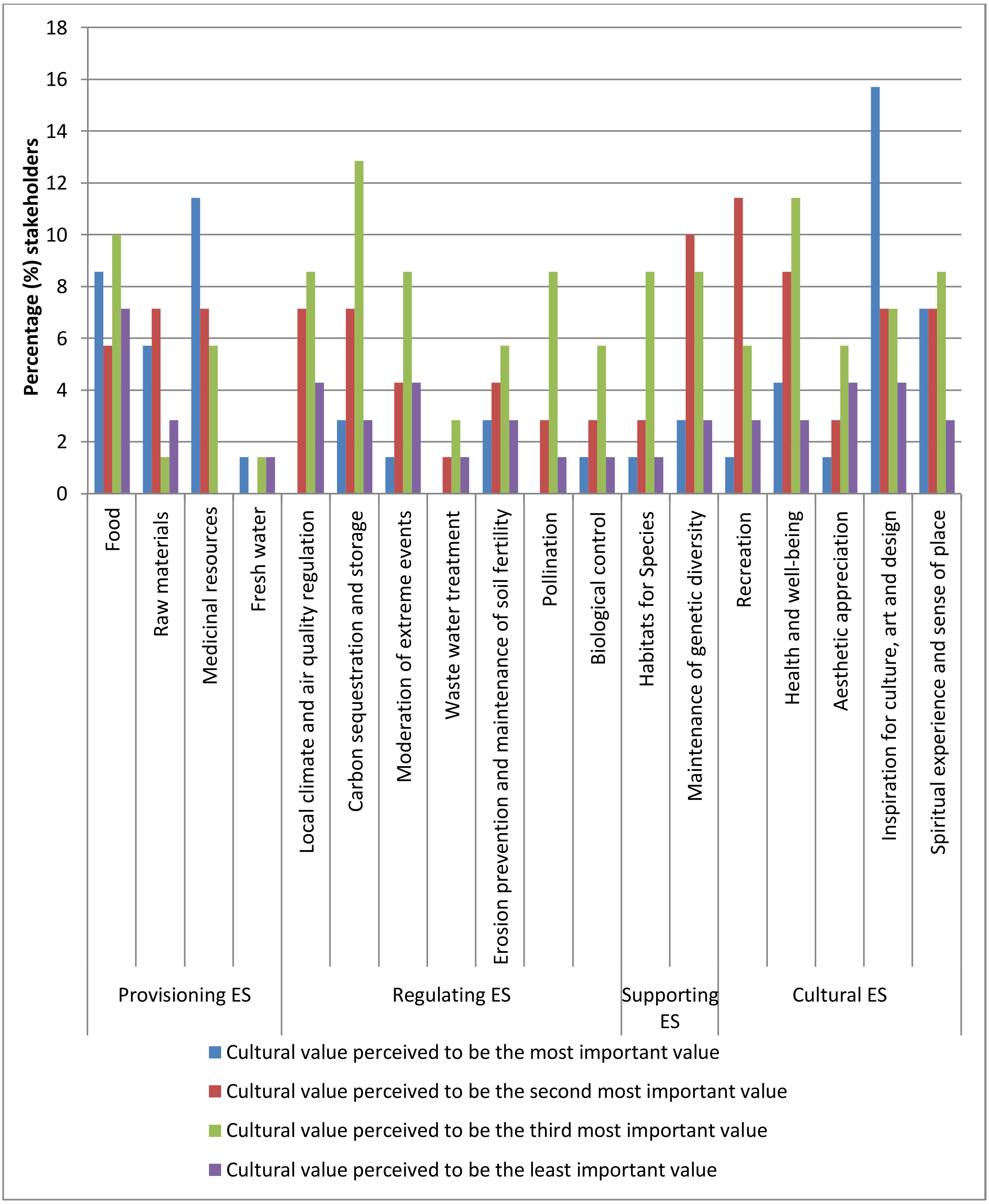


Figure 4-23: The percentage of stakeholders that perceived the cultural value of ESs at health clinic gardens to be the most important, second most important, third most important and the least important value.

4.3.4 Willingness to pay for ecosystem services

When concerning the willingness to pay (WTP) for ESs in the clinic gardens, there were no statistically significant differences found between most of the different sub-districts (**Table 4-**

20). There were only one of the ESs that expressed significantly different effect sizes between the WTP amounts between the sub-districts (p-value<0.05), namely aesthetic appreciation. Only this ES will be discussed in this section.

Table 4-20: The mean, standard deviation and ANOVA p-values for the total of the willingness to pay amounts (rand) for different ESs between the sub-districts. Shaded cells are statistically significant.

Ecosystem services	Sub-district	Mean	Std. Deviation	ANOVA p-value*
Food	Ventersdorp	2000.00		0.000**
	Tlokwe	172.00	137.26	
	Matlosana	366.18	464.76	
	Wolmaransstad-Maquassie Hills	188.13	202.13	
	Phokwane	214.29	170.08	
Raw materials	Ventersdorp	75.00		0.900
	Tlokwe	208.33	118.15	
	Matlosana	188.18	101.67	
	Wolmaransstad-Maquassie Hills	187.00	95.37	
	Phokwane	178.33	153.03	
Freshwater	Ventersdorp	55.00	63.64	0.494
	Tlokwe	500.00		
	Matlosana	300.00		
	Wolmaransstad-Maquassie Hills			
	Phokwane	300.00	282.84	
Medicinal resources	Ventersdorp	500.00		0.161
	Tlokwe	126.25	153.15	
	Matlosana	112.50	58.63	
	Wolmaransstad-Maquassie Hills	150.00	122.47	
	Phokwane	184.00	184.47	
Local climate and air quality regulation	Ventersdorp			0.435
	Tlokwe	154.00	194.50	
	Matlosana	120.71	109.18	
	Wolmaransstad-Maquassie Hills	175.00	114.56	
	Phokwane	280.00	213.89	
Carbon sequestration and storage	Ventersdorp	175.00	176.78	0.677
	Tlokwe	180.00	136.38	
	Matlosana	180.36	145.83	
	Wolmaransstad-Maquassie Hills	225.00	146.39	
	Phokwane	385.56	625.00	
Moderation of extreme events	Ventersdorp			0.788
	Tlokwe	153.33	95.04	
	Matlosana	228.67	191.41	
	Wolmaransstad-Maquassie Hills	246.43	164.84	
	Phokwane	296.67	319.34	

Wastewater treatment	Ventersdorp	300.00		0.911
	Tlokwe	45.00		
	Matlosana	212.50	122.22	
	Wolmaransstad-Maquassie Hills	400.00		
	Phokwane	300.00	467.26	
Erosion prevention and maintenance of soil fertility	Ventersdorp	60.00	56.57	0.320
	Tlokwe	150.71	54.80	
	Matlosana	229.50	186.30	
	Wolmaransstad-Maquassie Hills	227.78	156.35	
	Phokwane	1433.75	3465.71	
Pollination	Ventersdorp	125.00	106.07	0.060
	Tlokwe	70.00	52.32	
	Matlosana	199.67	121.90	
	Wolmaransstad-Maquassie Hills	166.88	127.31	
	Phokwane	374.29	331.61	
Biological control	Ventersdorp	500.00		0.634
	Tlokwe	52.50	67.18	
	Matlosana	212.86	246.58	
	Wolmaransstad-Maquassie Hills	179.17	140.01	
	Phokwane	266.25	324.78	
Habitats for species	Ventersdorp	200.00		0.542
	Tlokwe	33.33	24.66	
	Matlosana	145.00	161.69	
	Wolmaransstad-Maquassie Hills	254.00	200.20	
	Phokwane	490.00	762.97	
Maintenance of genetic diversity	Ventersdorp	500.00	458.26	0.104
	Tlokwe	132.50	142.11	
	Matlosana	274.07	211.86	
	Wolmaransstad-Maquassie Hills	250.91	173.74	
	Phokwane	245.50	180.72	
Recreation	Ventersdorp	50.00		0.802
	Tlokwe	95.00	49.24	
	Matlosana	160.00	185.54	
	Wolmaransstad-Maquassie Hills	222.50	183.95	
	Phokwane	162.86	168.62	
Health and well-being	Ventersdorp	100.00	86.60	0.319
	Tlokwe	82.50	53.77	
	Matlosana	266.39	203.45	
	Wolmaransstad-Maquassie Hills	227.78	158.33	
	Phokwane	219.00	194.12	
Aesthetic appreciation	Ventersdorp	1173.33	1600.04	0.057
	Tlokwe	140.00	116.83	
	Matlosana	246.15	170.12	
	Wolmaransstad-Maquassie Hills	230.00	169.71	
	Phokwane	385.00	356.58	

Inspiration for culture, art and design	Ventersdorp	86.67	70.95	0.343
	Tlokwe	60.00	62.18	
	Matlosana	245.38	212.23	
	Wolmaransstad-Maquassie Hills	205.56	160.46	
	Phokwane	182.22	172.27	
Spiritual experience and sense of place	Ventersdorp	20.00	21.21	0.429
	Tlokwe	27.50	10.61	
	Matlosana	472.00	558.53	
	Wolmaransstad-Maquassie Hills	230.00	204.94	
	Phokwane	236.67	227.54	

*Since there was no statistical significance there was no distinction made between the averages of the different sub-districts.

**The Ventersdorp sub-district only had one stakeholder that was willing to pay statistically significantly more for the food produced in the clinic garden than the other sub-districts, but because there was only one stakeholder no further attention can be given to the food willingness to pay amount.

The average WTP amount for aesthetic appreciation differed significantly between most of the sub-districts (**Table 4-21**). When concerning the average amount stakeholders of each sub-district were willing to pay for aesthetic appreciation, the Ventersdorp sub-district was significantly different from the other sub-districts (**Table 4-22**).

Table 4-21: The effect size of the willingness to pay for aesthetic appreciation for the different sub-districts.

	N	Mean	Std. Deviation	Effect size			
				Wolmaransstad	Ventersdorp	Tlokwe	Matlosana
Ventersdorp	3	1173.33	1600.04	0.59			
Tlokwe	4	140.00	116.83	0.53	0.65		
Matlosana	13	246.15	170.12	0.09	0.58	0.62	
Wolmaransstad	6	230.00	169.71		0.59	0.53	0.09
Phokwane	6	385.00	356.58	0.43	0.49	0.69	0.43
Total	32	342.81	530.69				

Table 4-22: The number of stakeholders that was willing to pay for aesthetic appreciation and the average amount (rand) stakeholders were willing to pay for this ES.

Sub-district	Number of stakeholders WTP for aesthetic appreciation	Average amount stakeholders were willing to pay for aesthetic appreciation	
Tlokwe	4	R 140.00	
Wolmaransstad-Maquassie	6	R 230.00	
Matlosana	13	R 246.15	
Phokwane	6	R 385.00	
Ventersdorp	3		R 1 173.33

Willingness to pay for health and well-being by the different stakeholder had a p-value of 0.048 (**Table 4-23**). Facility managers and groundskeepers were willing to pay similar amounts (R 189.38 and R 195.63 respectively) for health and well-being, while other stakeholders were willing to pay more (R 361.11) for health and well-being (**Table 4-24**).

Table 4-23: The ANOVA p-values for the total willingness to pay for different ESs by different stakeholders. Shaded cells are statistically significant.

Ecosystem service	ANOVA p-value*
Food	0.179
Raw materials	0.148
Freshwater	0.527
Medicinal resources	0.606
Local climate and air quality regulation	0.205
Carbon sequestration and storage	0.581
Moderation of extreme events	0.079
Wastewater treatment	0.770
Erosion prevention and maintenance of soil fertility	0.591
Pollination	0.571
Biological control	0.350
Habitats for species	0.445
Maintenance of genetic diversity	0.125
Recreation	0.479
Health and well-being	0.048
Aesthetic appreciation	0.430
Inspiration for culture, art and design	0.238
Spiritual experience and sense of place	0.394

*Since there was no statistical significance there was no distinction made between the averages of the different stakeholders.

Table 4-24: The number of different stakeholders willing to pay for health and well-being and the average amount (rand) they were willing to pay for health and well-being.

Stakeholders	Number of stakeholders willing to pay for ES	Average amount stakeholders were willing to pay for ES	
		1	2
Facility manager	16	R 189.38	
Groundskeeper	16	R 195.63	
Other	9		R 361.11

For most ESs there were no significant effect sizes between the WTP perceptions of different stakeholders (**Table 4-25**). There were three ESs were the differences in perceptions on the value between the groundskeepers and facility managers were statistically significant. There were four ESs were the perceptions of the other stakeholders differ statistically from the groundskeepers and facility managers. It is important to note that for some ESs there were very few stakeholders that answered the questions concerning willingness to pay for ESs, and these may therefore not be statistically significant even if they had high effect sizes. For example, for freshwater, only one other stakeholder and one facility manager were willing to pay for this ES.

Table 4-25: The mean, standard deviation and significant effect sizes of ESs as perceived by different stakeholders. Shaded cells are statistically significant.

		N	Mean	Std. Deviation	Effect size	
					Grounds keeper	Facility manager
Food	Groundskeeper	14	361.07	508.876		
	Facility manager	16	133.75	120.989	0.45	
	Other	9	261.67	190.821	0.20	0.67
Raw materials	Groundskeeper	9	225.00	101.550		
	Facility manager	8	122.50	75.309	1.01	
	Other	7	195.71	135.260	0.22	0.54
Freshwater	Groundskeeper	3	366.67	230.940		
	Facility manager	1	300.00		0.29	
	Other	1	10.00		1.54	
Medicinal resources	Groundskeeper	9	145.00	145.731		
	Facility manager	5	149.00	122.495	0.03	
	Other	2	250.00	70.711	0.72	0.82
Local climate and air quality regulation	Groundskeeper	8	105.63	85.584		
	Facility manager	8	252.50	222.116	0.66	
	Other	4	168.75	94.373	0.67	0.38
Carbon sequestration and storage	Groundskeeper	11	154.09	113.948		
	Facility manager	16	293.44	480.856	0.29	
	Other	7	271.43	152.362	0.77	0.05
Moderation of extreme events	Groundskeeper	15	204.67	160.829		
	Facility manager	11	215.00	294.185	0.04	

	Other	6	433.33	108.012	1.42	0.74
Wastewater treatment	Groundskeeper	5	194.00	167.310		
	Facility manager	6	308.33	351.307	0.33	
	Other	1	350.00		0.93	0.12
Erosion prevention and maintenance of soil fertility	Groundskeeper	15	203.33	134.611		
	Facility manager	19	700.79	2257.523	0.22	
	Other	10	277.00	201.552	0.37	0.19
Pollination	Groundskeeper	18	181.11	130.683		
	Facility manager	11	258.18	303.992	0.25	
	Other	7	185.71	98.802	0.04	0.24
Biological control	Groundskeeper	9	322.22	285.166		
	Facility manager	13	172.69	261.706	0.52	
	Other	6	180.83	86.627	0.50	0.03
Habitats for species	Groundskeeper	10	146.50	116.811		
	Facility manager	10	386.50	606.250	0.40	
	Other	2	160.00	197.990	0.07	0.37
Maintenance of genetic diversity	Groundskeeper	24	202.50	142.432		
	Facility manager	21	232.86	192.449	0.16	
	Other	11	342.73	253.144	0.55	0.43
Recreation	Groundskeeper	11	168.64	160.314		
	Facility manager	10	149.00	176.648	0.11	
	Other	3	283.33	152.753	0.72	0.76
Health and well-being	Groundskeeper	16	195.63	127.435		
	Facility manager	16	189.38	169.989	0.04	
	Other	9	361.11	244.665	0.68	0.70
Aesthetic appreciation	Groundskeeper	11	241.82	180.586		
	Facility manager	12	520.83	821.434	0.34	
	Other	5	224.00	231.582	0.08	0.36
Inspiration for culture, art and design	Groundskeeper	14	234.64	207.869		
	Facility manager	15	138.67	138.441	0.46	
	Other	6	260.00	188.149	0.12	0.64
Spiritual experience and sense of place	Groundskeeper	9	288.33	489.738		
	Facility manager	9	192.78	180.885	0.20	
	Other	6	492.50	517.144	0.39	0.58

4.3.5 Ecosystem disservices (EDSs)

When concerning the perceived presence of the EDSs in the clinic gardens, there were no statistically significant differences found between the different sub-districts (**Table 4-26**) or between the different stakeholders (**Table 4-27**).

Table 4-26: The mean, standard deviation and ANOVA's for the total of the presence of different EDSs between sub-districts.

Ecosystem disservices	Sub-districts	Mean	Std. Deviation	ANOVA p-value*
Allergies	Ventersdorp	1.00	1.15	0.132
	Tlokwe	0.31	0.75	
	Matlosana	1.11	1.20	
	Wolmaransstad-Maquassie Hills	0.43	0.85	
	Phokwane	0.73	1.01	
Pests	Ventersdorp	2.50	0.58	0.066
	Tlokwe	1.46	1.27	
	Matlosana	2.21	0.99	
	Wolmaransstad-Maquassie Hills	1.21	1.48	
	Phokwane	1.82	1.25	
Accidents	Ventersdorp	0.00	0.00	0.428
	Tlokwe	1.00	1.15	
	Matlosana	0.64	1.16	
	Wolmaransstad-Maquassie Hills	1.00	1.41	
	Phokwane	1.18	1.40	
Damage to buildings or other structures	Ventersdorp	0.75	0.96	0.687
	Tlokwe	1.46	1.27	
	Matlosana	1.18	1.33	
	Wolmaransstad-Maquassie Hills	0.93	1.33	
	Phokwane	1.55	1.51	
Fear and stress	Ventersdorp	2.00	1.41	0.816
	Tlokwe	1.15	1.14	
	Matlosana	1.43	1.32	
	Wolmaransstad-Maquassie Hills	1.21	1.31	
	Phokwane	1.36	1.36	
Blockage of view	Ventersdorp	0.75	1.50	0.221
	Tlokwe	0.00	0.00	
	Matlosana	0.36	0.91	
	Wolmaransstad-Maquassie Hills	0.00	0.00	
	Phokwane	0.18	0.60	

*Since there was no statistical significance there is no distinction made between the averages of the different sub-districts.

Table 4-27: The ANOVA p-values for the total presence of different EDSs as perceived by different stakeholders.

Ecosystem disservices	ANOVA p-value*
Allergies	0.086
Pests	0.181
Accidents	0.738
Damage to buildings or other structures	0.082
Fear and stress	0.125
Blockage of view	0.285

*Since there was no statistical significance there is no distinction made between the averages of the different stakeholders.

For most EDSs there were no significant effect sizes between the WTP perceptions of different stakeholders (**Table 4-28**). When concerning the significant effect sizes, in most cases it was the other stakeholders that differ from the groundskeepers and/or facility managers.

Table 4-28: The mean, standard deviation and significant effect sizes of EDSs as perceived by different stakeholders. Shaded cells are statistically significant.

		N	Mean	Std. Deviation	Effect size	
					Grounds keeper	**Facility manager**
Allergies	Groundskeeper	26	0.46	0.989		
	Facility manager	26	0.88	0.993	0.43	
	Other	13	1.23	1.235	0.62	0.28
Pests	Groundskeeper	26	1.81	1.386		
	Facility manager	26	1.46	1.140	0.25	
	Other	13	2.23	1.013	0.31	0.68
Accidents	Groundskeeper	26	1.04	1.371		
	Facility manager	26	0.77	1.107	0.20	
	Other	13	0.85	1.345	0.14	0.06
Damage to buildings or other structures	Groundskeeper	26	1.69	1.350		
	Facility manager	26	1.00	1.233	0.51	
	Other	13	0.85	1.345	0.63	0.11
Fear and stress	Groundskeeper	26	1.50	1.364		
	Facility manager	26	0.92	1.129	0.42	
	Other	13	1.69	1.251	0.14	0.62
Blockage of view	Groundskeeper	26	0.19	0.694		
	Facility manager	26	0.08	0.392	0.17	
	Other	13	0.46	1.127	0.24	0.34

The Matlosana sub-district had the highest percentage of stakeholders that perceived allergies (32.86%), accidents (18.57%) and damage to buildings or other structures (22.86%) to be present in the health clinic gardens (**Figure 4-24**). Allergies, pests, damage to buildings or other structures and fear and stress were the only EDSs that were perceived to be present at all the sub-districts. Blockage of view was the least perceived to be present in the health clinic gardens in the different sub-districts.

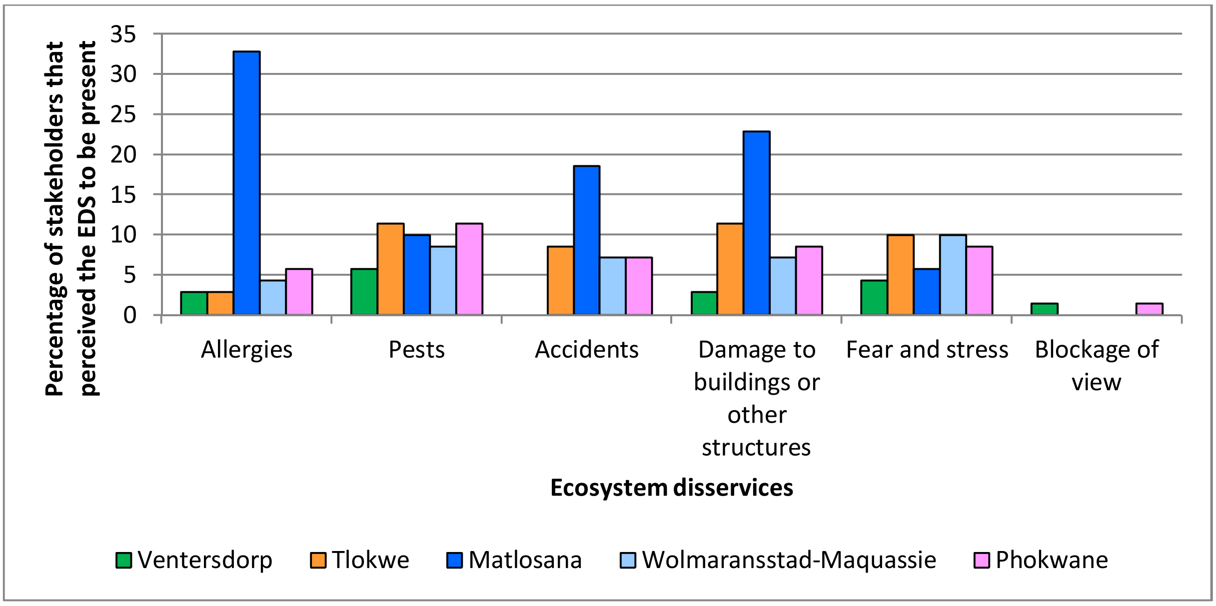


Figure 4-24: The percentage of stakeholders in each sub-district that perceived the EDSs to be present in the health clinic garden.

Allergies, accidents, damage to buildings or other structures, fear and stress and blockage of view were perceived by most stakeholders not to be a problem (**Figure 4-25**). Pests, however, were perceived by most stakeholders to be an abundant (big) problem (40%). **Table 4-29** indicates the average presence value as perceived by the different sub-districts.

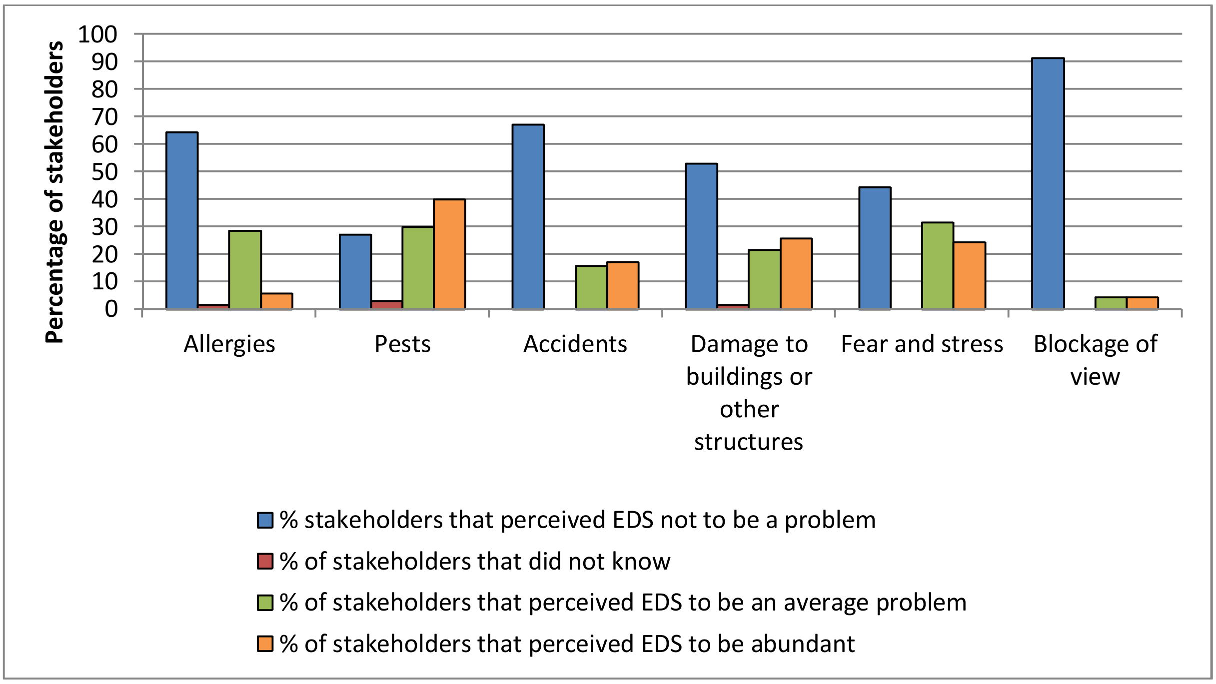


Figure 4-25: The percentage of stakeholders that perceived the EDSs not to be a problem, that did not know, to be a small or average problem, or to be abundant in the health clinic garden.

EDSs were stated by the stakeholders as either being absent, average or abundant; there was also an option of “don’t know” if the stakeholders did not know anything about a specific EDS (**Table 4-4**). The average presence values given by all the interviewed stakeholders for EDSs can be seen in **Table 4-29**. The EDSs perceived to be the most present was pests followed by fear and stress both in the Ventersdorp sub-district.

Table 4-29: The number of interviewed stakeholders that perceived the different EDSs to be present in the health clinic gardens, and the average presence value given to each EDS.

Sub-districts	Number of stakeholders that perceived EDSs to be present	Average presence value
Allergies		
Tlokwe	13	0.31
Wolmaransstad-Maquassie Hills	14	0.43
Phokwane	11	0.73
Ventersdorp	4	1.00
Matlosana	28	1.11
Pests		
Wolmaransstad-Maquassie Hills	14	1.21
Tlokwe	13	1.46
Phokwane	11	1.82
Matlosana	28	2.21
Ventersdorp	4	2.50
Accidents		
Ventersdorp	4	0.00
Matlosana	28	0.64
Tlokwe	13	1.00
Wolmaransstad-Maquassie Hills	14	1.00
Phokwane	11	1.18
Damage to buildings or other structures		
Ventersdorp	4	0.75
Wolmaransstad-Maquassie Hills	14	0.93
Matlosana	28	1.18
Tlokwe	13	1.46
Phokwane	11	1.55
Fear and stress		
Tlokwe	13	1.15
Wolmaransstad-Maquassie Hills	14	1.21
Phokwane	11	1.36
Matlosana	28	1.43
Ventersdorp	4	2.00
Blockage of view		
Tlokwe	13	0.00
Wolmaransstad-Maquassie Hills	14	0.00
Phokwane	11	0.18
Matlosana	28	0.36
Ventersdorp	4	0.75

4.4 Discussion

4.4.1 Demographics

With all the demographic questions there were significant differences between the answers given by the participants, indicated by the Cramerøs V values. These differences could be explained by the fact that different demographic groups use and perceive green spaces differently (Wilkerson *et al*., 2018).

4.4.1.1 Occupational role

All the sub-districts had facility managers and groundskeepers. These two occupational roles were intentionally selected at each health clinic as they have a direct role in the management and maintenance of the clinic gardens in other district municipalities in South Africa (Cornelius, 2016; Cilliers *et al*., 2018). Facility managers were not necessarily physically involved with gardening, but play an important role in managing the garden, providing equipment and other resources (Cornelius, 2016). Community Work Programme (CWP) workers who were part of the óotherô stakeholder group were not appointed to all clinics and only work where it is necessary (Hambisana, 2018). These workers could, however, be of great importance as they engage with the clinic personnel and with the community, potentially being a link to transfer knowledge between clinic and community (Cornelius, 2016).

Only a few volunteers (part of the óotherô stakeholder group) were present in the Matlosana and Phokwane sub-districts. It could be that volunteers were not benefitting from working in the clinic gardens. Community Health Workers (CHWs), clinic committee members and cleaners (part of the óotherô stakeholder group) were generally appointed at the clinics and received a salary or stipend; therefore, it could be that these stakeholders feel that it was their duty to work in the clinic gardens.

Groundskeepers were among the most involved at the health clinic gardens. Their involvement may contribute to indigenous knowledge as they were members of the community that gain gardening knowledge from older community members or through experience by working in the gardens (Cilliers *et al*., 2018). This knowledge can then, in turn, be communicated to the community (Cilliers *et al*., 2018).

Facility managers were involved in the garden mainly in a supervisory role. Some of these facility managers may, however, be passionate about establishing and maintaining the gardens, especially the vegetable gardens, and could, therefore, become “champions” in building the resilience of the clinic gardens (Cilliers *et al*., 2018).

A lack of involvement of different stakeholders in the health clinic gardens may, however, be a limiting factor regarding the provisioning of different ESs and the co-production of knowledge (Cilliers *et al*., 2018). Therefore Cilliers *et al*. (2018) recommend that there should be a high variety of different stakeholders present at each clinic with partnerships formed between clinics and the Department of Agriculture and with local universities.

4.4.1.2 Age

Although the average age of interviewed stakeholders was the highest at the Phokwane local municipality other age groups were also well represented such as 31.3% are 0-14 years old, 30.8% are 15-34 years old, 29.2% are 35-64 years old, and 8.6% are 65+ years old (STATS SA, 2018b), indicating that people from the lower age groups are also working at the clinics. The Frances Baard District Municipality, however, had a high proportion of persons older than 65 years when compared to the other District Municipalities (STATS SA, 2018b). In a study conducted by Dunnett and Qasim (2000) in urban gardens in England, it was determined that younger adults were less involved in gardening than older people. People under the age of 35 generally spent only one hour a week gardening, people between 35 and 45 years of age generally spent two to four hours a week gardening, and people over the age of 55 generally spent 5 hours gardening (Dunnett & Qasim, 2000).

The Wolmaransstad-Maquassie Hills municipality where the average age of the interviewed stakeholders was much lower, it could be that they appointed younger people to create job opportunities for the youth. Fransson and Gärling (1999) state, when concerning age, younger people are generally more concerned about environmental decline than older people. Van Liere and Dunlap (1980) stated that a possible reason for this could be that younger people are less integrated in the existing social order. According to Fransson & Gärling (1999), this existing social order is often threatened by solutions to environmental problems, and therefore it is logical to expect that younger people support actions against environmental decline more often than older people.

Groundskeepers were in general younger than facility managers and had to do more physical work. The facility manager position was the highest position at the clinics, and therefore only senior personnel will be able to fulfil this role.

Age did not seem to be a good indicator of participation in gardening practices as there was evidence that both younger and older people engage in gardening practices. If age was accompanied by other factors, such as gender and knowledge, it is likely to influence participation in gardening at the health clinic gardens.

4.4.1.3 Gender

Women, more than men, regard having enough food to eat as an important motivation for gardening (McClintock *et al*., 2016). When purchasing vegetables, women also view eating healthy and affordability as important considerations (McClintock *et al*., 2016). Historically and currently the collection of leafy vegetables is mainly associated with women (Jansen van Rensburg *et al*., 2007). Vaske *et al*. (2001) stated that females are more environmentally oriented than males, especially when the focus is on local natural resource issues. Females are also more involved in urban agricultural practices (Magidimisha *et al*., 2016).

The reason why only in some of the sub-districts more females than males were interviewed was difficult to explain, but the general dominance of different gender groups in different age groups could play a role.

For the entire Northern Cape Province, there are more males than females for the age group 15-49 years and are more females than males for the age group 50-64 years there (STATS SA, 2018b). As most of the stakeholders were around the age of 50 years in the Phokwane sub-district, more stakeholders were women than men.

For the North West Province, there were more males than females for the age group 15-59 years and more females than males for the age group 60-64 years (STATS SA, 2018a). For the Ventersdorp, Tlokwe, and Wolmaransstad-Maquassie Hills sub-districts there were indeed more males than females interviewed. The average age of stakeholders in the Matlosana sub-district was higher than three of the other sub-districts which could explain the higher percentage of females interviewed in this sub-district.

4.4.1.4 Home language

The most abundant home language of interviewed stakeholders was Setswana as it is one of the main languages spoken in the North West and Northern Cape Provinces (STATS SA, 2018). In the North West Province Setswana is the home language of 71.5% of the population in this province, followed by Afrikaans which is the home language of 7.2% of the population in this province (STATS SA, 2018a).

Afrikaans was spoken the most in the Northern Cape (Phokwane sub-district); it is the home language of 56.8% of the population in this province, followed by Setswana which is spoken as a home language by 33.4% of the population in this province (STATS SA, 2018b).

Matlosana sub-district had the largest variety of home languages; this could be because sub-district covers a larger surface area than most of the other sub-districts. In a study conducted by Von Stapelberg (2006) the same five home languages were recorded, with the addition of English, for managers at the Matlosana Municipality. For the recipients of services, it differed somewhat as the similar home languages are Afrikaans, Sesotho, Setswana and isiXhosa (Von Stapelberg, 2006). For both these groups, Afrikaans was, however, the most spoken home language. It could also be because of the gold mines in the area which attracts different ethnic groups, as the economies of the local municipalities in the Dr Kenneth Kaunda District Municipality are mainly dependent on gold mining (Kleynhans, 2012).

4.4.1.5 Highest level of education

According to Ostman and Parker (1987), education is often used as a predictor of environmental knowledge and behaviour. While studying the relationship between education and environmental knowledge, Ostman and Parker (1987) found remarkable correlations between education and environmental awareness, environmental knowledge, and following behaviours.

Most stakeholders had completed school and, therefore, had a matric certificate. Thirty per cent of the stakeholders had not completed school, while 42.9% had received tertiary education. Many members of rural communities do not have the opportunity to finish school (HSRC & EPC, 2005). While others finish school but do not have the opportunity to obtain any tertiary qualifications (HSRC & EPC, 2005). The facility members were mostly trained nurses and therefore had received tertiary education. Groundskeepers do not necessarily require any tertiary education to be appointed for the position.

The highest percentage of stakeholders interviewed in the Phokwane sub-district was facility managers. It was also the only sub-district where the highest percentage of stakeholders was facility managers. Most of the facility managers had a university degree; therefore, this could explain the high percentage of interviewed stakeholders that had a university degree in the Phokwane sub-district.

4.4.1.6 Religion

Most people need to feel part of a spiritual entity, especially Africans are said to be religious in all things (Oladipo, 2004); therefore, most stakeholders belong to a church. Most people in the North West Province have a religious affiliation for Christianity (92.2%) followed by no religious affiliation or belief (5.1%), which was similar in the Northern Cape Province where 95.8% are Christian, and 1.7% has no religious affiliation or belief (STATS SA, 2018b).

White (1967) hypothesised that Christian beliefs are centred on the fact that humans have supremacy over nature, meaning nature is something to be dominated, conquered and subdued by humans, according to Genesis 1 in the Bible. White (1967) further stated that this Judeo-Christian belief is the reason for our current ecological crisis, being that it is fundamentally anti-environmental. Schultz *et al*. (2000) tested White's hypothesis and found that people who believe the Bible in a more literal sense, have more anthropocentric environmental concerns. Schultz *et al*. (2000) further stated that this does not mean that these people are not concerned about environmental decline, but instead are concerned with the effect that environmental decline will have on humans. Greeley (1993) stated that belief in the Bible does not lead to lower levels of environmental concern, but rather the 'moral rigidity' found in some religions.

4.4.1.7 Health

Pretty (2004) identified three different types of engagement with nature which could improve one's health, namely seeing nature, being in nature, and active involvement in nature. Gardening practices are in the third type of engagement (Pretty, 2004; Hawkins *et al*., 2011), and could offer the most health benefits to those working in the health clinic gardens. By only seeing a garden could provide benefits to people visiting and working at the clinics. Benefits include a decrease in the chance of getting ill, a decrease in feelings of frustration and more enthusiasm for work (Pretty, 2004). Maas *et al*. (2006) found that general good health is positively related to the amount of green and agricultural areas in the living environment of participants. It was also determined that people with a lower socioeconomic status have a higher positive correlation between green areas and health when compared to those with higher socioeconomic status (Maas *et al*., 2006).

The high visiting rates at clinics could also be related to the fact that households in the Dr Kenneth Kaunda district have rated the quality of local public clinics to be good (54.9%), average (18.2%) and poor (23.2%) (STATS SA, 2018a). Households in the Frances Baard district have rated the quality of local clinic services to be good (42.8%), average (30.7%) and poor (23.9%) (STATS SA, 2018b).

When concerning all the interviewed stakeholders, most visit the clinic every few weeks or once a month (**Figure 4-8**), which could be because they work at a clinic and had easy access to medical services. The stakeholders may also become ill more frequently as they regularly come in contact with patients. There were also quite high numbers of stakeholders interviewed that never go to the clinics for their own health (**Figure 4-8**). During the interviews, some stakeholders stated that they take care of themselves, as they had the knowledge to do so, while others stated that they rather make use of hospital services than clinic services.

4.4.1.8 Role of the clinic

Clinics and community health centres are generally there to provide primary health care services to the community (Cullinan, 2006). The stakeholders had however identified other roles the clinics play in their lives that were not necessarily formally acknowledged.

4.4.1.9 Politics

Most stakeholders were not interested in politics; this could be due to a lack of service delivery, or a lack of support.

4.4.1.10 Income

Most stakeholders receive their income from the Department of Health (government) as all the clinics were funded by the government. Other sources of income include non-governmental organisations (NGOs), Community Work Programme (CWP) which falls under Cooperative Governance Traditional Affairs, Marang, own business and Agang.

Very few people receive social grants, as most receive a salary or had a fixed income. The main categories of social grants are social grants for the elderly, social grants for children and social grants for the disabled (Neves *et al*., 2009). According to Cilliers *et al*. (2018) grants may create a false sense of security of being able to afford the food necessary to sustain life. Therefore, people need to be informed of the benefits gardens can provide in terms of food and nutrition security (Cilliers *et al*., 2018).

People's socio-economic status plays a role in the selection of plants as people with lower incomes tend to select plants primarily for utility and food purposes (McClintock *et al*., 2016; Goodness, 2018; Cilliers *et al*., 2018). McClintock *et al*. (2016) also found that low-income stakeholders regard the affordability of vegetables as important. Poor people view themselves as having a low income but also having bad health, being illiterate, having a lack of social services, and feeling vulnerable and powerless in general (Krantz, 2001).

The types of ESs present and the importance of ESs to urban residents are often different along socio-economic gradients (Wilkerson *et al*., 2018). Du Toit *et al*. (2018) found in their review that the socio-economic status of participants influenced the perceptions they had of the benefits provided by green spaces. It was especially true for provisioning services, where more affluent participants place less emphasis on these services (Du Toit *et al.*, 2018).

Concern for the environmental is a luxury which can only be afforded after the basic needs (adequate food, shelter, and economic security) have been met (Van Liere & Dunlap, 1980). Therefore, it could be said that a higher socio-economic status allows one to consider aesthetic matters (Cottrell, 2003; Fransson & Gärling, 1999). According to Vaske *et al.* (2001) people with a middle economic status usually have sufficient resources and formal education that enables them to be aware of the effect human impacts have on natural resources. However, Schultz and Zelezny (1999) found that the theory that environmental concern is a luxury for the wealthy is untrue across different cultures.

4.4.1.11 Connectedness to nature

In order for stakeholders to answer this question they had to think abstract, and not all people can report their connection to nature at this abstract level (Mayer & Frantz, 2004). It could be the reason why there where quite a few stakeholders that stated that they were very little connected to nature.

Most of the stakeholders perceived themselves to be completely connected to nature (**Figure 4-11**). It could be since they know the interview will be concerning the garden and therefore think they should be completely connected to nature, or they really feel a deep connection and understand our dependence of nature. Connecting with nature may have many benefits, such as gardening may have stress-reducing properties (Hawkins *et al.*, 2011).

4.4.2 Presence of ecosystem services

When concerning habitats for species which had a statistically significant p-value, most stakeholders perceived this service not to be present in the health clinic gardens. It could be because the clinic gardens were not created to be a habitat for organisms. Groundskeepers will be the most likely to perceive this service to be present as they work in the garden most of the time and could see what was going on in the garden, which was reflected by the higher average value given by groundskeepers.

The recreation ES also had a statistically significant p-value. Because the clinic gardens were not created for recreational purposes, stakeholders could perceive this service to be absent or insufficient. Groundskeepers will be the most likely to perceive this service to be present as they work in the garden most of the time and can see how and when people use the garden for recreational purposes. It was reflected by the higher average value given by groundskeepers. According to Dunnett and Qasim (2000), there is a link between relaxation, stress-reduction and feelings of personal well-being gained from a garden and physical and mental health. It is also very likely, according to Dunnett and Qasim (2000), that by merely seeing the garden from the inside of a building could be very valuable especially in reducing stress. Therefore, facility managers may also experience benefits from the clinic garden even if they were not physically in the garden.

For most of the ESs (nine) the majority of the stakeholders perceived them to be insufficient (**Figure 4-13**). Furthermore, for eight ESs the majority of the stakeholders perceived them not to be present at all. Only for the biological control ES were there equal numbers of stakeholders that perceived it to be insufficient and sufficient.

The most sufficient ESs as stated by the stakeholders were erosion prevention and maintenance of soil fertility and health and well-being (**Figure 4-14**). Land degradation and desertification could occur due to soil erosion (TEEB, 2011). Therefore, vegetation is needed to reduce surface runoff after precipitation by intercepting water through the leaves and stems (Gómez-Baggethun *et al*. 2013; TEEB, 2011). Fertile soil is vital for plant growth as it contains the necessary nutrients required (TEEB, 2011). It would, therefore, seem that the interviewed stakeholders realised how important plants were in preventing soil erosion.

The other ES that was perceived to be the most present in the health clinic gardens was health and well-being. Green spaces have many benefits, including being a setting for physical exercise, reduction of ultraviolet radiation and air pollution, and helps the relief of stress (Sarajevs, 2011). The fact that health clinic gardens were the topic of discussion could also have influenced the interviewed stakeholders to take health and well-being into consideration.

The ES of maintaining genetic diversity was also perceived to be highly present in the health clinic gardens. It is a supporting ES, meaning it supports the other ESs, it can also be considered to be a service itself, and for example some, species might have an existence value under cultural ESs (DEFRA, 2007). The interviewed stakeholders, therefore, seem to be aware of the many different kinds of plants present in the garden and the benefits they provide.

A five-point Likert scale was used by Cornelius (2016) to rate the answers of the participants to the specific ES questions. An answer of 1 indicates strong disagreement and 5 indicates strong agreement (Cornelius, 2016). Cornelius (2016) used the 4/5 results (high presence) to create a graph that indicates the percentage of stakeholders that perceived the ESs as valuable. Cornelius (2016) used the term “valuable” to refer to a high presence and not to the actual value as determined in this study. When comparing the results of this study with that of Cornelius (2016), the overall percentage of stakeholders that perceived ESs to be sufficiently present were much less. The most stakeholders interviewed by Cornelius (2016) perceived spiritual and sense of place to be the most abundant in the clinic gardens of the Bojananla District Municipality at 98.61%. In this study, most stakeholders perceived erosion prevention and maintenance of soil fertility and health and well-being to be the most abundant at 43%. Even though this study had fewer options (four options – no, don’t know, not sufficient, sufficient) when compared to the study of Cornelius (2016) (five options – strongly disagree, disagree, neither agree nor disagree, agree, strongly agree), there was a more even distribution between the options. A possible reason for this is that in this study an interpreter was used as well as illustrations of each ES which were not used by Cornelius (2016). These additions may have increased the understanding of the concepts by the stakeholders and thus provided more accurate perceptions.

When concerning the box and whisker diagram (**Figure 4-15**) the provisioning services were perceived to be less present than the other ESs by the interviewed stakeholders. This result differs from the findings of Cornelius (2016) that found that the supporting ESs were the least present as perceived by the stakeholders. Provisioning services are an ecosystem’s material outputs (Langemeyer, 2015) and are therefore most “visible” in the gardens; it might, therefore, be that people are more aware of the presence or absence of these ESs as they are easier to observe. The greatest variance in stakeholder perceptions was found for the cultural ESs. As cultures are different and have different views, the stakeholders might perceive the presence of cultural ESs to vary.

4.4.3 Values of ecosystem services

Human perceptions are influenced by background, upbringing, culture and education (Cornelius, 2016; Barthel *et al*., 2010; Bendt *et al*., 2013). Facility managers have a background in human health and well-being and will view all ESs through this “lens”. Groundskeepers, in contrast, have more knowledge about the plants (Cornelius, 2016).

4.4.3.1 Economic value

The ESs that were perceived to have economic value by most of the stakeholders were the maintenance of genetic diversity, food, health and well-being and erosion prevention and maintenance of soil fertility (**Figure 4-16**). Carpenter and Folke (2006) stated that for some ESs there are existing markets, such as for food products, while for other ESs markets are emerging, such as for carbon sequestration or pollutant emission quotas. Therefore, people may associate economic value more with certain ESs than with others.

It would be expected that most stakeholders would perceive the provisioning services to have economic value, as these ESs usually have existing markets (**Figure 4-17**) (Carpenter & Folke, 2006), which was true for food because most people buy or sell food and therefore know that it has a monetary value. Maintenance of genetic diversity is a supporting ES; therefore, it supports many of the other ESs. The stakeholders seemed to have realised this, and therefore more stakeholders had perceived this ES to have economic value. It could also be that stakeholders were not thinking about money that was saved to have genetic diversity but to obtain the diversity. It will cost money to buy more different plant species, and therefore they could view these services as having economic value. As the gardens are located at health clinics, more people may be aware of the economic benefits the garden might have in health and well-being. Most groundskeepers were aware of how important it was to prevent soil erosion, as the loss of soil may lead to new soil being bought. This knowledge that groundskeepers had may be a form of local ecological or indigenous knowledge which is the knowledge a specific group of people have of their local ecosystems, thus concerning the relationships among organisms and between organisms and the environment (Olsson & Folke, 2001). Local ecological knowledge may consist of scientific and practical knowledge which is specific to a particular area and often involves a belief component (Olsson & Folke, 2001). Local and indigenous knowledge systems develop through experimentation, adaption, and co-evolution over extended time periods. These knowledge systems can promote sustainable ecosystem management by providing valid and useful knowledge, in addition to methods, theory and practices (Tengö *et al*., 2014).

Of the four value options, the economic value was chosen as the most important value by some stakeholders for food, raw materials, medicinal resources, erosion prevention and maintenance of soil fertility, maintenance of genetic diversity, health and well-being, and inspiration for culture, art and design (**Figure 4-18**). Of these values, the maintenance of genetic diversity was perceived by most stakeholders to have economic value as well as being the most important value. As earlier stated the stakeholders could realise that this service supported the other services and was therefore of economic importance. There are markets for food, raw materials and medicinal resources; therefore, it would be of economic importance to people. Erosion prevention and maintenance of soil fertility, health and well-being, and inspiration for culture, art and design are services for which there are no direct markets. Therefore, it could be suggested that through prior experience the stakeholders had come to the knowledge that these services have an economic value.

It is considered uneconomical by Reuther and Dewar (2006) for people with a low income to participate in gardening if they can access food cheaper than they can produce it or if they can access higher alternative incomes than gardening. This is, however, not always the case and urban agriculture becomes a survival strategy (Reuther & Dewar, 2006).

Regarding different stakeholder perceptions, only biological control and all the cultural ESs had shown statistically significant differences.

4.4.3.1.1 Biological control ï economic value

One would expect that groundskeepers would rate biological control to have medium to high economic value. However, rather groundskeepers on average perceive biological control to have economic value, but it was the least important value. The other stakeholders may have more knowledge due to experiences or training received about the importance of biological control especially when concerning money.

4.4.3.1.2 Economic value of cultural ecosystem services

The average economic values for groundskeepers and facility managers were very low. This was because many stakeholders did not perceive the cultural ESs to have economic value. These services generally have more to do with personal feeling and preference (Lembani, 2015; De Groot *et al*., 2002). It has been determined by McHale *et al.* (2013) that the way that people use and value the ecosystems in which they live is often different from typical economic evaluations of ESs.

4.4.3.2 Ecological value

The ESs that were perceived to have ecological value by most of the stakeholders were erosion prevention and maintenance of soil fertility, carbon sequestration and storage, health and well-being, and pollination (**Figure 4-18**). It would be expected that most stakeholders perceive regulating and supporting ESs to have ecological value, as these services directly relate to ecological functions. This was the case for erosion prevention and maintenance of soil fertility and carbon sequestration and storage, both of which are necessary to maintain life (TEEB, 2011). Vegetation cover plays a vital role in preventing soil erosion which could lead to land degradation or desertification (TEEB, 2011). Soil fertility, on the other hand, is important to support plant growth (TEEB, 2011). Plants remove carbon dioxide from the atmosphere thus acting as carbon stores (TEEB, 2011).

Health and well-being was the third most chosen ES to have ecological value. It could be that when the stakeholders saw the illustration, they thought more about the environment and less about the concept of health and well-being. Alternatively, perhaps they feel that if humans were healthy and happy they can better look after nature, thus influencing the ecology. The role that green areas play in maintaining health is becoming increasingly recognised (TEEB, 2011). The functional role of ecosystem structures and processes has ‘value’, but it may not have direct or indirect value in market economies (Farber *et al.*, 2002). Thus, some ESs may have an ecological value but not an economic value. There may also be cases where an ecosystem is isolated from human economic activity and that the activity occurring in the ecosystem is irrelevant to humans (Farber *et al.*, 2002).

The stakeholders perceived the ecological value of 16 ESs, including all seven the regulating and two supporting ESs, to be the most important value (**Figure 4-19**). It could be because the garden was part of the environment and therefore most of the ESs will have ecological value. The stakeholders could also have been influenced by the knowledge that we as researchers were doing surveys on the garden, and therefore felt that they needed to include the ecological value. The ecological value might also be the easiest to understand of the four values, and most easily applicable to ESs.

4.4.3.2.1 Pollination – ecological value

The values given by all three stakeholder groups were relatively high (between 3 and 4) meaning that the stakeholders perceived the pollination ES to have a high ecological value. Pollination plays a vital role in the ecology as it is very important for the development of fruits, vegetables and seeds (TEEB, 2011). The facility managers and groundskeepers had similar perceptions that were significantly different from the perceptions of the other stakeholders. Facility managers were generally more educated than the other stakeholders, and the groundskeepers spend a lot of time in the clinic gardens. These differences could be a reason why these stakeholder groups were more aware of pollination than the other stakeholders, as it was found that education is one of the many benefits of gardens (Guitart *et al.*, 2012). Furthermore, it has been found that there is a relationship between education and environmental knowledge and awareness, (Ostman & Parker, 1987).

4.4.3.3 Social value

The ESs that were perceived to have social value by most of the stakeholders were carbon sequestration and storage, local climate and air quality regulation, maintenance of genetic diversity, and health and well-being (**Figure 4-20**). Social conditions (such as planning, finance, attitudes, and desires) influence urban gardens (Lin & Egerer, 2018). Plant selection, management, and soil preparation are influenced by complex social networks, organisations, knowledge, and power dynamics (Lin & Egerer, 2018).

It would be expected that most stakeholders would perceive cultural services to have social value, as these services relate to social interaction, which was the case for only one ES, namely health and well-being. Healthy and happy people may feel more willing to be social. Carbon sequestration and storage was perceived by most stakeholders to have social value and could be due to the fact that when socialising, much carbon was produced which was sequestered by the plants and stored. At the same time, plants produce oxygen which makes living and thus socialising, possible. It could also be that the illustration was misleading, as the illustration showed a person exhaling and another person inhaling ï this could be mistaken as two people talking, although the illustrations were explained. Local climate and air quality regulation were also perceived to have social value by many stakeholders and could be due to the fact that the shade provided by plants creates spaces for people to get together and socialise.

Some stakeholders perceive the social value to be the most important when concerning food, which could be because in many cultures food is prepared and enjoyed in unique ways (Wentzel-Viljoen *et al*., 2011). The preparation of traditional medicines is also a social event where knowledge is exchanged (Airriess & Clawson, 1994). Social cohesion in urban gardens is very important, especially for older people who often have limited social contact (Langemeyer *et al*., 2016). The social exchange of knowledge is also important to conserve information regarding gardening practices (Barthel *et al*., 2014). Younger gardeners may not have all the knowledge or experiences required to maintain a successful garden yet; therefore, the knowledge passed down from older generations may be of great social-ecological value (Barthel *et al*., 2014).

4.4.3.4 Cultural value

The ESs that were perceived to have cultural value by most of the stakeholders were an inspiration for culture, art and design, food, and health and well-being (**Figure 4-22**). Turpie *et al*. (2017) found that cultural values were among the highest values associated with nature. With 11 official languages, South Africa has a rich cultural and ethnic diversity (Wentzel-Viljoen *et al*., 2011). Wentzel-Viljoen *et al*. (2011) found that the food intake of individuals is linked to their ethnic and cultural groups and societies. These differences result in people having different eating patterns, eating different kinds of foods and having varying nutrient content in their diets (Wentzel-Viljoen *et al*., 2011).

It would be expected that most stakeholders would perceive the cultural services to have cultural value as these services directly relate to cultural activities and customs. Most cultures have their unique way of seeing, making and designing things (Wentzel-Viljoen *et al*., 2011), which was the case for the ES inspiration for culture, art and design, but not the others. Stakeholders may also have been led to choose cultural value, as the word “culture” appears in the ES name. The way food is cooked and enjoyed is also culturally specific (Haines-Young & Potschin, 2012; Wentzel-Viljoen *et al*., 2011).

The cultural value was only perceived to be the most important value for two ESs, medicinal resources and inspiration for culture, art and design. Both these services could be viewed differently by different cultures.

In urban gardens, the high value placed on cultural ESs seemed to stem from a need to connect to nature, or to feel included in nature (Camps-Cavet *et al*., 2016). Stakeholders of health clinic gardens may place a higher cultural value on regulating ESs as these are important functions that need to take place in order to make life on earth possible (Langemeyer, 2015; De Groot *et al*., 2002). According to Dunnett and Qasim (2000) gardens also have other values, including emotional, psychological, and healing values. These values were not addressed in this study but can be included in future studies.

A comparison had been made between the values of ESs from the health clinic gardens and the ESs from urban gardens in Barcelona (**Table 4-30**). In clinic gardens regulating ESs was the category most highly valued by stakeholders. In urban gardens, cultural ESs were the category most highly valued by participants (Camps-Cavet *et al*., 2016). Recreation has been the driving force of many urban gardening initiatives in Barcelona, as it provides a place to escape to relax and reduce stress (Camps-Cavet *et al*., 2016). These are also benefits clinic gardens could provide to the community. It would, therefore, be expected that if the opportunities for relaxation are increased the value of cultural services would also increase.

Table 4-30: The valuation of ESs from health clinic gardens and urban gardens in Barcelona (Camps-Cavet *et al*., 2016). The average valuing ES was the average percentage of all interviews and surveys in which the ESs has been stated valuable. The average value was the average importance of ESs ï on a 4-point scale for clinic gardens (1=least important and 4=most important) and a 5-point Likert scale for urban gardens (0=not important and 5=highly important).

	Health clinic gardens		**Urban gardens in Barcelona (Camps-Cavet *et al*., 2016).**	
Ecosystem services	**Average valuing ES (%)**	**Average value (1 to 4)**	**Average valuing ES (%)**	**Average value (0 to 5)**
Provisioning services	22.38	1.95	74.85	3.58
Regulating services	35.20	2.05	91.00	4.12
Habitat services	38.39	2.02	96.00	4.26
Cultural services	36.14	1.96	92.57	4.49

4.4.4 Willingness to pay for ecosystem services

Generally, there were differences between the willingness-to-pay values of the different sub-districts, which was because the health clinic gardens were different, each differed in size and the resources, they provided. As a result, the presence or absence of ESs played a large role in the willingness-to-pay values of stakeholders.

According to Chee (2004), because ESs are generally not owned by anyone it is difficult to obtain compensation payment from people who benefit from these services. Furthermore, most ESs are not in the market sphere and are therefore ñinvisibleò to many (Chee, 2004). Moreover, characteristics such as level of income and education greatly influence the amount stakeholders will be willing to pay (Chee, 2004).

People may not be willing to pay for a service because they genuinely perceive it to be worthless, or it could stem from other reasons (Chee, 2004). One reason for not being willing to pay is that the participant does not fully understand what is being valued (Chee, 2004). Another reason could be resulting from a form of protest against the commodification of ESs (Chee, 2004). Furthermore, the participant might believe that paying for the ES is the responsibility of the government (Chee, 2004).

It has been suggested that people may experience a sense of satisfaction of voluntary contribution to a public good (Chee, 2004). People could also base their WTP on their desire to do their ôfair shareö for the environment or community (Chee, 2004). Participants may also give lower WTP values when they think that the money will actually be collected (Chee, 2004).

Some of the interviewed stakeholders found it challenging to give the ESs a monetary value, as they felt that it is nature and therefore free (Clark *et al*., 2000). This problem was partly solved by having a reference amount because some people cannot pay but it does not mean they are not willing to (Clark *et al*., 2000). Another limitation of the WTP concept is that it would appear that some of the willingness to pay values were not necessarily based on actual market values (Chee, 2004). Furthermore, prior knowledge (or the lack thereof), biased opinions and level of understanding can also influence the amount people are willing to pay for ESs (Chee, 2004).

4.4.5 Ecosystem disservices

Similar to the findings of Cornelius (2016) the stakeholders did not perceive EDSs to be a big problem, indicating that the clinic gardens are more beneficial than harmful.

How these EDSs are identified and viewed depend on the experiences of the viewer which was influenced by local cultures, values, norms and perceptions (Shackleton *et al*., 2016).

The Matlosana sub-district had the most plant species that could potentially cause allergies when compared to the other sub-districts, which could indicate that the stakeholders were aware of the allergy-causing plants in the clinic gardens.

Of the six EDSs, only pests were perceived by most stakeholders to be a big problem, which could be because it was one of the easiest recognisable disservices which could affect a variety of things, from the plants to the humans directly.

In contrast with results found by Cornelius (2016), damage to buildings or other structures, allergies and pests were identified as the most prominent EDSs at health clinic gardens. The Lebala micro-garden (Molebatsi *et al*., 2010) is an open area in the traditional Tswana tshimo which provides visibility for dangers such as snakes and spiders. This could explain why fewer stakeholders perceived this EDS (fear and stress) to be present. The naga micro-garden (Molebatsi *et al*., 2010) is usually an overgrown natural area which could be the cause of many allergies and the habitat of the pests.

4.5 Conclusion

Most interviewed stakeholders were facility managers and groundskeepers, with an average age of 44.63 years. Most interviewed stakeholders were females, and most of them spoke Setswana as a home language. The highest level of education of most stakeholders was the completion of secondary education. The majority of the stakeholders belong to a church which they mostly attend once a week for Sunday services. Most stakeholders visit the clinic every few weeks or once a month for their health. Most stakeholders perceived the clinic to help the community with health care, while a majority feel that politics meant nothing or were not interested in politics. The income of most stakeholders was from the Department of health, and most interviewed stakeholders feel completely connected to nature.

Generally, there was no or very little difference in the perceptions of the different stakeholders. It would appear that greater contact with nature makes some stakeholders more aware of its benefits, for example, groundskeepers that were generally more actively involved in the clinic gardens may be more aware of the benefits nature provided.

It could be that there was more social cohesion in some sub-districts than others, in other words, some sub-districts could have more close-knit communities than others. It would appear that the Phokwane sub-district differs the most from all the other sub-districts, as it was the only sub-district included in the study from the Northern Cape Province.

Most stakeholders perceived the ESs to have ecological value (48.50%); this was followed by social value (45.64%), economic value (24.79%) and lastly cultural value (19.37%). These results were in contrast with the findings of Cornelius (2016) where cultural services were regarded as being the most important. In this study by Cornelius (2016) only the presence of ESs was recorded and not the real value. The value was assumed based on whether or not something was present in the clinic garden (Cornelius, 2016). Turpie *et al.* (2017) also found that cultural values were among the highest values associated with nature. Even though many ESs are related to different cultures, it seems that the stakeholders do not realise this or that it did not play a large role any more as people become more westernised.

Cornelius (2016) found that the ES spiritual experience and sense of place was perceived to be the most important ES, in this study this was not the case. An average of 32.14% of the interviewed stakeholders perceived this ES to have any value, in contrast with the 98.61% that rated this service as valuable in the study of Cornelius (2016).

The provisioning of food was an important function as an average of 46.07% of the stakeholders perceived this service as being valuable. This result indicates the potential of health clinic gardens to be sources of food to the wider community, especially for more vulnerable patients.

It would appear that people enjoy being in the garden, as the clinic gardens provide many different benefits. The social value of the clinic gardens was also very important as it brings different people together. It is important that different stakeholders work together and share their knowledge in order to improve gardening practices. Costanza *et al*. (2017) stated that there is also a need to inform the wider community of the importance of ESs. The support of the public will determine the success of biodiversity conservation (Miller & Hobbs, 2002). In order to obtain broader public support, a wider, more diverse audience should be reached with a message that clearly states how important biodiversity is and how it influences human lives (Miller & Hobbs, 2002). People living in a city often perceive conservation as something that occurs somewhere else such as in a national park, wilderness area, or rainforest and is usually experienced second-hand on television or in a magazine (Miller & Hobbs, 2002). Thus, people attach importance to biodiversity in terms of entertainment value (Miller & Hobbs, 2002).

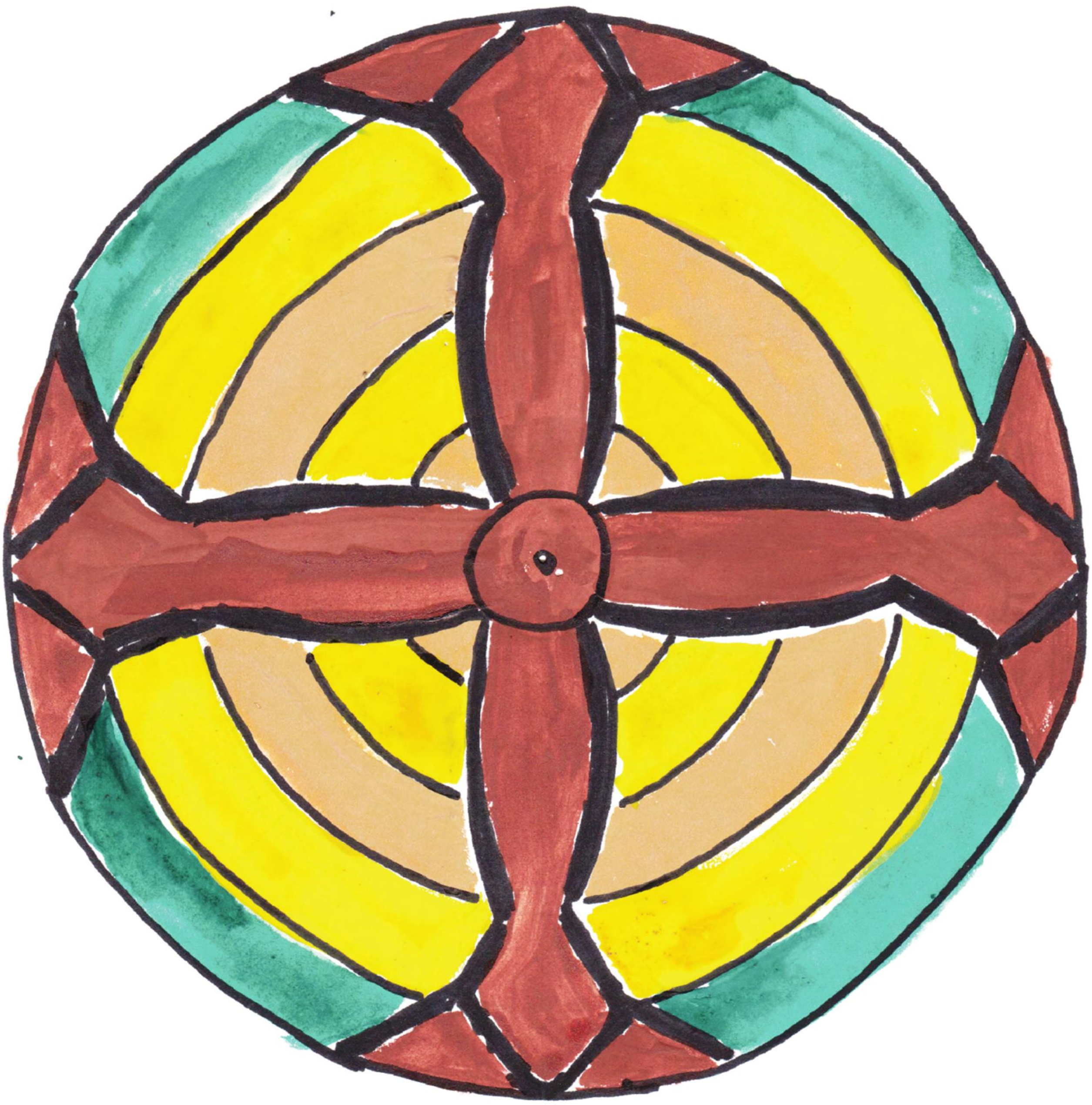
The protection of habitats may be promoted by compassionate and informed members of the local community, the so-called ñchampionsò (Cornelius, 2016) because many land-use decisions are made by country officials, city administrators, and landowners (Miller & Hobbs, 2002). For example, in Australia community-based projects have been implemented to protect the ecological health of the landscapes so that flora and fauna are protected, and the farmers can make a living (Dilworth *et al*., 2000). A positive feedback loop is created by community-based efforts as they use local support, which in turn creates an interest in local conservation issues (Miller & Hobbs, 2002).

Champions are considered to be the individuals of a community that are inspiring and enthusiastic, who usually drive and motivate others in the community to act (Cornelius, 2016). Cornelius (2016) found that some health clinic gardens had examples of champions where one person was motivated to make a success of the clinic garden and to inspire other members of the community to participate. Cornelius (2016) stated that these champions should be appreciated and empowered so that they can play a larger role in the management of the community instead of ñcorrupt governmental institutionsò having all the say. Tsegay *et al*. (2014) found that community champions include activists, community leaders, elders, traditional leaders, village heads, councillors and members of parliament. Some of the roles of champions include supporting community involvement and facilitating group discussions (Tsegay *et al*., 2014). These champions can, therefore, be vital in the survival of clinic gardens.

There were some negative associations made with the clinic gardens such as pests or allergies, even so, the percentage stakeholders that perceived EDSs to be present was quite low, which indicates that the perception of the usefulness of the clinic gardens is overall more positive.

The aim of this chapter was to develop and conduct a social survey to determine the social, cultural, economic and ecological value of a variety of ESs and EDSs as perceived by different stakeholders. A total of 70 different stakeholders (facility managers, groundskeepers, and various community members) were interviewed, and their perceptions on presence, value and willingness to pay for a variety of ESs were determined. The different sub-districts were compared to each other, as well as the three core stakeholder groups.

Chapter 5: Qualitative data analysis, results and discussion



CHAPTER 5 - QUALITATIVE DATA ANALYSIS, RESULTS AND DISCUSSION

5.1 Introduction

Qualitative methods, according to Wilkerson *et al*. (2018), are appropriate to use in economic valuation studies to understand the meanings, values and interactions that urban residents attach to their local environment. The perceptions people have of ecosystem services (ESs) and disservices (EDSs) can provide one with valuable information for decision making (Delshammar *et al*., 2015).

Tzoulas *et al*. (2007) developed a conceptual framework which links green infrastructure, ecosystem health and human health and well-being. The themes identified from the interviews reflected this conceptual framework as green infrastructure and ecosystem health can be correlated to the natural and environmental theme, and human health and well-being can be correlated to the anthropogenic and human theme. If the green infrastructure and ecosystem health are improved, it provides the environmental settings of public health (Tzoulas *et al*., 2007), as green spaces are ecologically and socially important to human communities (Barbosa *et al*., 2007).

The way the interviews are conducted by the researcher is very important as it could influence the participant (Boynton *et al*., 2004). If the researcher unconsciously rushes through some questions, the participant may perceive those questions to be unimportant, while a tired or bored researcher may convey a lack of interest resulting in the participant not necessarily answering correctly (Boynton *et al*., 2004).

Indigenous Western people are usually more familiar with indicating preferences and rating scales than most other groups (Boynton *et al*., 2004). The questionnaire items may, therefore, have other meanings to other groups of people, or it may be incomprehensible (Boynton *et al*., 2004). Therefore, the qualitative analysis was conducted to obtain additional information the questionnaire could not. When one uses a translator for the questionnaire, they may change the meaning of some concepts to attempt to clarify questions or protect the participants or themselves (Boynton *et al*., 2004). It is best to avoid using children or other family members as translators completely, because their ability to understand and process information may be low (Boynton *et al*., 2004). Professional translators or interpreters should be used if possible, but it is important to remember that they do not necessarily ensure the correct translation because some words or phrases do not exist in all languages (Boynton *et al*., 2004).

The following is important to note when conducting a qualitative study:

- Natural setting ï qualitative data will be collected in the field at the site where participants experience the garden under study (Creswell, 2014). The participants will not have to go to another location, nor do they have to complete instruments (Creswell, 2014). This face-to-face interaction with people leads to information being gathered and seeing them behave and act within their context is one of the main characteristics of qualitative research (Creswell, 2014).
- Researcher as a key element ï the qualitative researcher collects data through examining documents, observing behaviour or interviewing participants (Creswell, 2014). Therefore, a questionnaire was developed by the researcher that was used to determine the perceptions stakeholders have of health clinic gardens.
- Multiple sources of data ï qualitative researchers usually gather data of multiple forms, such as interviews, observations, documents, and audio-visual information rather than relying on a single data source (Creswell, 2014). All the data is then reviewed, organised into categories or themes by the researcher (Creswell, 2014). In this study data were collected through using interviews, observations, taking photographs and GPS coordinates and recording the interviews. Notes were also written during the interview concerning the behaviour of the interviewee, for example, was he/she comfortable, was he/she excited about the research, did he/she know of the concepts being used, etc.
- Participantsômeanings ï in qualitative research it is important to determine the meaning the participants attach to the problem or issue and not to rely solely on the meaning as derived by the researcher or by literature (Creswell, 2014).
- Emergent design ï qualitative research design is considered to be emergent according to Creswell (2014). Therefore, the research plan has to be flexible and able to change once the researcher enters the field and begins to collect data (Creswell, 2014). According to Creswell (2014), the questions may change, the forms of data collection may shift, and the individuals studied and the site visited may be modified. The main aim of qualitative research is to learn about the problem or issue from participants and to address the research to obtain that information (Creswell, 2014).
- Reflexivity ï the qualitative researcher has to reflect on how they may have potential in shaping their interpretations of the data by their personal background, culture, and experiences (Creswell, 2014). Therefore, the researcher has to be aware of the fact that his/her background may shape the direction of the study (Creswell, 2014).

This chapter in support of chapter 4 will address objective 2, namely to develop and conduct a social survey to determine the social, cultural, economic and ecological value of a variety of ESs and EDSs as perceived by different stakeholders. Relevant data were transcribed and analysed using ATLAS.ti software. Results obtained from this chapter will complement the results of the quantitative study (chapter 4) and will be used in chapter 7 when all the quantitative and qualitative data is consolidated.

5.2 Materials and methods

5.2.1 The realisation of data analysis

A total of 70 interviews were held with stakeholders of 32 health clinic gardens, during which field notes were taken and each interview digitally recorded. Of the 70 interviews, 18 interviews were selected and analysed, reasons for this follow. Firstly, although 70 interviews were held with stakeholders of health clinic gardens, not all of the interviews contained ñrichò data, referring to data that contains very little additional information. Secondly, the interviews were held to complete an interview schedule (questionnaire) on ESs and thus many of the data was already present in the quantitative data. Thirdly, some of the participants gave very cryptic answers which would not have provided much additional information. Fourthly, all 70 interviews were read and the 18 containing the ñrichestò data were subjectively selected. The ñrichest dataòwas interviews were the stakeholders provided a lot of additional information and explanations for their choices, which was not required by the questionnaire. Fifthly, the other interviews were listened to ensure data saturation. Lastly, 18 interviews were selected that represent three stakeholder groups, namely facility managers (6), groundskeepers (6) and community members (6).

The data were analysed according to the steps of generic data analysis by Creswell (2014) supported by ATLAS.ti (Friese, 2014). There are specific key steps in the thematic analysis of the qualitative data, listed hereafter (Schurink *et al*., 2011). The documents used in ATLAS.ti were a combination of field notes and interview transcripts.

The first step in analysing the qualitative data was to organise and prepare the data for analysis (Creswell, 2014). Therefore, all voice recordings of the interviews were transcribed, all material visually scanned, field notes transferred to a computer, and data was sorted and arranged into different types depending on the sources of the data (Creswell, 2014; Schurink *et al*., 2011).

Secondly, all the above-mentioned data was read (Creswell, 2014), and notes were written down on each (Schurink *et al*., 2011). This step provided an idea of the general sense of the information and an opportunity to reflect on the meaning (Creswell, 2014).

In the third step, the data was coded, which involves creating categories of segmented sentences collected during the interviews (Creswell, 2014). These categories were then labelled with one term that best represents the data (Creswell, 2014; Schurink *et al.*, 2011).

There were eight steps followed during the coding process, known as Tesch's eight steps (Creswell, 2014):

(i) All transcripts were read in detail and thoughts and ideas were written down as they came to mind.

(ii) An interview transcript was chosen and read while asking what it was about and thinking about its underlying meaning. All thoughts were written down and repeated with other interviews.

(iii) A list of all the emerging topics was made after which similar topics were clustered together. These topics were then organised into the major, unique and leftover topics.

(iv) The topics were then compared with the data. This preliminary organising scheme was then used to determine if new categories and codes were emerging.

(v) Categories were created by finding descriptive wording for the topics. Similar topics were grouped together to shorten the list to create only a few categories. Lines were also drawn between categories to indicate interrelationships.

(vi) Final names for each category was chosen and alphabetically organised.

(vii) All data belonging to each category was gathered in one place in order to perform a preliminary analysis.

(viii) Codes that did not work correctly were recoded.

During step four descriptions and/or themes were derived from the coding process (Creswell, 2014). In a description, information is rendered concerning people, places, or events in a setting (Creswell, 2014). Themes are the topics that appear as major findings in qualitative studies and are often used as headings in the findings section of studies and should represent a variety of perspectives of the participants (Creswell, 2014). As these themes were identified, underlying similarities between them were noted (Schurink *et al.*, 2011).

Step five entails determining how the themes and description will be represented in the qualitative narrative (Creswell, 2014). The most used approach is to use a narrative passage to convey the findings of the analysis (Creswell, 2014). This narrative may present the information in terms of chronological events, in a detailed discussion of the themes or a discussion with interconnecting themes (Creswell, 2014). Visuals, figures, or tables were also used to aid the discussion of the information (Creswell, 2014).

In the final step, the findings and results were interpreted (Creswell, 2014). This step allows one to determine the ðlessonsô that were learned (Creswell, 2014; Schurink *et al*., 2011). These lessons included own interpretations and findings from literature (Creswell, 2014).

The relationships between codes can be visually displayed by making use of network views in ATLAS.ti (Friese, 2014). Within a network view, the relationships between codes, categories and/or themes are indicated by connecting the codes with a solid line as well as using a circle to indicate the source code and an arrow to indicate the target code (Friese, 2014). The codes were further explored, and more links were identified with codes in other categories and themes (Friese, 2014).

Relationships between codes were created and classified by following the guidelines discussed by Friese (2014):

- ñis a part ofò a relationship where one code complements or strengthens other codes or themes.
- ñis a property ofò relationships where codes are essential to other codes or themes.
- ñis associated withò relationships where not enough information was available to indicate more specific relationships.
- ñis a cause ofò relationships where one code was identified as the cause of another code or theme.
- ñcontradictsò relationships where one code contradicted other codes or themes.

Names were given to codes firstly by assigning each code the first letter of the theme. Therefore, all codes relating to the theme anthropogenic and human will receive the letter A, to the theme natural and environmental will receive the letter N, and the theme connection between natural and anthropogenic will receive the letter C. These letters were followed by an asterisk for the theme names. The theme and category names are in capital letters. The codes under each category begin with the first letter of the theme, then the category name followed by the specific code name. Each category and associated codes were given a colour so that the visualisation of the codes was made easier.

The data was first organised and prepared for analysis, by transcribing the voice recordings of the interviews and combining it with the field notes made by the researcher during and after the interviews. The data was then read, and important words or phrases were assigned specific codes. A list was then compiled of all the categories of codes. It was then noted that some themes were emerging from the categories, namely those categories relating to nature, people and how these two meet (**Table 5-1**).

Table 5-1: The three themes emanated from data analysis.

Themes	**Clinic gardens as ecosystems**	**Anthropogenic dimension in clinic gardens**	**Interdependence between environmental and anthropogenic components**
Categories	Participants are aware of the benefits of plants	Three core stakeholder groups identified	Prerequisites to cultivate a clinic garden
	Participants identified constraints caused by plants	The role of the clinic in comprehensive community health	Emotional experiences as a valuable outcome of clinic gardens
	Animals as associated with contributing and inhibiting aspects in the clinic garden	Dissonance about the free versus fee-for-vegetables	Understanding the clinic garden and food production
	Participants aware of the origin of water sources	Role of government in clinic gardens	Alternative medicine use from clinic gardens
		Contradictory interest in politics	Reasons for clinics not having food gardens

5.3 Results and Discussion

Appendix D1 provides the 87 codes and a description of each, as contained in the comments on ATLAS.ti. Appendix D2 provides the relationships identified between the codes.

Three themes emerged during the coding process, these themes include anthropogenic and human, natural and environmental, and the connection between natural and anthropogenic. They were renamed to be more descriptive, namely understanding the anthropogenic dimension in clinic gardens, describing clinic gardens as ecosystems, and interdependence between environmental and anthropogenic components of a clinic garden.

5.3.1 THEME 1: Describing clinic gardens as ecosystems

In order for health clinic gardens to exist, there has to be a natural component which forms the base for the initiative. According to Tzoulas *et al*. (2007), ecosystem functions and services of the natural environment create urban ecosystems where the socio-economic and other aspects of public health can exist. The different aspects that influence clinic gardens as ecosystems can be seen in **Figure 5-1**. All aspects that directly relate to nature, natural processes and the influences of nature on humans are included in this section. Most ESs relate to plants; therefore, plants could offer many benefits to humans. Plants, however, could also be a constraint when people are disadvantaged by them. Animals also play a role, as they may be viewed as beneficial or harmful. Water is an essential component that is necessary to maintain life on earth.

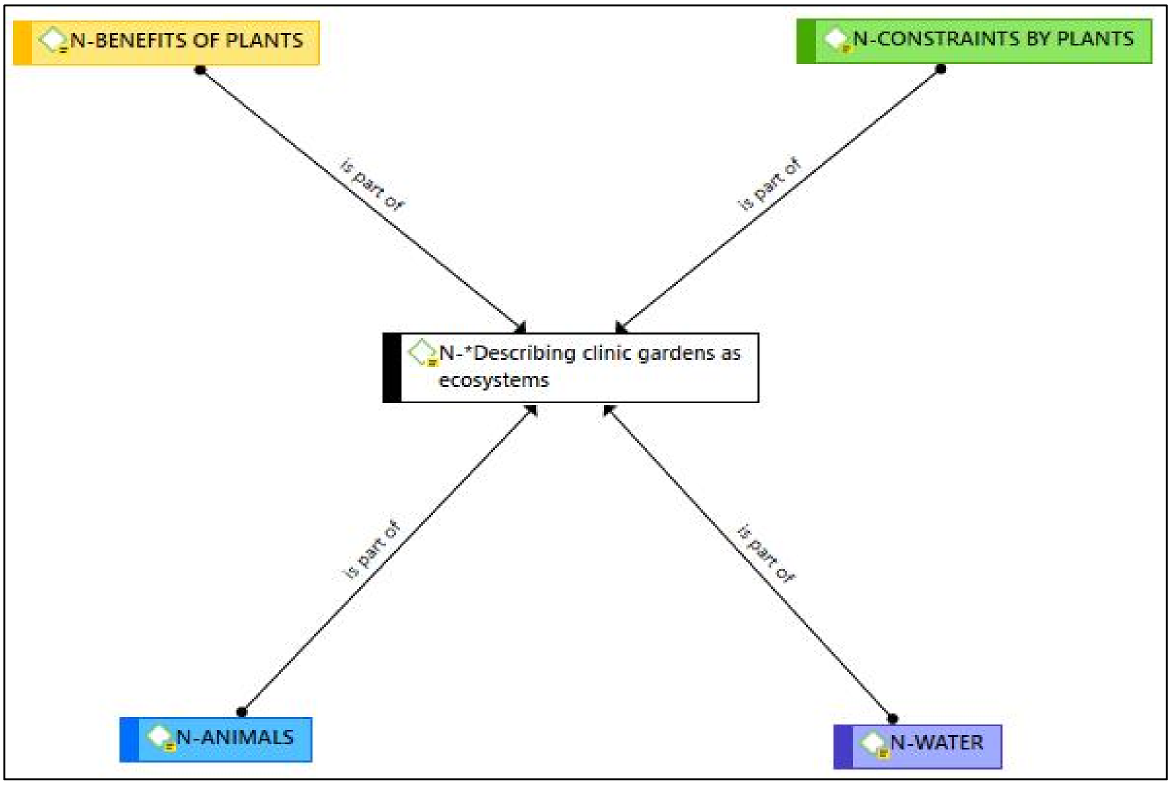


Figure 5-1: The aspects that influence the clinic gardens as ecosystems.

5.3.1.1 Participants are aware of the benefits of plants

During the interviews stakeholders often remarked on the benefits they obtain from the clinic garden or nature in general. Many of these benefits relate to the ESs discussed in chapter 4. One participant described the compost made from the raw materials obtained from mowing the lawn of the health clinic garden. The way they make compost was described as "*grass is cut and mixed and put in a hole with water and it is covered. It is then mixed after two weeks, and after three months we put it in the garden, this mixture makes grass so green*".

Some participants felt that the environment benefits if the garden was well maintained stating that the environment will look "nice". Furthermore, the plants will grow better and be more nutritious according to the participants. A maintained garden was also thought to protect and preserve the environment. The understanding of the researcher was that a well-maintained garden will contribute to the overall wellness of the environment, thus a case of plants benefiting plants.

Participants had gathered or observed others gather wood from the trees within the health clinic boundaries to be used as firewood to prepare meals. One participant stated that the wood from an old tree was used for fire making. It was also stated that people collect wood to sell as a means of income. Fire is a crucial part of many lives as it may be one of the only ways used to prepare meals as few of the participants have access to electric or gas stoves (STATS, 2018a, b).

An interesting benefit mentioned by one participant was that the garden maintains itself. The garden seems to thrive even though it was not cared for by humans. This participant stated that “*the trees are green even though we do not give it water*”.

Participants recognise that plants provide fresh air, especially to patients waiting outside of the clinics. A participant shared that “*primary school education says that plants inhale carbon dioxide*”, which indicates that many people had a basic knowledge of carbon sequestration and storage. One participant stated that carbon sequestration and storage improve smell and consequently health. One participant gave an interesting scenario of cars entering the health clinic yard emitting carbon dioxide which was taken up by the clinic trees. This participant, therefore, related the carbon dioxide emitted only by the cars on the yard to carbon sequestration and storage by clinic plants.

Erosion did not occur because plants protect the soil. A participant stated that “*plants eradicates erosion, plants keep soil intact. During rain the plants protect the soil*”. Especially the groundskeepers seem to realise the importance of plants protecting the soil.

One participant, a facility manager, stated that impurities from wastewater were trapped in the grass which keeps harmful things from children. This participant also told the researcher that provisions were made to “*catch*” wastewater so that it did not reach people.

Trees protect against extreme events, such as rain, strong winds, and they also reduce wind. One participant stated that trees do protect from rain and wind but not from lightning. Another participant stated that even though trees protect people from wind, the wind could damage the trees.

The participants seem to appreciate the trees providing shade, as one participant stated that “*when it is hot we can sit in the shade*”. Participants feel that the shade provided by plants cools the immediate area and ñ*makes the area cooler*ò. Shade was also mentioned to be beneficial for cars.

One participant stated that the wind was pollinating the plants and distributing the seeds. This participant said that ñ*Wind shakes flowers and seeds are distributed to places I did not plant them*ò.

It would seem that the following ESs were especially of importance to the participants, namely raw materials, carbon sequestration and storage, erosion prevention and maintenance of soil fertility, wastewater treatment, moderation of extreme events, local climate regulation, and pollination. All of these ESs except raw materials were regulating ESs. Two other additional benefits by plants were that the environment benefits the environment and that plants grow even if they were not maintained by humans. These two benefits may be very important to the health clinic gardens as there were often no resources available to maintain the clinic gardens.

5.3.1.2 Participants identified constraints caused by plants

Some participants expressed their concern about the disadvantages of certain plants. These constraints (also described as disadvantages) were however less than the benefits identified. Plant roots block the drain thus blocking the sewage. One participant feels that old trees cause problems, for example, they fall on people, cars and buildings. One participant feels that plants die when exposed to wastewater, in other words, the plants cannot survive some ñchemicalsò. Grass and flowers cause allergies in the clinic gardens. One participant stated: ñ*the pollen from the flowers have sinus effect on some people*ò. Participants stated that the plants they received do not grow, which could be due to a lack of resources. A common problem was tree roots cracking the pavement of the clinics. A disadvantage at one clinic was that the trees were located at the back of the building where people cannot go and benefit from them, which was not a disadvantage of the plants themselves, but if trees cannot be reached they cannot provide benefits. At some clinics, trees were too small to have a specific function or service, such as providing shade, protection from the weather, or sequestering carbon as stated by some participants. In a study conducted by Delshammar *et al*. (2015) in Sweden, it was also found that the natural growth of plants was sometimes a disservice, for example, a tree being too high or too wide.

It has been found that EDSs often play a big role in the perception and implementation of urban ecosystems (Schaubroeck, 2017; Von D˜hren & Haase, 2015; Kronenberg, 2015). It would seem that the following EDSs were especially of concern to the participants, namely damage to buildings and structures, accidents, and allergies. Other interesting constraints identified by the participants were the plants not being able to withstand chemicals, plants not growing properly, plants not being accessible and trees being too small.

5.3.1.3 Animals as associated with contributing and inhibiting aspects in the clinic garden

Many participants mentioned the presence of animals in the health clinic gardens. The relationship between the participants and the animals were both beneficial and disadvantageous. Beneficial relationships include the provision of habitats for birds; they love and enjoy the garden. These birds eat pests and therefore contribute to biological control. When birds eat the pests, vegetables can grow. One participant stated that ñ*birds are helping the environment by eating harmful insects*.ò Birds were also said to spread seeds. Raw materials were given to animals as food, especially grass, one participant stated ñb*efore rainfall people from community asked to cut the grass if the clinic to give to animals, which amounted in a bale for one week. They could feed animals for at least a week*.ò Therefore, animals assist in refuse removal by eating ñwasteò that would usually be thrown away. Butterflies, bees, other insects and birds pollinate flowers, which is an important ES.

Stakeholders view some animals as negative; they damage, destroy and eat the plants. One participant stated that ñ*no, no, no, the garden is for the people, animals are bad; they eat the plants that are meant for people*.ò Ants, mice, rats, pigeons, sheep, snakes and spiders were present in the garden, and they were mostly perceived as a problem. Rats had gone into the pharmacy of one clinic and ate the medicine. Pigeons were considered to be pests, because ñ*their droplets block the gutters*ö, as stated by one participant. Sheep eat vegetables from the clinic garden, especially cabbage. Spiders were observed in the clinic garden, and there was a fear of not knowing how harmful the spiders were, as one participant stated: ñ*we don't know how dangerous they are*ö. Often pest control was needed to get rid of pests, and they spray chemicals, which may lead to additional costs which could also be seen as a disadvantage.

5.3.1.4 Participants aware of the origin of water sources

Stakeholders perceived the source of the water used at the clinics to be either from a borehole or the municipality. Water was either pumped from a borehole or ñboorgatò which is the Afrikaans word used by many people and used in the garden or was obtained from the municipality (tap) as one participant stated: ñ*we do not have freshwater, we use water from the tap*ö.

5.3.2 THEME 2: Understanding the anthropogenic dimension in clinic gardens

In order for health clinic gardens to exist, there had to be a human component that drives the initiative. Some human-made components and ideas are needed in order for the clinic gardens to be successful, which is supported by Tzoulas *et al*. (2007) who stated that community satisfaction, involvement, and identity, are needed for the social well-being of communities and individuals. Different dynamics influence clinic gardens from an anthropogenic perspective, which includes the clinics themselves, the government, the economy and politics (**Figure 5-2**). The overall perceptions of the stakeholders gave the impression that the government and politics were not very important dynamics influencing the clinic gardens.

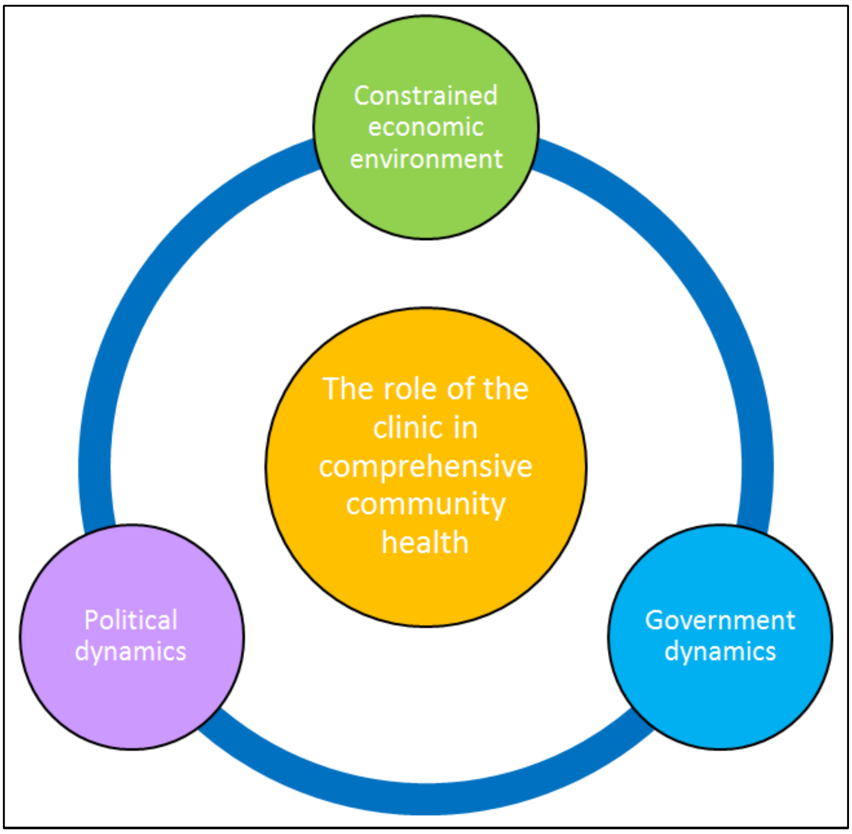


Figure 5-2: The dynamics that relate to the understanding of the anthropogenic dimension of clinic gardens.

5.3.2.1 Three core stakeholder groups identified

There were three core stakeholder groups, namely facility managers, groundskeepers, and community members. Facility managers were in most cases a professional nurse in charge of the clinic. Their role is to facilitate and manage the clinic activities (Cilliers *et al*., 2018; Cornelius, 2016). In this study, there were also acting facility managers interviewed. The groundskeepers are paid gardeners (Cilliers *et al*., 2018; Cornelius, 2016).

The community members include people from the Community Works Program (CWP), Community Health Workers (CHWs) (or caregivers as used by Cornelius, 2016; Cilliers *et al*., 2018), and other volunteers. The CWP is initiated by the Department of Works and receive a stipend from the government (Cilliers *et al*., 2018; Cornelius, 2016). CHW are paid a stipend by the Department of Health to work on community health care and gardening (Cilliers *et al*. 2018; Cornelius, 2016).

5.3.2.2 The role of the clinic in comprehensive community health

The role of the clinic in comprehensive community health was perceived differently by the participants (**Figure 5-3**). Two codes contradicted each other, namely clinic responsibility to avoid accidents by cutting or pruning trees and clinics not being allowed to cut trees (**Figure 5-3**). Some participants felt that their safety had to be a priority at the clinics while others felt that they could not be held responsible for accidents at it was not the duty of the clinics to cut or prune trees. These two codes, as well as the other codes, were a part of the category ñthe role of the clinic in comprehensive community healthò which was a part of the theme ñunderstanding the anthropogenic dimension in clinic gardensò.

Some participants feel that it was the role of the clinic to avoid accidents by cutting dangerous branches that could fall on people. Others feel that the clinic assists the community when they were sick or had any other medical enquiries. One participant stated the following ñ*the role of the clinic is to ensure the health of the community and the surrounding area meet the national standard*ò. Another participant stated the following ñ*role of the clinic is to help the community in any way they can, to keep the community healthy and teach them*.ò Stakeholders feel that the role of the clinics was to be easily accessible so that community members can easily get to the clinics, without making use of public transport. Another perceived role of the clinic was providing the community with information. It was stated that people need to be educated about the garden, the participants want to learn, and there was a need for education between the groundskeeper and the community. One participant felt very strongly when saying: ñ*our people need to be educated about the garden. They don’t know if plants grow right. They eat green peaches; they do not allow peaches to become ripe. They do not know they will get stomach problems if they eat green peaches*.ò Education did not only concern the garden but also concerned health as stated by a participant that ñthe *role of the clinic is to help me understand sickness, awareness about many sicknesses when they arise I can know how to deal with them*ò. Other participants felt that the role of the clinic was to keep people from cutting trees or taking wood or other raw materials and to provide orphans with food and to provide job opportunities to form a source of income to employees.

The perceptions stakeholders had of the role of the clinic differ and were not always in line with the actual role. Local clinics and community health centres were created to treat ñambulatory patientsò referring to people able to walk and not confined to a bed (Cullinan, 2006). The role of clinics is to cover a comprehensive variety of ñpreventative, promotional, curative and rehabilitation servicesò (Cullinan, 2006). The services offered by clinics and community health centres according to Cullinan (2006) include ñmother and child care, immunisation, family planning, treatment for sexually transmitted infections, minor trauma and care for those with chronic illnesses such as diabetes and hypertensionò. More severe cases are referred to hospitals (Cullinan, 2006). Cullinan (2006) further states that it is the responsibility of the National government to monitor the provincial implementation of policies, but is rarely done as there is a lack of systems and staff to do so adequately.

Many of the responsibilities participants felt that the clinics should cover are responsibilities of the municipalities (South Africa, 1998; Robinson, 2015). Some of the functions district and local municipalities are responsible for are the supply of water, the supply of electricity, sewage purification and disposal, solid waste disposal sites, road maintenance, passenger transport services, and firefighting services (South Africa, 1998). It is also stated in the Government Gazette (South Africa, 1998) that district and local municipalities are responsible for serving the area of the district municipality as a whole with health services. Furthermore, the district and local municipalities are responsible for the establishment, conduct and control of fresh produce markets serving the area of the district municipality as a whole (South Africa, 1998). The municipalities do not, however, meet all of these responsibilities and therefore becomes a growing burden to the clinics. As soon as municipal responsibilities are not met, civil society takes over these roles.

Even though there are primary health care clinics that provide excellent services, there are no standards which the clinics should meet, nor are there ways to implement and maintain standards (Robinson, 2015). The initiatives, inspiration, motivation and dedication of the facility managers is what usually leads to clinics being well-run, rather than national, provincial or district office efforts or systems (Robinson, 2015).

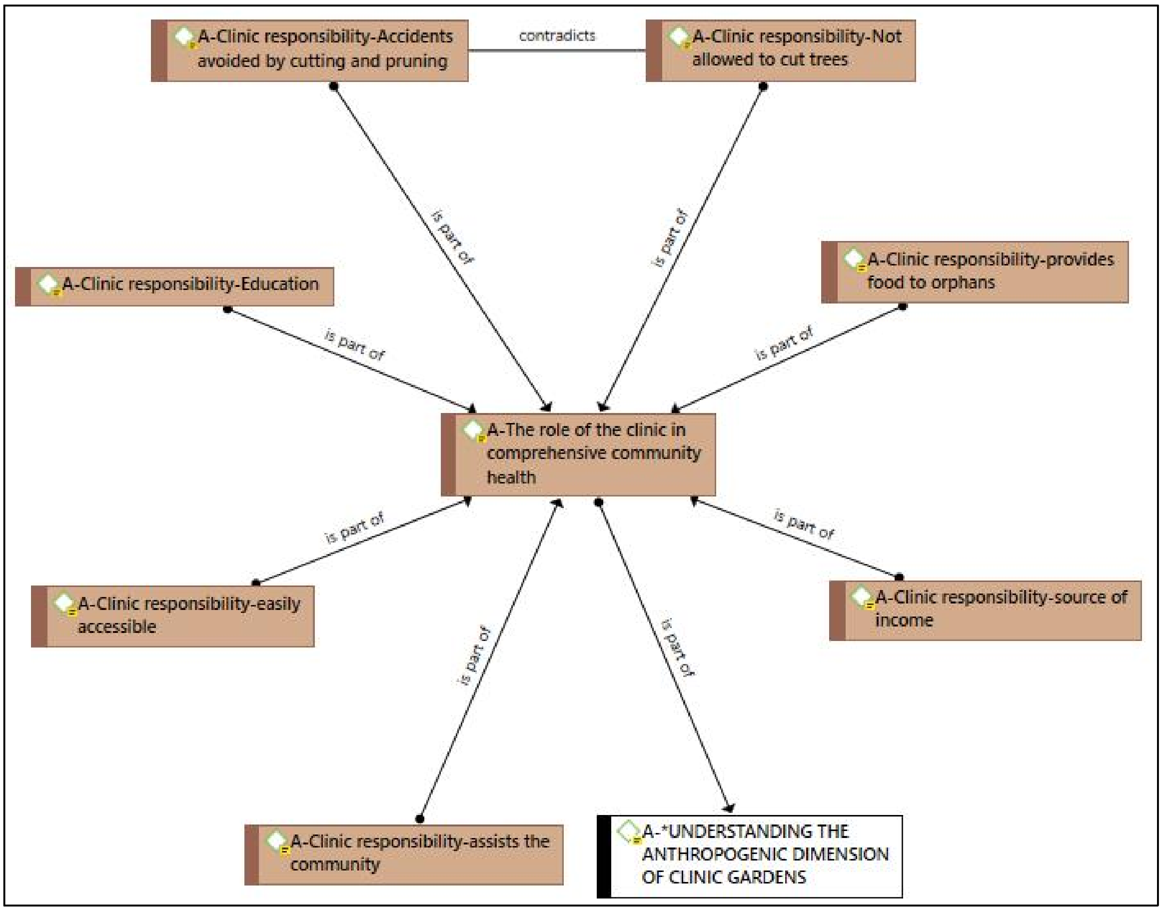


Figure 5-3: The perceptions of the role of the clinics in comprehensive community health.

5.3.2.3 Dissonance about the free versus fee-for-vegetables

Some participants perceive ESs to be free or something that cannot be bought while others perceive these services to have economic value. Even though most of the codes related to this category had to do with nature, money and the use of it was a human-made entity; therefore, this category was created under the anthropogenic and human theme.

Free ESs or ESs perceived not to have a value include health and well-being, an inspiration for art, culture and design, and local climate regulation. With ESs being present many participants perceive their presence to save money, this includes raw materials, freshwater, medicinal resources, local climate regulation, moderation of extreme events, erosion prevention, aesthetic appreciation, pollination, food, maintenance of genetic diversity, carbon sequestration and storage, health and well-being, and inspiration for art, culture and design. For example, one participant stated that it “*saves money as materials are not bought, does not have to buy compost*” and “*saves money because medicine does not have to be bought*”. Another participant stated that “*if the wind pollinates plants, it saves me money because it is not necessary to buy flowers*”. Another participant stated that “*money that I* *would have used to buy fruit will be saved if I get fruit from trees*ö Although vegetables were given away in some cases to the ill and needy excess vegetables were sold to employees of the clinic, or to the community.

In some cases, the additional costs of obtaining some benefits were a disadvantage. For example, as stated by one participant ñ*money is needed to plant the correct plants to attract insects*ö for pollination. Additionally, this participant stated that ñ*it is nice to have a garden with nice things in it, but you need money for that.*ö Another participant stated that in order to have plants in the garden seeds had to be bought.

Some participants were not willing to pay for ESs with their own hard-earned money as one participant stated: ñ*I will not pay out of my own pocket, I am here to work, not make donations*ö

Some participants were not able to pay for the ESs because it was obtained for free. One participant stated: ñ*God's gift, I am not supposed to pay for it.*ö Money was saved because a service did not need to be bought, for example as stated by a participant ñ*money is important, if we destroy the plants, it will cost money to protect the soil.”*

5.3.2.4 Role of government in clinic gardens

According to some participants, the government had some responsibilities when concerning the clinic gardens. This role was however not regarded dominant as very little was said about it. One participant stated: ñ*if I am the government I will pay to have more different plants*ö The Department of Agriculture had provided some clinics with seed in the past.

Local governments are primarily responsible for achieving food security. These governments have to create and implement policies that ensure peace, social, political and economic stability, equity and gender equality (FAO, 1996). These policies are important so that no governing body can use food as an instrument for political and economic pressure (FAO, 1996).

5.3.2.5 Contradictory interest in politics

Most stakeholders were either for or against politics. Some participants were interested in politics and follow it; while other participants felt that politics mean nothing, and they were therefore not interested in politics. Some felt that politicians were in charge of making decisions that impact the country. The country is ruled by a political party, without political parties, there will be no politics. One participant stated: ñp*olitics are where policies are developed on how to govern and run the country*ö

5.3.3 THEME 3: Interdependence between environmental and anthropogenic components of a clinic garden

In order for health clinic gardens to exist, there must also be a collaboration between the human and natural components for the initiative to become a reality. Tzoulas *et al*. (2007) state that outdoor or indoor physical activity promotes health and well-being and is suggested to have direct health prevention and curative maintenance effects. Therefore Tzoulas *et al*. (2007) concluded that “physical health, physical activity and socio-economic and community health are inseparable”. How an ecosystem is managed is guided by human needs, socio-economic factors and cultural conditions (Tzoulas *et al*., 2007).

According to Cilliers *et al*. (2018) all gardens, including health clinic gardens can be viewed as “social-ecological systems”. As described by Berkes *et al*. (2003) social-ecological systems refer to humans and biophysical systems being inter-connected since they co-evolved. Humans are thus dependent on ecosystems for the ESs that they provide.

ESs provided by urban areas are according to Wilkerson *et al*. (2018) affected by socio-economic factors through two different yet interdependent direct pathways. Firstly, socio-economic factors have an influence on the management of urban green spaces and therefore on the supply of ESs. Secondly, socio-economic factors can alter human needs and activities which include the demand for ESs.

The clinic garden ecosystems and anthropogenic dimension meet to provide many benefits or services, as seen in **Figure 5-4**. This relationship includes the cultivation necessities to maintain a clinic garden, the emotional experiences obtained from clinic gardens, the production of food, alternative medicine use, and reasons for not having a vegetable garden.

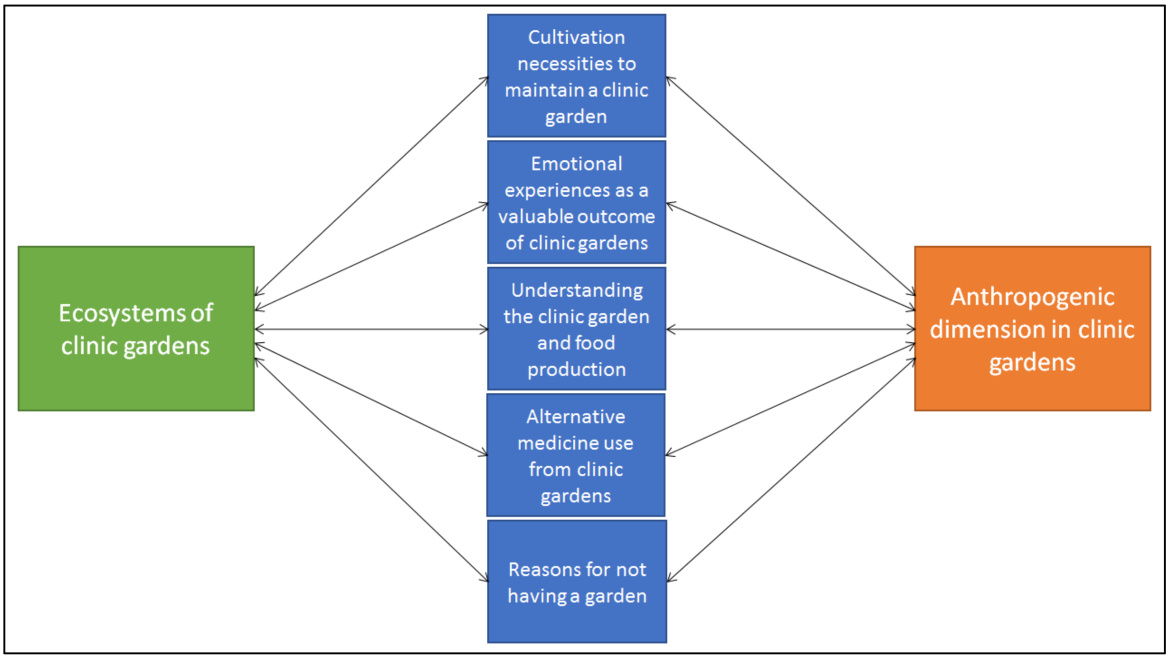


Figure 5-4: The interdependence between the ecosystems of clinic gardens environment of clinic gardens and the anthropogenic dimension in clinic gardens.

5.3.3.1 Prerequisites to cultivate a clinic garden

Cultivation necessities include prerequisites that had to be present in order for the clinic garden to be successful. These prerequisites include education, community members, facility manager, groundskeeper, plants and equipment, pollination, pest control (birds eating pests), plants protecting the soil, water (preferably from a borehole) and love for the garden (**Figure 5-5**). All of the prerequisites codes were associated with the category ŗprerequisites to cultivate a clinic gardenò as all these codes were part of other categories (**Figure 5-5**). As these clinic gardens can be described as social-ecological systems (SES) (Cilliers *et al.,* 2018), it widens our perception of ESs from being only ecological towards it being social and cultural as well (Langemeyer *et al.*, 2016). These clinic gardens serve as important places to exchange knowledge in the form of gardening skills, cultural traditions, or the physical exchange of plants, seeds and recipes (Cilliers *et al.*, 2018).

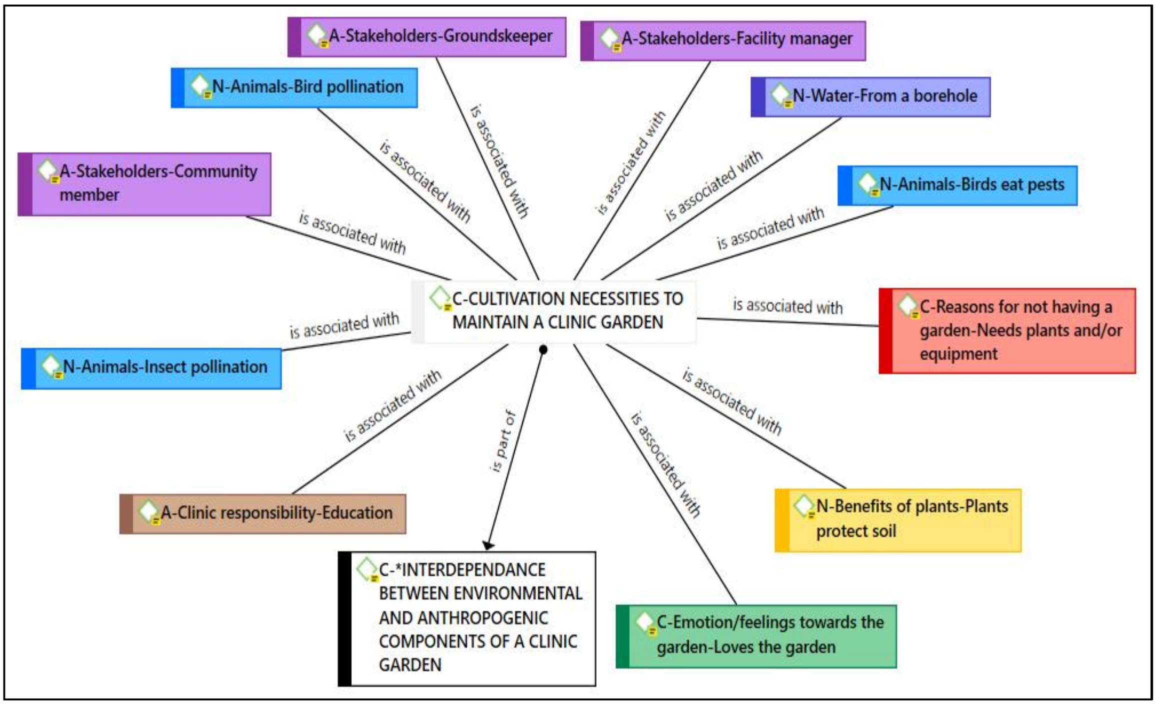


Figure 5-5: The prerequisites to cultivate a successful clinic garden.

5.3.3.2 Emotional experiences as a valuable outcome of clinic gardens

Ecosystems provide a set of non-material outputs that people view as being important, therefore the need to classify cultural ESs (Haines-Young & Potschin, 2012). These outputs are often used by people to determine their ñspiritual significanceò, ñmeaningò or ñidentityò (Haines-Young & Potschin, 2012).

There were a variety of benefits described by the participants when regarding their emotional experiences. One participant stated for example that ñ*if the garden is beautiful you will feel better if you are sick*ò. Another stated that ñ*people can come to the garden and draw, make art, or take photos*ò. A participant stated that youth were taught about art and culture and informed about bursaries. In the past, people went to the clinic garden to take wedding photos. The participants feel that the garden makes people feel better; it improves their health as one participant stated: ñ*it is healthy to be in the garden*ò. People receive healthy food, and they inhale clean air, as stated by a participant ñ*when patients are sitting on grass waiting they are inhaling fresh air*.ò Participants experience peace of mind when in the garden. The participants feel that the clinic gardens were beautiful; many had also stated that community members see the clinic gardens as being beautiful. Some people want to know how to make their gardens more beautiful. The participants stated that being in the garden makes them happy, they enjoy being in the garden. One participant stated that ñ*everyone can be happy and social with a variety of plants*ò. One participant stated that the garden attracts people to do their spiritual activities in the garden and another stated ñ*I love* *a garden*", which refers to loving nature, volunteering to work in the garden, living off the land, and/or not eating meat. It was stated that pastors or priests had visited some clinics; they were invited or went on their own. The participants feel that socialisation occurs as people were brought together at the clinic garden. There were also children playing in the garden as there was space for children to play. Some participants feel that people can pray in the garden, and prayer meetings were organised at some clinics. Prayer promotes socialisation because people do not pray alone, as stated by a participant: "*we don't pray alone, we pray as a group every morning*". The participants feel that the clinic gardens reduce stress; therefore, no treatment was required for stress as people can relax in the clinic garden.

5.3.3.3 Understanding the clinic garden and food production

Food production includes the food produced and also what was done with the produced food. According to the participants in some cases, food was given away to unemployed people, sick people, funerals and "*to patients especially those with TB, malnutrition, and underweight*". One participant said that "*they feed the unemployed and very sick, it is for malnutrition purposes. The sisters refer patients to the garden to receive food.*" At some clinics, participants felt that the presence of food tunnels makes it easier to protect plants, from bad weather. The participants had named many fruits that were produced in the clinic gardens, including lemons, oranges, tangerines and peaches. Participants stated that the food produced in the clinic gardens provides energy to make one active. One participant stated: "*oranges give energy for activities, especially when dancing*". There was, however, a loss in yield due to pests which were a "*big problem, they reduce amount of food given to patients*".

5.3.3.4 Alternative medicine use from clinic gardens

It would be expected that more would be said about plants with medicinal benefits as the interviews were with clinic personnel, which was not the case. Very little information was given on alternative medicine from the garden. These clinics could have become so westernised with only traditional healers still making use of plants as a source of medicine.

Some plants were however mentioned by the participants to have medicinal value. One of these was aloe plants which were used as a medicinal resource for example in treating high blood pressure as stated by one participant. Another remedy was a mixture made with sugar, water and lemon juice and given to people with 'flu.

5.3.3.5 Reasons for clinics not having food gardens

There were different reasons given by participants from different clinics for not having a vegetable garden (**Figure 5-6**). All of the codes were part of the category ñreasons for clinics not having food gardensò (**Figure 5-6**). These reasons include people stealing from the garden, people destroying the garden, a lack of sunlight (there were walls and trees that provide too much shade), a lack of seeds and plants and/or equipment, a lack of space as one participant stated ñ*the space is overcrowded, clinic is too small*ò and a lack of water.

Many other Sub-Saharan domestic, home and community gardens have also been found to have challenges that prevent them from delivering optimum ESs (Cilliers *et al*., 2018). These challenges include a lack of available land, safety and security issues, unavailability of water, inefficient gardening practices, loss of cultural heritage and indigenous knowledge as well as knowledge gaps regarding vegetables, and cultivation of aggressive alien species (Cilliers *et al*., 2018). Health clinic gardens can potentially address these challenges as they usually have adequate land available, are usually fenced in with many clinics having 24-hour security, and can promote co-production of knowledge from various stakeholders, including scientists, homeowners, agricultural extension officers, traditional health practitioners, community members, facility managers, and dieticians (Cilliers *et al*., 2018).

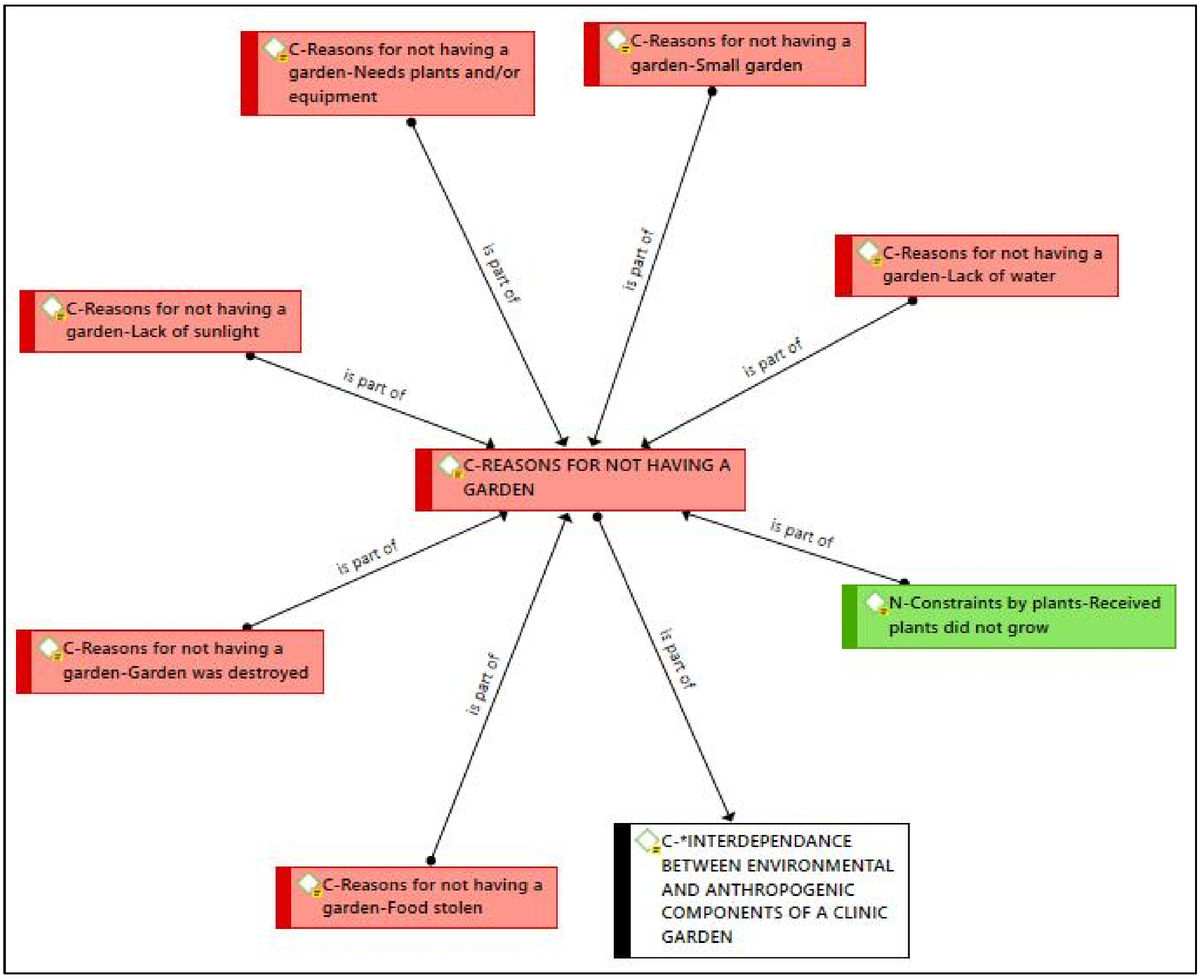


Figure 5-6: The different reasons that were given for why the clinics do not have a food garden.

5.4 Conclusion

In this chapter, the qualitative data obtained from the interviews were analysed, by transcribing the relevant data and using ATLAS.ti software for analysis. A total of 18 transcripts were analysed which resulted in 87 codes which were grouped into 14 categories which were then grouped into three themes.

The themes contain codes relating to components, positive and negative, present in health clinic gardens which contribute to the success or failure of these gardens. The participants described the ecosystems of clinic gardens as providing raw materials, carbon sequestration and storage, erosion prevention and maintenance of soil fertility, wastewater treatment, moderation of extreme events, local climate regulation and pollination which were all seen as benefits provided by plants. The negative features or constraints by plants were described by the participants as causing damage to buildings and other structures, and allergies. Other negative features of plants were that they cannot survive wastewater chemicals, plants do not grow, plants being inaccessible and trees being too small. Animals were described by the participants as either being good or bad. Good animals include birds and insects both responsible for pollination. Bad animals include ants, snakes, mice, rats, pigeons, sheep and spiders. It was also determined that the source of the water used in the clinic gardens were either from a borehole (ñboorgatò) or the municipality accessible through taps.

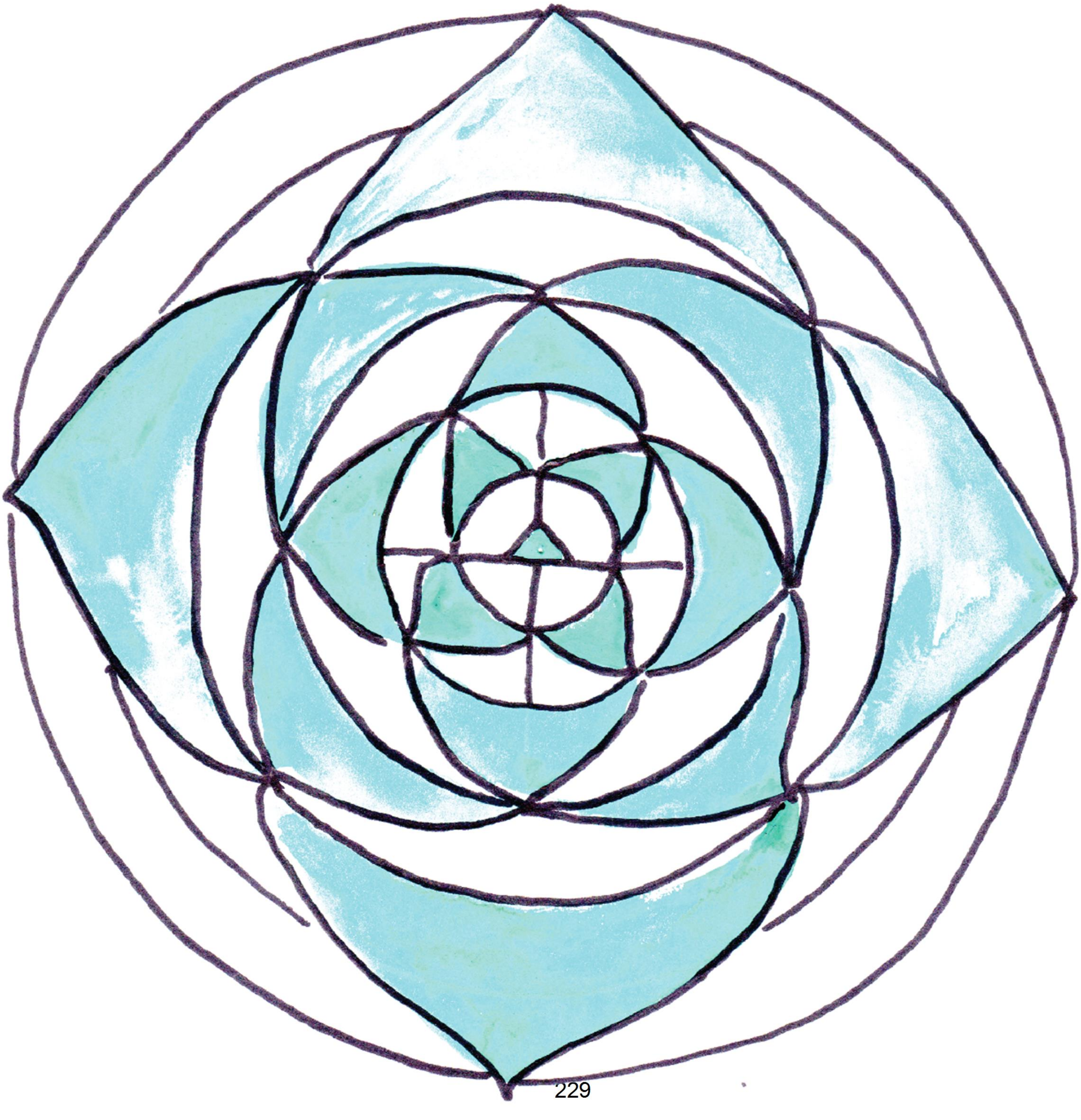
The understanding of the anthropogenic dimension of clinic gardens was that there were three main stakeholder groups, namely facility managers, groundskeepers and community members. These stakeholders had different perspectives on the role of the clinics, government, economy and politics play in the success of health clinic gardens. The perceived role of the clinics in comprehensive community health was assisting the community, being easily accessible, educating people, maintaining the trees in the garden, providing food to orphans and being a source of income. Many of these perceived roles were not actually the role of clinics, but become a burden to these clinics because they were not met by the government. The stakeholders perceive the role of the government to provide the clinics with seed and equipment in order to make the clinic gardens successful. The provisioning of seed and equipment did not, however, occur at all the clinics. There seems to be a dissonance about the free versus the fee-for-vegetables. Some participants feel that vegetables and other ESs were free and cannot be paid for, while others perceive the ES to have monetary value and were therefore important for the economy. Most participants acknowledge politics but were not really interested. Therefore, politics did not seem to play a large role in the success or failure of health clinic gardens.

All of these components come together in the health clinic gardens creating interdependence between environmental and anthropogenic components of a clinic garden. In order for people to cultivate a garden both environmental and human elements were necessary, for example, plants (natural) and equipment (human). Emotional experiences as a valuable outcome of clinic gardens were achieved when a beautiful garden (nature) inspires feelings of happiness or love (human). Food production entails growing food such as fruit (nature) and giving it away to patients (human). Alternative medicines were obtained from the garden as plants such as aloes (nature) were used to treat ailments (human). Unfortunately, there were also reasons given by participants for why the vegetable gardens at the clinic were not successful. There were different reasons including a lack of plants and seeds (nature) and food being stolen (human).

Health clinic gardens were complex social-ecological systems dependent on many different components to be successful. There were adequate inputs and resources required to create, manage and maintain the clinic gardens.

The information obtained in this chapter will support the findings of chapter 4 and may provide reasons for the different emerging phenomena that will be discussed in chapter 6.

Chapter 6: Consolidation of results on "actual value" and "perceived value" of ecosystem services in health clinic gardens



CHAPTER 6 - CONSOLIDATION OF RESULTS ON "ACTUAL VALUE" AND "PERCEIVED VALUE" OF ECOSYSTEM SERVICES IN HEALTH CLINIC GARDENS

6.1 Introduction

Urbanisation is increasing, and it is expected that the world's urban population will make up 66% of the global population by 2050 (United Nations, 2014). By 2050 it is expected that the two fastest urbanising continents, will become 56% (Africa) and 64% (Asia) urban (United Nations, 2014). This urbanisation is creating a 'gap' between humans and the natural world because humans do not depend on local ecosystems but rather on their modern lifestyles. (Miller, 2005; Stokes, 2006). As people in cities lose connection with local ecosystems, they fail to realise how dependent they are of nature (Samways, 2007).

Humans and their social and economic manifestations, as well as native and introduced plants, animals and microbes together create urban ecosystems (Pickett *et al*., 2011). Urban ecosystems can be places for people and nature to connect, as many natural areas within cities, including health clinic gardens, are social-ecological systems (SES) (Cilliers *et al*., 2018), referring to a system where humans and nature co-exist (Walker & Salt, 2006; Langemeyer *et al*., 2016). When human-nature interaction occurs, human lives are enriched which then contributes to economies and human well-being in many ways (Tengö *et al*., 2014). In order to sustainably manage these ecosystem processes, we need to maintain all knowledge originating from multiple systems (Tengö *et al*., 2014). The exchange of knowledge between a diversity of knowledge systems (co-production of knowledge) can lead to the generating of new knowledge, which could improve the capacity to react to conditions, change, responses, and in some cases fundamental relationships in the dynamics of SES (Tengö *et al*., 2014). It could also be used to determine or predict future trajectories or pathways (Tengö *et al*., 2014).

The combination of social and ecological data will aid in generating better understandings of the ecological functioning of urban areas (Goodness & Anderson, 2018), which is, however, a challenge across different disciplines as there is a lack of detailed examinations of how specific social features match up with ecological patterns and functioning (Goodness & Anderson, 2018).

The functional role of ecosystem structures and processes has 'value', but it may not have direct or indirect value in market economies (Farber *et al*., 2002). Thus, some ESs may have an ecological value but not an economic value. There may also be cases where an ecosystem is isolated from human economic activity or that the activity occurring in the ecosystem is irrelevant to humans (Farber *et al*., 2002).

This chapter will address objective 3, namely to compare/test relationships between the actual and perceived values of ESs. Correlations were used to determine if there were any associations or relationships between the number of actual values in a clinic garden and the perceived value of stakeholders.

6.2 Methods

Correlations between the data obtained from the ecological surveys (chapter 3) and the interviews (qualitative and quantitative) (chapters 4 and 5) were determined and graphs were created to indicate the relationships between all the data for the different ESs. Microsoft Excel (2010) was used to create the graphs, and to determine averages.

In the qualitative analysis only 18 of the 70 interviews were analysed and therefore the results of chapter 5 can only be used in general and not for specific clinics.

The data that was used for the correlations were obtained from the ecological data (chapter 3) and the stakeholder perceptions of ñpresenceò and ñwillingness to payò (WTP) values (chapter 4). In the cases where the actual monetary values were determined, it was compared with the WTP values as perceived by the stakeholders. In all the other cases, the actual presence of the ESs (chapter 3) was compared to the perceived presence as stated by the stakeholders (chapter 4). The ESs that were used and the reason for using them can be seen in **Table 6-1**.

Table 6-1: The ecosystem services of which the ñactual valueò and the ñperceived valueò were compared.

Ecosystem services	Reasons for inclusion
Provisioning ecosystem services	
Potential food plant species present	The potential food plant species were identified by using the literature (Chapter 3). The results were then compared to the percentage stakeholders of each clinic that perceived food to be present in the clinic gardens (Chapter 4).
The monetary value of food	The market value of the fruit and vegetables produced at the clinic garden in the last season was determined (Chapter 3) and compared to the average willingness to pay amount for the vegetables and fruit produced in the clinic gardens (Chapter 4).
Potential raw material plant species	The plant species that could potentially be used as raw materials were determined by using the literature (Chapter 3) and compared to the percentage stakeholders of each clinic garden that perceived raw materials to be present in the clinic gardens (Chapter 4).
Potential medicinal resources	The plant species with potential medicinal uses were identified making use of literature (Chapter 3) and compared to the percentage stakeholders of each clinic that perceived medicinal resources to be present in the clinic gardens (Chapter 4).
Regulating ecosystem services	
Presence of carbon sequestration and storage	The amount of carbon stored (kg) was calculated (Chapter 3) and compared to the percentage of stakeholders of each clinic garden that perceived carbon sequestration and storage to be present in the clinic gardens (Chapter 4).
The monetary value of carbon sequestered and stored	The monetary value of the sequestered carbon was calculated (Chapter 3) and compared to the average willingness to pay amounts for carbon sequestration and storage as perceived by the stakeholders at each clinic garden (Chapter 4).
Local climate regulation	The tree-crown cover was calculated (Chapter 3) and compared to the percentage of stakeholders that perceived local climate regulation to be present in the clinic gardens (Chapter 4).
Supporting ecosystem services	
Habitat for species	The percentage of each clinic garden that could potentially serve as habitat for animals and plants were calculated (Chapter 3) and compared to the percentage stakeholders that perceived habitats for species to be present in the clinic gardens (Chapter 4).
Maintenance of genetic diversity	The total number of plant species in each clinic garden was determined (Chapter 3) and compared to the percentage of stakeholders that perceived genetic diversity to be present in the clinic gardens (Chapter 4).
Cultural ecosystem services	
Aesthetic appreciation	The number of ornamental plant species was determined (Chapter 3) and compared to the percentage of stakeholders that perceived the clinic gardens to be aesthetically pleasing (Chapter 4).
Spiritual experience and cultural value	The number of plants with potential spiritual or cultural value (Chapter 3) was compared to the percentage stakeholders that perceived the clinic gardens to be of spiritual or cultural value (Chapter 4).

6.2.1 Statistical analysis

Nonparametric correlations were used as this method determines monotone associations between all ordered variables without there being strict assumptions of normality (Swanepoel *et al*., 2011). Correlation of 0.1 was regarded as small, 0.3 as medium and 0.8 as large.

6.2.2 Rating of health clinic gardens

The median values for all of the ES types rather than their average values were used to give ratings to each clinic for the different ESs (**Table 6-2**), similar to that done in Chapter 3. There was no distinction made between the different types of stakeholders. The average value of all the stakeholders at each clinic was obtained and used in determining the rating of the clinic. The median is the number that occurs in the middle of all the values if the values are placed from smallest to largest value and are used when there are outliers that would otherwise skew the data (Swanepoel *et al*., 2011), as was the case in this study. Outliers are those clinics of which the numbers were much higher than the others and stand out above the rest. In some cases, no outlier(s) were identified if there were many clinics with similar values. Median and average values were both given in all the graphs to show the difference.

For the monetary value of carbon sequestration and storage, the low, medium and high values were used for the rating of health clinic gardens.

Table 6-2: The values assigned to each clinic based on its position on the graphs.

	Clinic position on graph	**Value**
Ecological data ï actual presence of ESs	No data	0
	Below median	1
	Above median	2
	Outlier	3
Stakeholder presence of ESs perceptions	0% of stakeholders perceive ES to be present	0
	Less than 100% of stakeholders perceive ES to be present	1
	100% of stakeholders perceive ES to be present	2
Stakeholdersôwillingness to pay for ESs	Not willing to pay	0
	Willing to pay less than the actual value	1
	Willing to pay more than the actual value	2

Results of the rating of health clinic gardens in terms of the actual value and perceived value of ESs can be found in section 6.3.5.

6.3 Results and Discussion

6.3.1 Provisioning ecosystem services

The provisioning ESs that were compared can be seen in **Table 6-1**.

6.3.1.1 Food plants present

There was a correlation between the total potential food plant species and the percentage of stakeholders that perceived vegetables and fruit to be present in the health clinic gardens (**Table 6-3**). This correlation indicated that when the number of potential food plant species was higher, there was a higher percentage of stakeholders that perceived food plant species to be present in the health clinic gardens (**Figure 6-1**).

Table 6-3: The correlation between the total potential food plant species and the percentage of stakeholders that perceived food to be present in the clinic garden.

		Total potential food plant species
Percentage of stakeholders that perceived food to be present in the clinic garden	Correlation Coefficient	**.569****
	Sig. (2-tailed)	0.001

**Correlation was significant at the 0.01 level (2-tailed)

There were 19 clinics where all the stakeholders interviewed perceived the health clinic gardens to produce food. There were many clinic gardens where all of the stakeholders said food was produced, but the number of food plant species was low (**Figure 6-1**). The problem was that the number of food plant species was here not as important as the cover of the actual food plant species. The cover of the actual food plant species needs to be addressed in future studies.

Only 16 of the 19 clinics provided the researchers with data regarding the plant species and the amount that was given away. The remaining three clinics stated that no vegetables or fruit were given away in the previous growing season (2017/18) even so they still perceived the clinic gardens to produce food. An example of this was Jan Kempdorp community health centre that had a vegetable garden and numerous fruit trees, but they gave none of the produce away.

The clinics with the most potential food plant species were Steve Tshwete (27 species), Khuma (27 species) and Jan Kempdorp (23 species) (Chapter 3) (**Figure 6-1**). All the interviewed stakeholders at these three clinics perceived the gardens to produce food. Of these three stakeholders perceived the provision of food to be sufficient, while another three perceived it to be insufficient. Possible reasons why some stakeholders perceived food plant species to be insufficient was that there were pests in the clinic gardens that reduced the yield of vegetables and fruit, lack of space, lack of water, lack of sunlight, and a lack of seeds and equipment (Chapter 5).

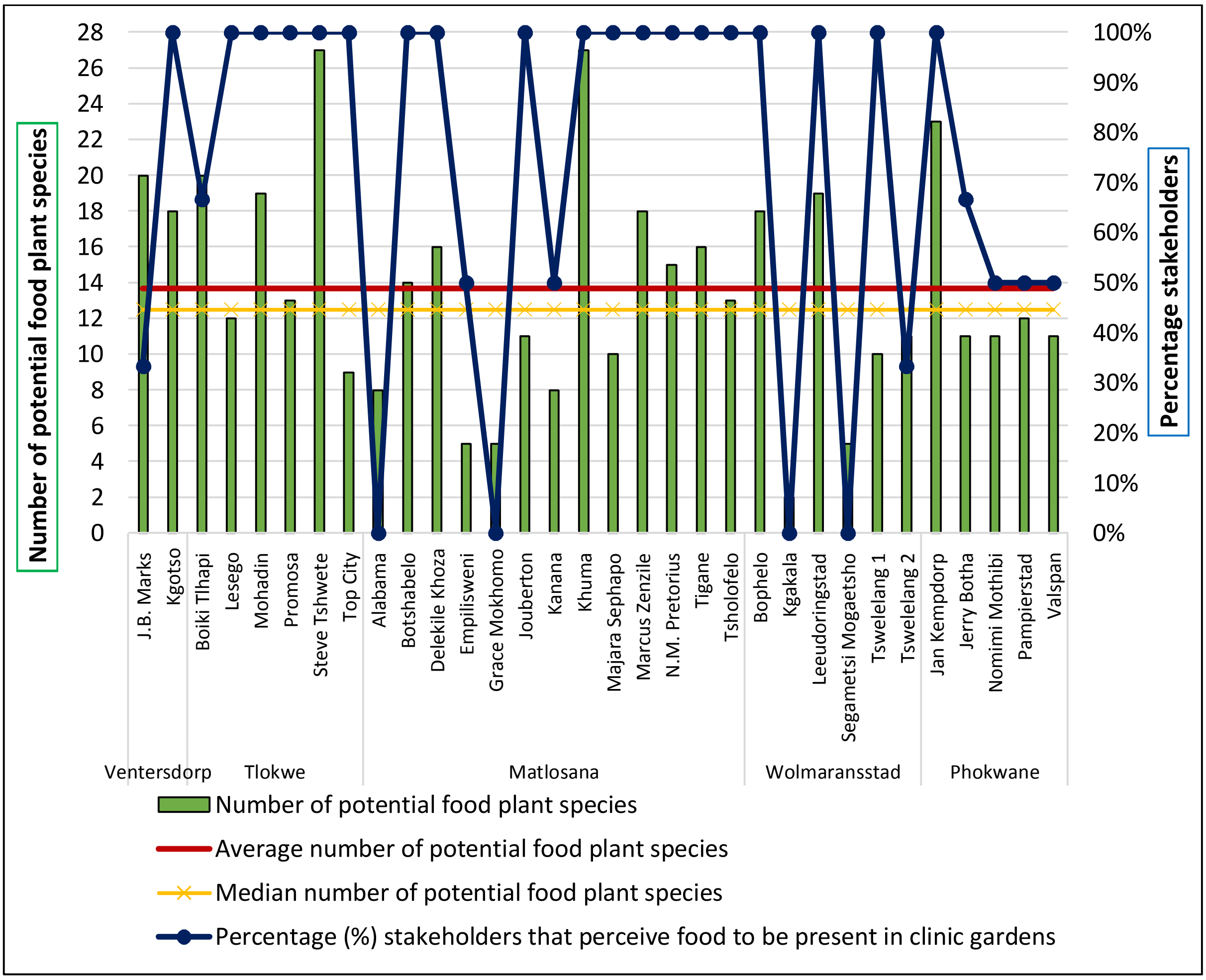


Figure 6-1: The number of potential food plant species identified at each health clinic garden and the percentage of stakeholders at each clinic that perceived the clinic garden to produce food.

The clinic garden that produced the most vegetable and fruit species that were given away (mentioned in Chapter 3) was Nomimi Mothibi clinic with nine food plant species. However, only the facility manager perceived the clinic garden to produce food. The other stakeholder was a general assistant that stated that in 2018 there were no seeds or plants available to plant. The vegetables and fruit that were produced in the clinic garden were for the year 2017. There was thus a dissonance between the perceptions of different stakeholders. The one seemed to take the potential into account while the other only acknowledged the state the garden was in at the time of the interview. In future, it would add clarity if a time frame is given to the stakeholders so that such problems do not occur.

At two health clinic gardens (Grace Mokhomo and Kgakala) estimates were provided of food given away in the last growing season, even so, all the stakeholders interviewed at these two clinics perceived the clinic gardens to produce no food. At the Grace Mokhomo CHC, the groundskeeper stated that there was a vegetable garden in the past but was discontinued due to people stealing the produce. The vegetables and fruit that were produced in the Grace Mokhomo CHC garden were thus for the year 2017. At the Kgakala clinic the groundskeeper stated that there was not enough space to have a vegetable garden, there was a vegetable garden in the past (2017), but since then the space available has decreased. It was also stated that someone that previously "helped" in the garden stole vegetables (Chapter 5).

Food is an essential ES needed to maintain life, as it addresses food security and diet improvement (TEEB, 2011; Langemeyer *et al*., 2016). For these reasons, it is important for clinics to have successful well-functioning food gardens of especially leafy greens and tomatoes that are suited to be grown in large quantities in smaller areas (Ackerman *et al*., 2014). Leafy greens could be an important source of food in rural communities as they are often well adapted to survive with little water and little maintenance (Jansen van Rensburg *et al*., 2007, Cornelius, 2016). Greater awareness of the usefulness of these leafy greens should be made at health clinics (Cornelius, 2016).

6.3.1.2 Thye monetary value of food

There was no correlation between the market value of vegetables and fruit produced and the average willingness to pay for the vegetables or fruit by the stakeholders (**Table 6-4**).

Table 6-4: The correlation between the market value of vegetables and fruit produced and the average willingness to pay for vegetables and fruit by the stakeholders.

		The market value of vegetables and fruit produced (rand)
Average WTP for food	Correlation Coefficient	0.216
	Sig. (2-tailed)	0.236

The clinic garden that produced vegetables and fruit with the highest market value was Nomimi Mothibi clinic (R 1653.81) (Chapter 3) (**Table 6-2**). The stakeholders, however, were not willing to pay very much for the food produced in this garden (Chapter 4).

There were 12 clinics that produced no fruit and vegetables in the 2017/18 growth season or gave none of the produce away. Of these only the stakeholders of five clinics seemed to take this into account and were not willing to pay for the vegetables and fruit. Possible reasons for the clinics to not have given any food away was that people steal from the garden, people destroy the garden, a lack of sunlight, a lack of seeds and plants and/or equipment in order to have and maintain the garden, a lack of space and a lack of water (Chapter 5).

There were almost equal numbers of clinics where the actual value was more than the WTP and where the WTP values were more than the actual value, which could indicate that the stakeholders do not realise what the value of the food was that was produced in the clinic gardens. There were three clinics, namely Promosa, Leeudoringstad, and Jerry Botha, where the actual value and willingness-to-pay values were very similar.

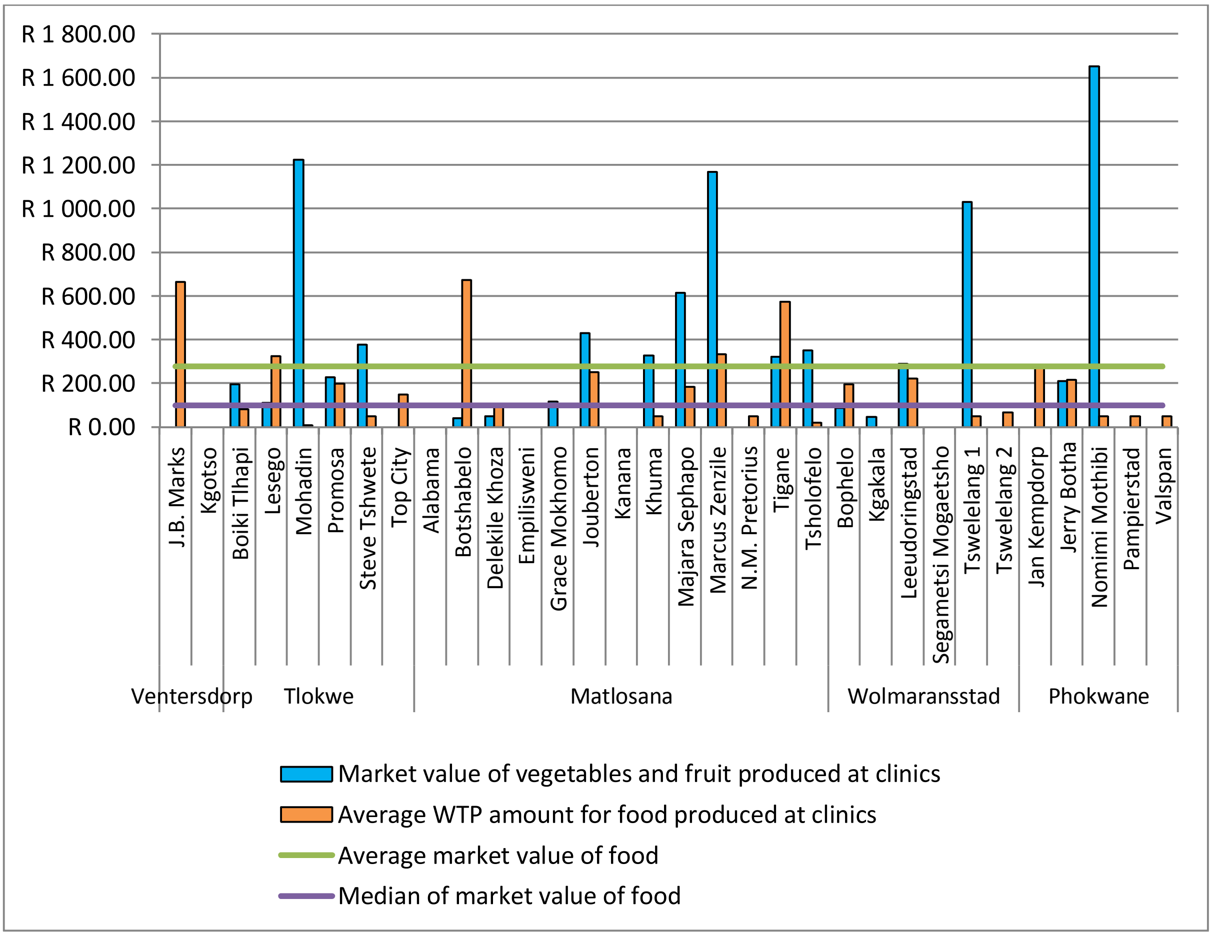


Figure 6-2: The comparison between the monetary value of vegetables and fruit produced in the clinic gardens with the willingness-to-pay (WTP) values of interviewed the stakeholders.

A few stakeholders did not seem to understand the willingness to pay question as they were willing to pay for something that was not produced or present in the clinic gardens. Some stakeholders said that they could not pay for something that they get for free, that was regarded as a ŋgiftò(Chapter 5).

According to Dallimer *et al*. (2014), it is apparent that the perceptions of the value of nature that humans have may be different from the actual economic value derived. The values people place on ecosystem functions, structures and processes may not always express the full value, because humans are one of many species present in an ecosystem (Farber *et al.*, 2002).

It has been found in a study by Zeithaml (1988) that there are different perceptions people may have of 'value'. Firstly, value is something which has a low price; secondly, value is whatever I want in a product; thirdly, value is the quality I get for the price I pay or value is what I get for what I give. This variety of meanings for value makes researching value difficult, according to Zeithaml (1988).

6.3.1.3 Raw materials

There was no correlation between the total number of potential raw material plant species and the percentage of stakeholders that perceived raw materials to be present (**Table 6-5**).

Table 6-5: The correlation between the total number of potential raw material plant species and the percentage of stakeholders that perceived raw materials to be present.

		Total number of potential raw material plant species
Percentage stakeholders that perceived raw materials to be present	Correlation Coefficient	-0.024
	Sig. (2-tailed)	0.898

There were five clinics where all the stakeholders interviewed perceived the gardens to produce raw materials and nine clinics where the stakeholders did not perceive the gardens to produce any raw materials (**Figure 6-3**). One of the benefits of plants identified through a qualitative analysis (Chapter 5) was that plants provide wood. Participants had gathered or observed others gather wood from the trees within the health clinic boundaries to be used as firewood. These fires were often used to prepare meals. One participant stated that the wood from an old tree was used for fire making. It was also stated that people collect wood to sell as a means of income.

The clinics with the most potential raw material plant species were Jan Kempdorp (26 species), Steve Tshwete (20 species), Khuma (20 species) and Leeudoringstad (20 species) (**Figure 6-3**). At Jan Kempdorp CHC alone, all the interviewed stakeholders perceived the clinic garden to provide raw materials, but they perceived it to be insufficient. The stakeholders at three of these clinics with the highest numbers of raw material plant species did not seem to realise the benefits plants provide in terms of raw materials. In the study of Cornelius (2016) 49.71% of the stakeholders perceived raw materials to be valuable. There is thus a need to inform stakeholders of the health clinic gardens of the benefits obtained from plants in the form of raw materials, but this should probably not be a main function of the health clinic gardens due to lack of space.

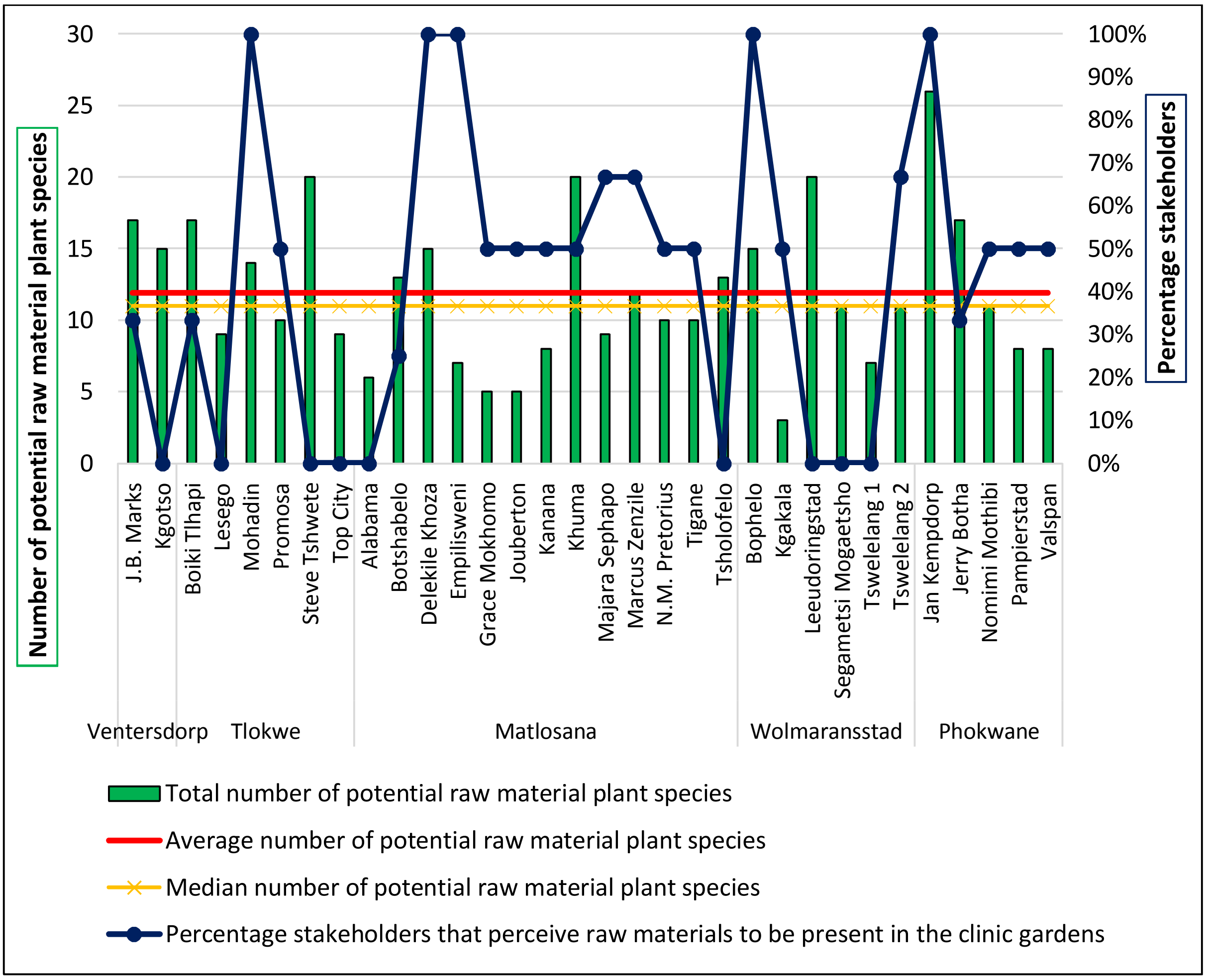


Figure 6-3: The total potential raw materials plant species identified in each health clinic garden and the percentage of stakeholders at each clinic that perceive the garden to produce raw materials.

A variety of raw materials could be obtained from ecosystems, including wood, biofuels and plant oils (TEEB, 2011), but at health clinic gardens wood is the main raw material obtained, but not in large quantities. Firewood plays a vital role in providing households with a source of energy. Some wood from trees in the health clinic gardens could be sustainably sourced to provide even more households with this vital service. About 12% of households in the Phokwane sub-district (Northern Cape) and Dr Kenneth Kaunda District Municipality (North West), do not have access to electricity for cooking. A further 8% of households in all five sub-districts, do not have access to electricity for lighting (STATS, 2018a, b). The trees at health clinic gardens were however not enough to provide all households with firewood, but some households may be benefited especially at the larger clinic gardens.

6.3.1.4 Medicinal resources

There was no correlation between the total number of potential medicinal plant species and the percentage of stakeholders that perceived medicinal resources to be present (**Table 6-6**).

Table 6-6: The correlation between the total number of potential medicinal plant species and the percentage of stakeholders that perceived medicinal resources to be present.

		Total number of medicinal plant species
Percentage stakeholders that perceived medicinal resources to be present	Correlation Coefficient	0.085
	Sig. (2-tailed)	0.645

There were only seven clinics where all the interviewed stakeholders perceived the clinic gardens to produce medicinal resources, while stakeholders from 14 clinics did not perceive the clinic gardens to be a source of medicinal resources (**Figure 6-4**).

Through qualitative analysis (Chapter 5) it was determined that the stakeholders make use of alternative medicines obtained from the health clinic gardens, but they were not aware of a large number of other potential medicinal plant species in the garden. Plants used include aloes and lemons. Aloes were especially used as a medicinal resource for example in treating high blood pressure as stated by one participant. A common ‘flu remedy was made from a mixture of sugar, water and lemon juice.

The clinics with the most potential medicinal plant species were J.B. Marks (31 species), Steve Tshwete (31 species), Boiki Tlhapi (28 species) and Khuma (27 species) (**Figure 6-4**). At none of these clinics did all the interviewed stakeholders perceive the clinic gardens to be a source of medicinal resources, while at Steve Tshwete clinic none of the interviewed stakeholders perceived the clinic garden to provide medicinal resources. Cornelius (2016) also found that few people realised the value of medicinal resources as only 56.63% of the stakeholders perceived this ES to be valuable. In the study of Bojanala District Municipality by Cornelius (2016) a few Traditional Health Practitioners (THPs) were involved in the health clinic gardens, which were not the case in this study. One reason why the stakeholders do not know about the medicinal values of plants could be because the plants were located in the gardens of health clinics, where people were supplied with medications for specific ailments. There may thus not be a need for additional medications. Some well-known remedies such as the use of aloes and lemons may still be used as these plants are better known (Van Wyk *et al*., 2009).

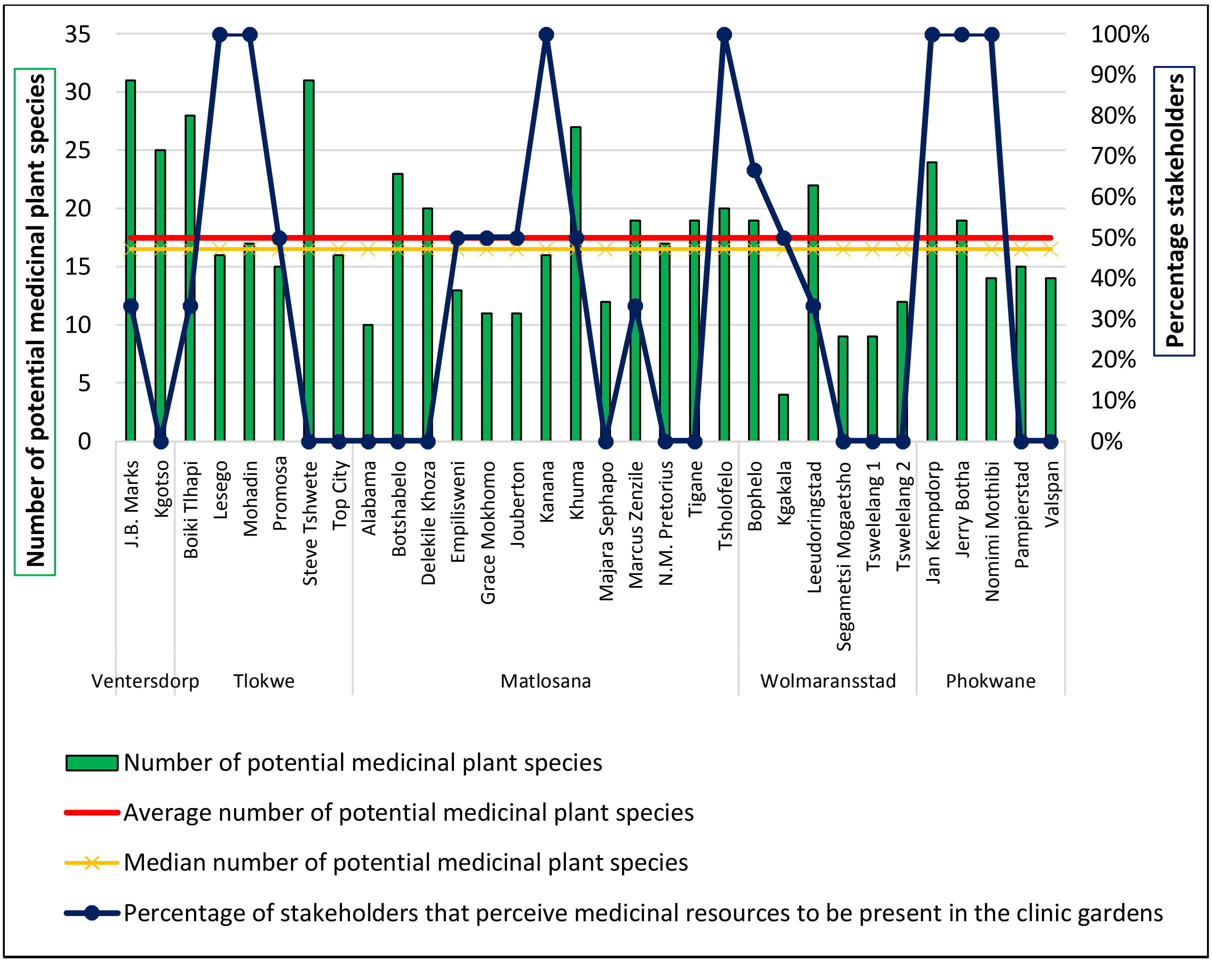


Figure 6-4: The number of potential medicinal plant species identified in each health clinic garden and the percentage of stakeholders that perceived the health clinic gardens to produce medicinal resources.

The clinic gardens contain a variety of plant species that could potentially be used as traditional medicines, as the use of plants to treat ailments has been part of the human culture since ancient times (Van der Merwe *et al*., 2001; Van Wyk *et al*., 2009). Even though the clinics provide patients with medication, the community could also be taught about specific plants that could be used to treat minor ailments and how to harvest these plants sustainably.

6.3.2 Regulating ecosystem services

The regulating ESs that were compared can be seen in **Table 6-1**.

6.3.2.1 Presence of carbon sequestration and storage by trees

There was no correlation between the amount of carbon sequestered and stored and the percentage of stakeholders that perceived carbon sequestration and storage to be present (**Table 6-7**).

Table 6-7: The correlation between the amount of carbon stored and the percentage of stakeholders that perceived carbon sequestration to be present.

		Amount of carbon stored (kg)
Percentage of stakeholders that perceived carbon sequestration to be present	Correlation Coefficient	0.012
	Sig. (2-tailed)	0.950

It is important to note that all plants sequester and store carbon. However, for this study, only trees were considered. At 26 clinics all of the interviewed stakeholders perceived the trees in the clinic gardens to sequester and store carbon (**Figure 6-5**). Only at one clinic did none of the stakeholders perceive the clinic garden to sequester and store carbon, as there were no large trees (Chapter 3). It would seem that some stakeholders had basic knowledge about carbon sequestration and storage, as one stakeholder said that in school it was taught that ñ*plants inhale carbon dioxide*ò (Chapter 5).

The clinics with the most potential to sequester and store carbon were Jan Kempdorp and Botshabelo (**Figure 6-5**). At both of these clinics, all of the interviewed stakeholders perceived this service to be present in the health clinic gardens, and both the stakeholders at the Jan Kempdorp CHC perceived this service to be sufficient. One aspect to consider is the fact that the frame of reference may influence the perceptions of the stakeholders. For example, at the Botshabelo clinic, two stakeholders perceived it to be sufficient and the other two perceived it to be insufficient, these two may have compared the clinic garden with the larger area around the clinic even though they were informed only to consider the clinic garden.

At the Tswelelang 1 clinic, there were only one tree species considered for carbon sequestration, namely a *Ziziphus mucronata* tree that was cut in the past and started to resprout and was thus still small. Because the tree was still small could have contributed to the fact that none of the stakeholders at this clinic perceived the trees to sequester and store carbon.

The vegetation in the clinic gardens can regulate air quality by removing pollutants such as greenhouse gasses from the atmosphere (Gómez-Baggethun *et al*., 2013; TEEB, 2011). Plants also remove carbon dioxide from the atmosphere and store it in their tissues (Gómez-Baggethun *et al*., 2013; TEEB, 2011). Stakeholders of the clinic gardens should, therefore, be informed of the benefits plants, especially trees, provide and they should be encouraged to plant more trees.

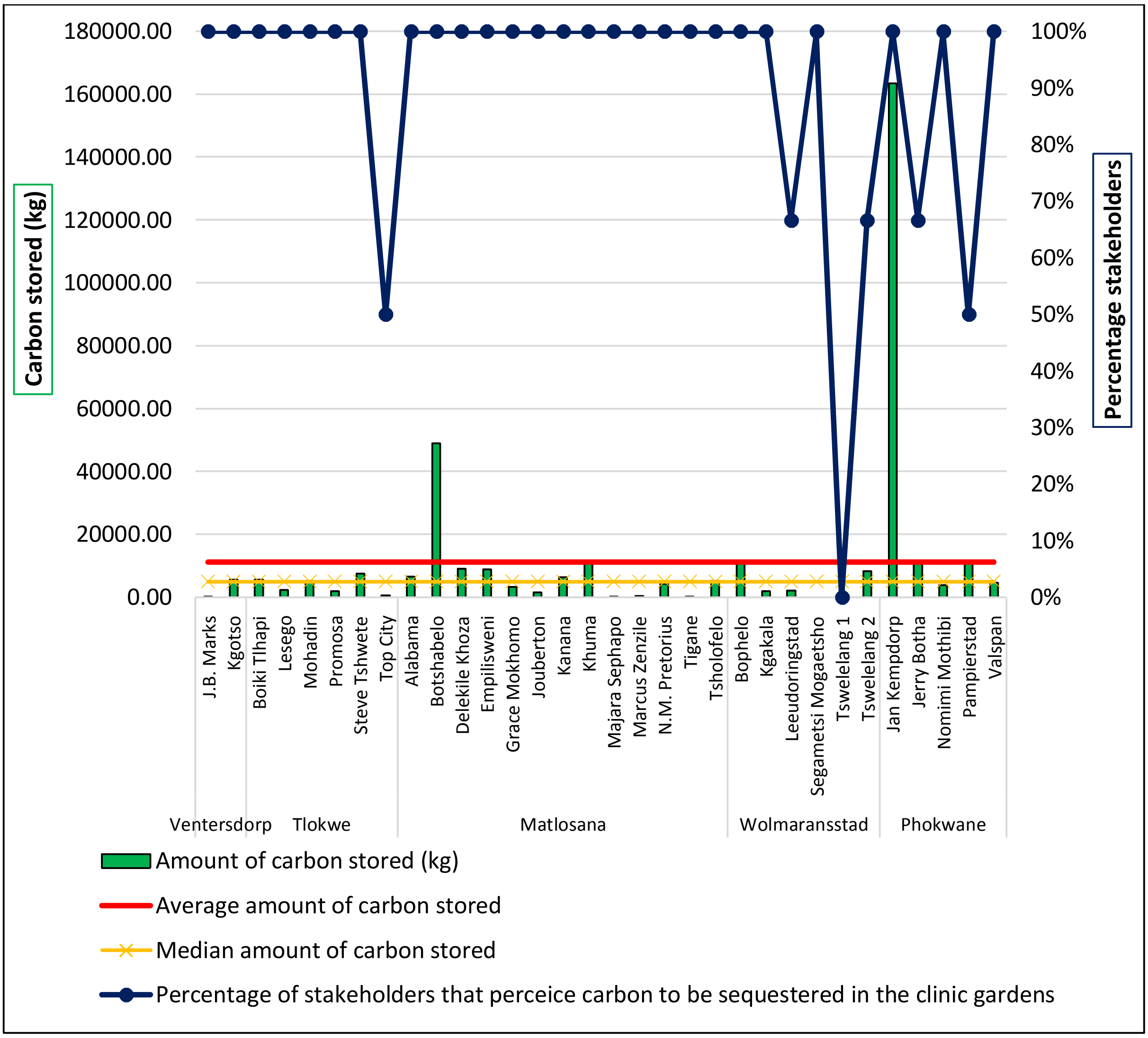


Figure 6-5: The amount of carbon sequestered and stored within the trees at each clinic garden and the percentage of stakeholders that perceive the clinic gardens to sequester and store carbon.

6.3.2.2 The monetary value of carbon sequestration and storage

There was no correlation between the value of the sequestered and stored carbon and the average willingness to pay for carbon sequestration and storage (**Table 6-8**).

Table 6-8: The correlation between the value of stored carbon and the average willingness to pay (WTP) amount for carbon sequestration and storage.

		Value of stored carbon (rand)
Average WTP for carbon sequestration and storage	Correlation Coefficient	0.199
	Sig. (2-tailed)	0.276

Initially, the actual value calculated for carbon sequestration (Chapter 3) was directly compared to the average willingness-to-pay (WTP) values as perceived by the stakeholders

(Chapter 4) (**Figure 6-6**). Generally, the actual value was much higher than the willingness to pay values, therefore the need for a primary and secondary y-axis (Microsoft Excel, 2010). **Figure 6-6** was however not a good comparison between the two values.

When considering only **Figure 6-6**, it seemed that the stakeholders did not realise how valuable the carbon was that was sequestered by the plants in the health clinic gardens. This was especially reflected by the high carbon value of Jan Kempdorp clinic (R 71932.02) and the low willingness to pay value of R 160.00. Carbon as a value was not widely known and the concept of carbon having a value was a bit strange. Most of the stakeholders probably also did not understand this concept as was discussed in Chapter 4. Carpenter and Folke (2006) stated that for some ESs there are existing markets, such as for food products, while for other ESs markets are emerging, such as for carbon sequestration or pollutant emission quotas. Therefore, people may associate economic value more with certain ESs than with others.

There was, however, an issue with scale, as the actual values were generally much higher than the willingness-to-pay values. Therefore, a scale was created to represent low, medium and high values both for the actual and WTP values (**Table 6-9**).

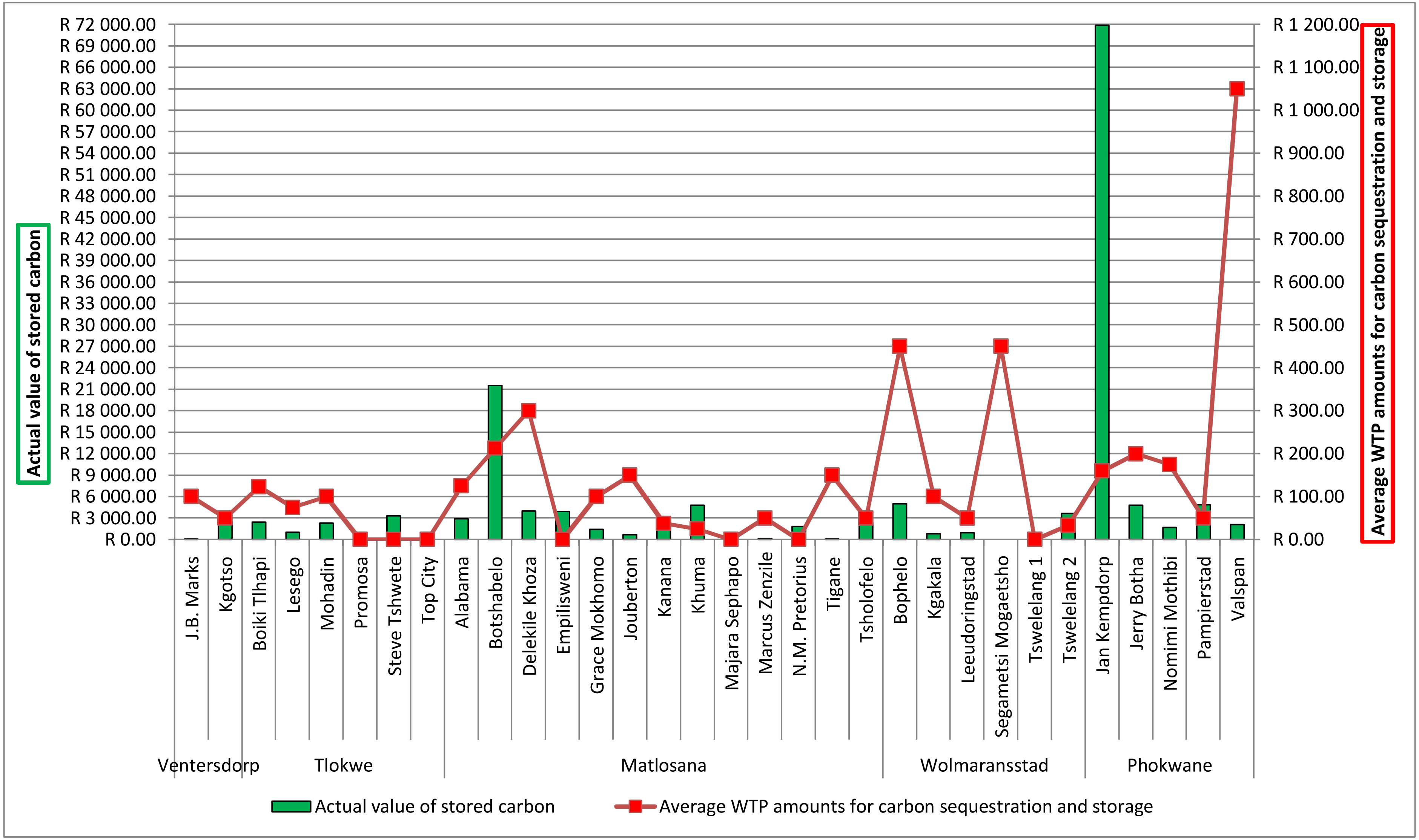


Figure 6-6: The comparison between the actual monetary value of carbon stored in trees and the WTP values of stakeholders.

In order to make a more accurate comparison between the actual values and willingness-to-pay values, a scale was developed to rate values in terms of low, medium and high value (**Table 6-9**). This scale was used to subjectively assign each clinic with a value of 1, 2, or 3 for both the actual and WTP values (**Figure 6-7**). A 3-colour scale was used under conditional formatting in Microsoft Excel (2010) to distinguish between the minimum, midpoint and maximum values. The colours (red, yellow and blue) were then used to subjectively classify values into the low, medium or high groups.

Through this comparison, there were 12 clinics where the actual values and the WTP values were in the same scale value, with either a low or medium value. There were no clinics where the actual and WTP values both had a high value. It was interesting to note that there were nine clinics where the WTP values were higher than the actual values. Through this comparison, the previous findings may not be relevant as it was possible that the stakeholders were aware of the value of carbon sequestration, but cannot apply it correctly to their specific environment. Even so, this will not be known until it is specifically tested. It could be that the high WTP values they gave were an indication that they do not understand the concept of carbon sequestration at all.

Table 6-9: The scale used to assign ñlow, medium or highò to every actual value determined and average willingness-to-pay values.

	Low	Medium	High
Actual	R 0.00 ï R 1018.00	R 1019.00 ï R 5032.00	R 5033.00 ï R 71933.00
WTP	R 0.00 ï R 50.00	R 51.00 ï R 213.00	R 214.00 ï R 1050.00
	1	**2**	**3**

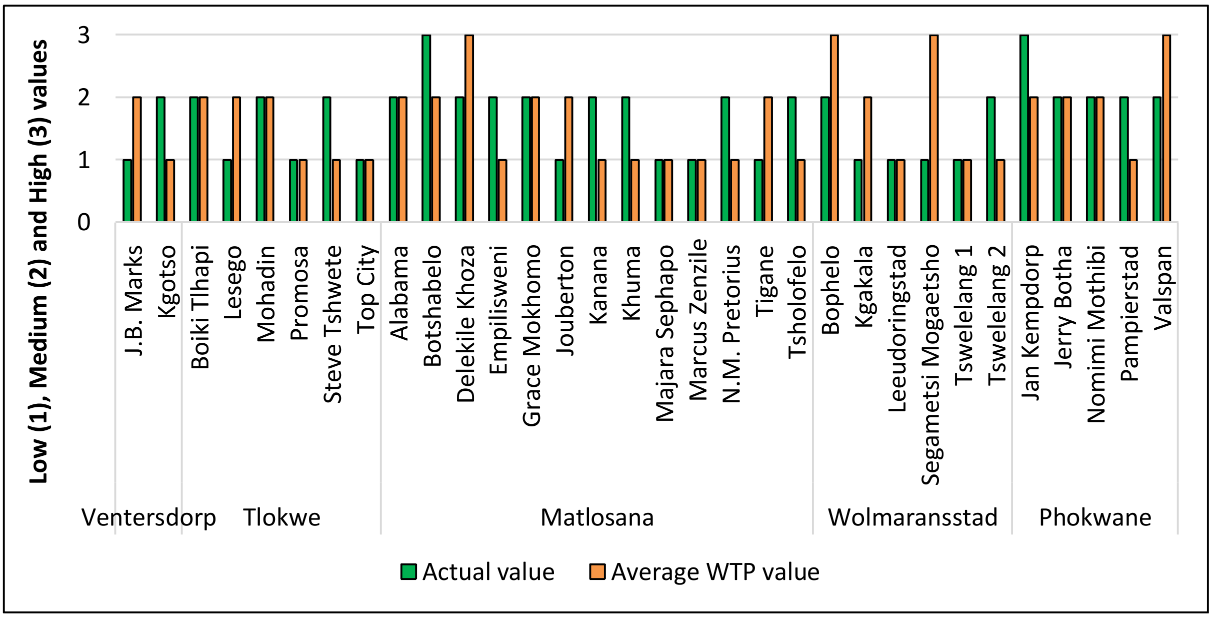


Figure 6-7: The scale values representing the actual values and average willingness-to-pay (WTP) values. A low value was represented by a 1, a medium value by a 2, and high value by a 3.

6.3.2.3 Local climate regulation

There was a correlation between the total tree cover and the percentage of stakeholders that perceived local climate regulation to be present in the health clinic gardens (**Table 6-10**). In all five cases where there were no trees, all stakeholders realised that this specific ES was not present (**Figure 6-8**).

Table 6-10: The correlation between the total tree cover and the percentage of stakeholders that perceived local climate regulation to be present in the clinic gardens.

		Total tree cover (m^2)
Percentage of stakeholders that perceived local climate regulation to be present	Correlation Coefficient	**.653****
	Sig. (2-tailed)	0.000

**Correlation was significant at the 0.01 level (2-tailed)

The crown cover of all the trees within the clinic gardens was measured to calculate the tree cover in m^2 (Chapter 3). During the interviews, the participants were asked whether they perceived the clinic gardens to regulate the local climate by providing shade (Chapter 4). The number of participants (stakeholders) that perceived the clinic gardens to regulate the local climate was calculated as a percentage of all stakeholders interviewed at each clinic (**Figure 6-8**). There were 21 clinics where all the interviewed stakeholders perceived the clinic gardens to regulate the local climate.

The clinics with the most potential to regulate the local climate were Jan Kempdorp, Botshabelo, Pampierstad and Empilisweni (**Figure 6-8**). At all four of these clinics, all of the interviewed stakeholders perceived the plants to regulate the local climate, and seven stakeholders perceived this ES to be sufficiently present in comparison to two that perceived it to be insufficient. It would seem that stakeholders had a deeper understanding of regulating ESs that clinic gardens provide, even embracing them without necessarily consciously knowing about them (Cornelius, 2016). This knowledge might have been obtained from working in gardens (groundskeepers and community members) or by previous generations who might have needed this information to survive harsh conditions (Wenger, 1998; Cornelius, 2016). This transferring of knowledge could be seen as an example of social-ecological memory, as information was transmitted from one generation to the next (Barthel *et al*., 2010; Reyes-Garcίa *et al*., 2014).

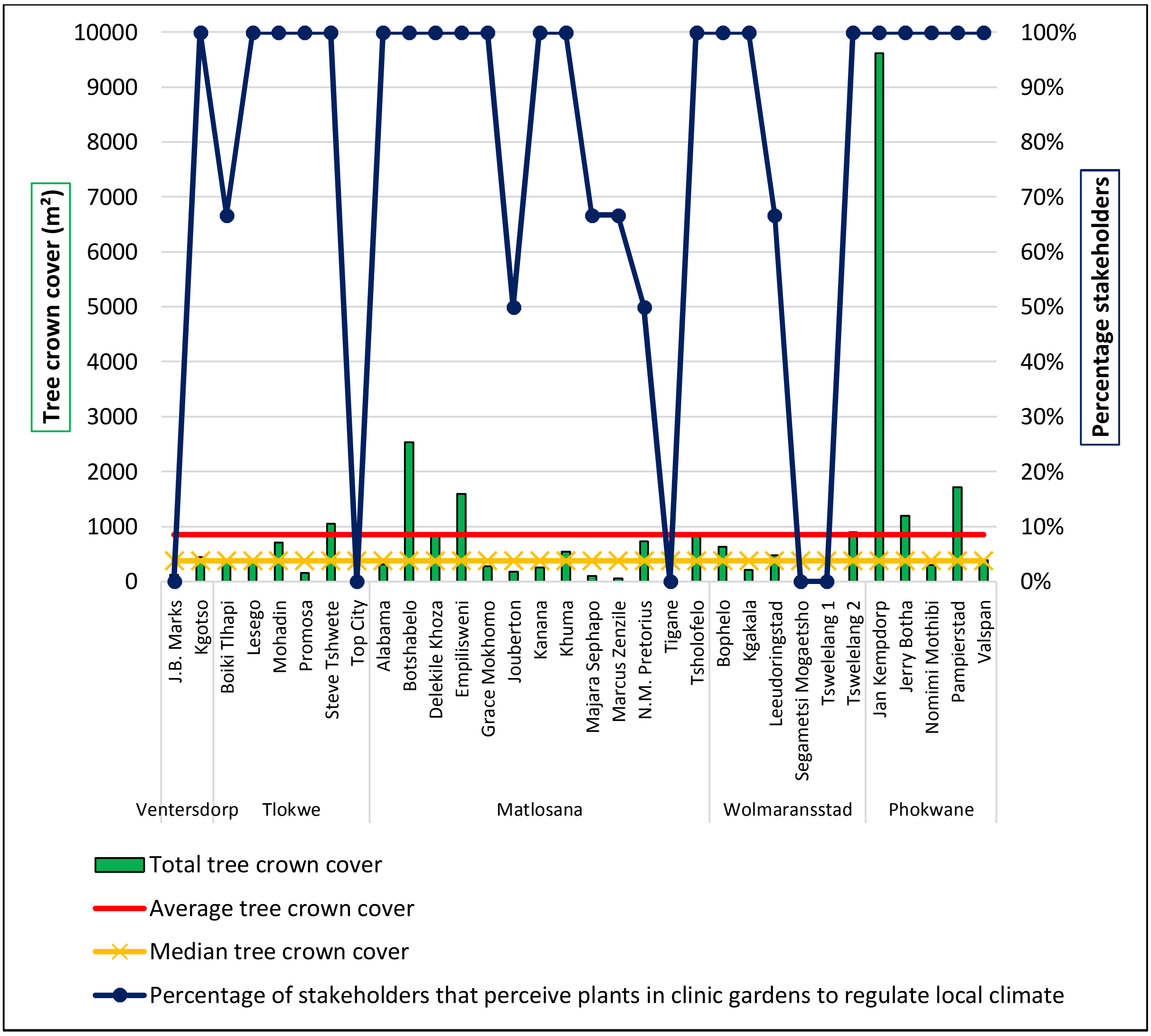


Figure 6-8: The total tree crown cover (m^2) in each health clinic garden and the percentage of stakeholders at each clinic that perceived the plants in the clinic gardens to regulate the local climate.

Vegetation in urban areas is important in lowering the temperature by shading and through absorbing heat from the air (Gómez-Baggethun *et al.*, 2013; TEEB, 2011).

6.3.3 Supporting ecosystem services

The supporting ESs that were compared can be seen in **Table 6-1**.

6.3.3.1 Habitat for species

There was no correlation between the percentage of the garden potentially available as habitat for animal and plants and the percentage of stakeholders that perceived habitats for species to be present in the health clinic gardens (**Table 6-11**). Although there was some awareness of the importance of the clinic gardens as habitats for species it was not based on real experience from the clinic gardens.

Table 6-11: The correlation between the percentage of the gardens potentially habitable for species and the percentage of stakeholders that perceived habitats for species to be present in the clinic gardens.

		Percentage of garden potentially habitat for plants/birds
Percentage of stakeholders that perceived habitats to be present	Correlation Coefficient	-0.171
	Sig. (2-tailed)	0.349

The habitat for species was determined by measuring the habitable micro-gardens, which includes lawn, vegetable garden, naga, ornamental garden, medicinal garden and hedge (Molebatsi *et al*., 2010) (Chapter 3). This habitable garden space was then calculated as a percentage of the entire yard of each health clinic garden (**Figure 6-9**). During the interviews, the participants were asked whether they perceived habitat to be present for plants and animals in the health clinic gardens (Chapter 4). The number of participants (stakeholders) that perceived the clinic gardens to provide habitat was calculated as a percentage of all stakeholders interviewed at each clinic (**Figure 6-9**). There were seven clinics where all the stakeholders perceived the clinic gardens to provide habitat for plants and animals, but only one of these clinics had more than the average percentage of habitat for space. There were also seven clinics where the stakeholders perceive the clinic garden not to provide habitat and interestingly three of these clinics had higher average percentages of habitats present. There was only one clinic of which the garden was 100% habitable by plants and animals, but not all of the stakeholders at this clinic seemed to realise this.

Some clinics had a tiny percentage of the entire garden that could serve as habitat for species. Even so, there were still stakeholders that perceived the clinic gardens to provide habitat. This is a good indication that the stakeholders seem to be aware of the ecological value a garden has in supporting fauna and flora but failed to apply this knowledge to their specific environment.

The clinics with the most potential to provide habitat for plants and animals were Marcus Zenzile, Empilisweni and N.M. Pretorius (**Figure 6-9**). None of the interviewed stakeholders at N.M. Pretorius clinic perceived the garden to provide habitat. There was only one stakeholder that perceived habitat for species to be sufficiently present, and only two that perceived it to be insufficient. In the study by Cornelius (2016), it was also found that few stakeholders viewed clinic gardens as possible habitats for animals and plants. Interestingly the stakeholders viewed the gardens more as places where animals pass through

(Cornelius, 2016). Therefore, as with the study of Cornelius (2016), there might be a lack of understanding of the importance of clinic gardens in providing habitats for species.

The clinic gardens were said by many stakeholders to be a habitat for birds, as the birds seem to love and enjoy the gardens (Chapter 5). Other animals living in the clinic gardens were perceived as being pests, including mice, rats, pigeons, snakes and spiders (Chapter 5).

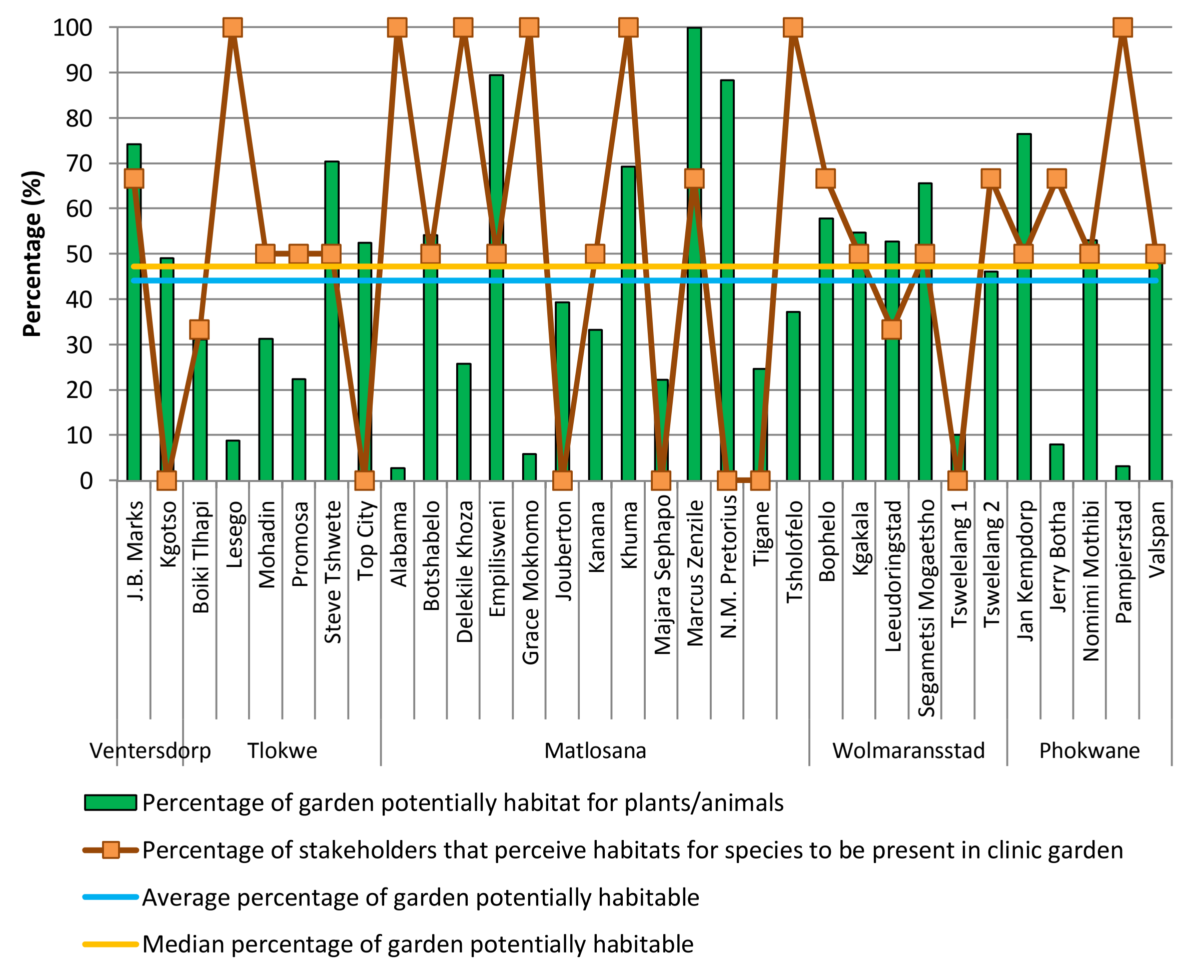


Figure 6-9: The comparison between the percentage of the garden potentially available for species and the number of stakeholders at each health clinic garden that perceive the garden to be a habitat for species.

Gardens, in general, may provide a place of refuge for many animal and plant species because it provides food, water and shelter (De Groot *et al*., 2002; Gómez-Baggethun *et al*., 2013; TEEB, 2011). The benefits of clinic gardens providing habitat for species should be communicated to the stakeholders to give them a better idea of how linked all species were within an ecosystem.

6.3.3.2 Maintenance of genetic diversity

There was no correlation between the total number of plant species and the percentage of stakeholders that perceived genetic diversity to be present in the health clinic gardens (**Table 6-12**).

Table 6-12: The correlation between the total number of plant species and the percentage of stakeholders that perceived genetic diversity to be present in the clinic gardens.

		Total number of plant species (maintenance of genetic diversity)
Percentage of stakeholders that perceived genetic diversity to be present	Correlation Coefficient	0.088
	Sig. (2-tailed)	0.633

At all the clinics, except one, all the stakeholders perceived the health clinic gardens to maintain genetic diversity (**Figure 6-10**). The clinics with the most potential to maintain genetic diversity were J.B. Marks (70 species), Steve Tshwete (66 species), Khuma (65 species), Jan Kempdorp (63 species) and Leeudoringstad (58 species) (**Figure 6-10**). All the stakeholders interviewed at these clinics perceived this service to be present in the health clinic gardens. Of these four stakeholders perceived this ES to be sufficiently present while eight stakeholders perceived it to be insufficient. In order for people to have respect and a sense of ownership for diversity, people have to come in contact with nature (Nakanshi *et al*., 2012). This connection with nature could be why stakeholders that work more in the garden seemed to realise the genetic diversity present in the clinic gardens more than other stakeholders.

Urban gardens play an important role in the conservation of genetic diversity (Molebatsi *et al*., 2010; Cornelius, 2016), as they potentially provide living space to resident and migratory species (De Groot *et al*., 2002). Genetic diversity is not always seen as an ES, but instead supports the supply of the other ESs (WBCSD, 2011). Therefore, an increase in genetic diversity could lead to an increase in all the other ESs (Bishop & Timberlake, 2007). The importance of genetic diversity has to be communicated with the stakeholders of the clinic gardens so that they can maintain or increase the plant diversity present in the gardens.

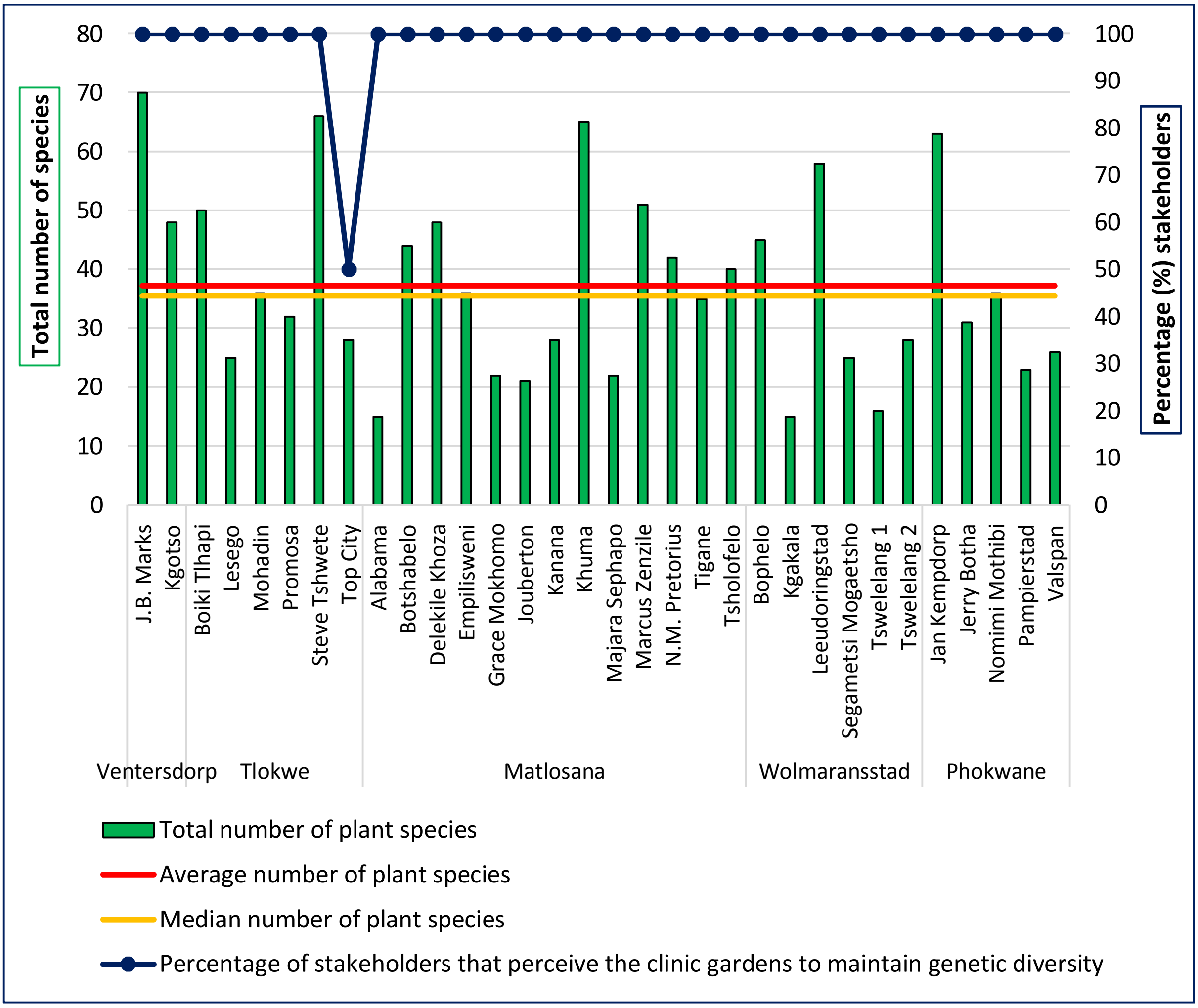


Figure 6-10: The comparison between the total number of plant species in each clinic garden and the percentage of stakeholders that perceive the clinic gardens to maintain genetic diversity

6.3.4 Cultural ecosystem services

According to Colding and Barthel (2013) when different cultures work together on the same land, a variety of spatial variations will be noticeable in habitats and species, which increases biodiversity. This is because each culture has unique ways to manage land which is related to the variations in habitat and species (Colding & Barthel, 2013). Therefore, a diverse group of cultures can together promote and build the capacity to learn, innovate and adapt (Colding & Barthel, 2013). The cultural ESs that were compared can be seen in **Table 6-1**.

6.3.4.1 Aesthetic appreciation

There was a correlation between the total ornamental plant species and the percentage of stakeholders that perceived clinic gardens to be aesthetically pleasing (**Table 6-13**). This correlation was however not strong, as there were cases where there were many ornamental species but no stakeholders that perceived the specific clinic garden to be aesthetically pleasing (e.g. Boiki Tlhapi).

Table 6-13: The correlation between the total number of ornamental plant species and the percentage of stakeholders that perceived the clinic gardens to be aesthetically pleasing.

		Total ornamental species (Aesthetic appreciation)
Percentage stakeholders that perceived gardens to be aesthetically pleasing	Correlation Coefficient	**0.301**
	Sig. (2-tailed)	0.094

There were eight health clinic gardens where all the interviewed stakeholders perceived the clinic gardens to be aesthetically pleasing, while none of the stakeholders at ten clinics perceived the clinic gardens to be aesthetically pleasing.

The clinics with the most potential to be aesthetically pleasing were Jan Kempdorp (21 species), Tsholofelo (19 species), Botshabelo (19 species), Boiki Tlhapi (18 species) and Empilisweni (18 species) (**Figure 6-11**). At two of these clinics, all the interviewed stakeholders perceived the clinic gardens to be aesthetically pleasing. At Boiki Tlhapi clinic, none of the interviewed stakeholders perceived the clinic garden to be aesthetically pleasing. There were two stakeholders that perceived this ES to be sufficiently present and three stakeholders that perceived it to be insufficient. All people have unique preferences when concerning what is aesthetically pleasing, some traits that influence preference are size, morphology, growth form, leaf traits, flowering, colour, and plant scent (Goodness *et al.*, 2016). It was found by Goodness *et al.* (2016) that visual aesthetic benefits of plants were mostly connected to large spreading trees and the presence of flowers. These characteristics were not always present in the health clinic gardens and could explain why some stakeholders did not find the clinic gardens aesthetically pleasing.

The stakeholders had expressed the benefits of the clinic gardens being beautiful, stating that it makes them feel better when they were sick. Another stakeholder said that wedding photos had been taken in one clinic garden in the past. It would seem that there was co-production of knowledge concerning the beauty of clinic gardens as people had inquired on how to achieve this (Chapter 5).

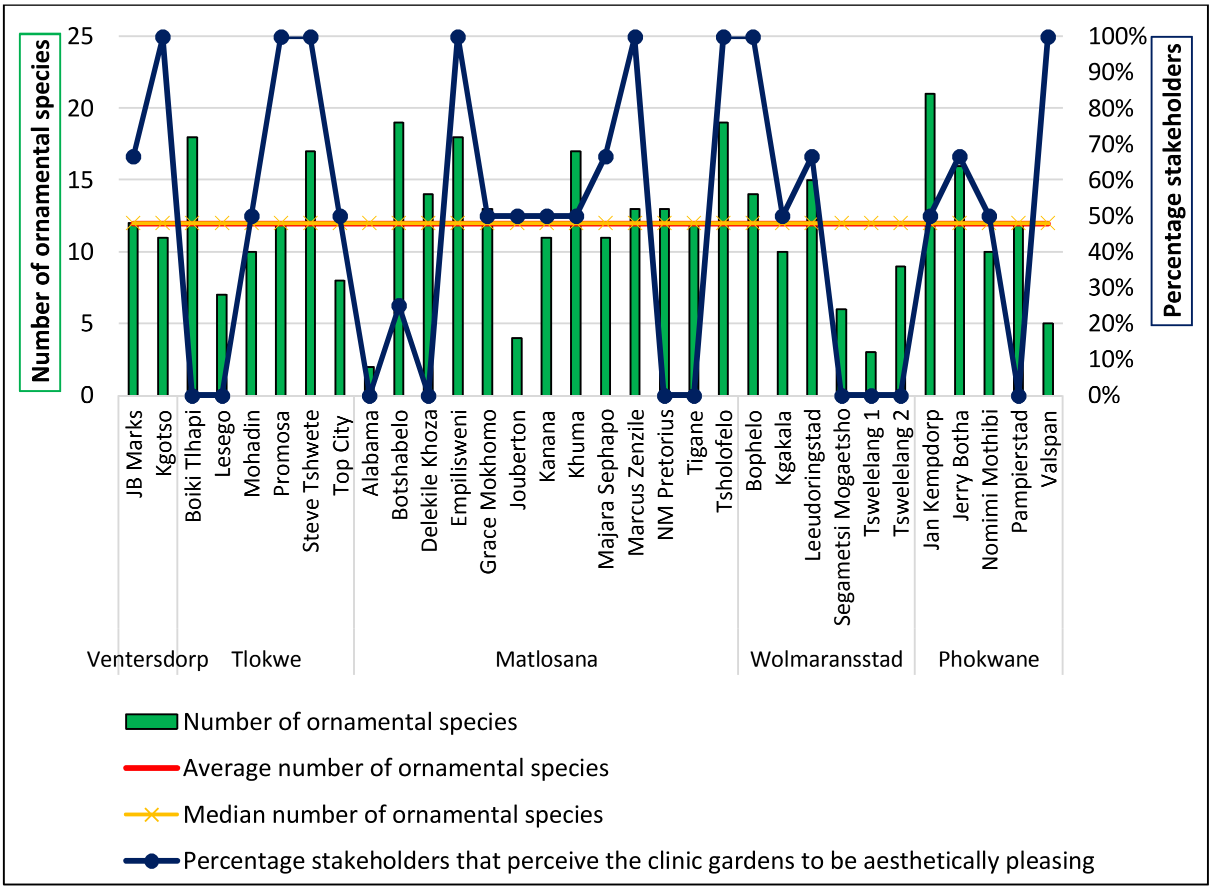


Figure 6-11: The number of ornamental plant species identified in each health clinic garden and the percentage of stakeholders at each clinic that perceive the gardens to be aesthetically pleasing.

6.3.4.2 Spiritual experience or cultural value

There was no correlation between the number of potential plants with spiritual or cultural value and the percentage of stakeholders that perceived the clinic gardens to have spiritual value (**Table 6-14**).

Table 6-14: The correlation between the number of potential plant species with spiritual or cultural value and the percentage of stakeholders that perceived the clinic gardens to have spiritual value.

		Number of potential plants with a spiritual or cultural value
Percentage stakeholders that perceived gardens to have spiritual value	Correlation Coefficient	-0.237
	Sig. (2-tailed)	0.192

There were 12 clinics where all the interviewed stakeholders perceived the health clinic gardens to be of spiritual value, but only in five of them, there were any species with potential value. In five clinics there were no stakeholders that perceived the clinic gardens to have spiritual value, but only in one of them, there were no species with spiritual or cultural value (**Figure 6-12**).

The clinics with the most potential to be of spiritual or cultural value were Promosa (2 species), Top City (2 species), Botshabelo (2 species) and Delekile Khoza (2 species) (**Figure 6-12**). At two of these clinics, all the interviewed stakeholders perceived the clinic gardens to be of spiritual or cultural value; and at the other two clinics, none of the stakeholders perceived the clinic gardens to have this value. People had been going to the clinic gardens to have a spiritual experience, especially to pray (Chapter 5). With 11 official languages and various religions present, including Christianity, Islam, Traditional African, and Hinduism (STATS, 2018a, b; Tibane, 2017), all the stakeholders might not have the same religious or spiritual orientation and therefore experience this ES differently.

The reason why some stakeholders perceived the clinic gardens to have spiritual value might be linked to the general feeling they get from the garden and not necessarily because of the presence of plant species with potential spiritual or cultural values. It has been found that natural features such as forests, caves or mountains are considered to be sacred or have religious meaning in many cultures around the world (TEEB, 2011).

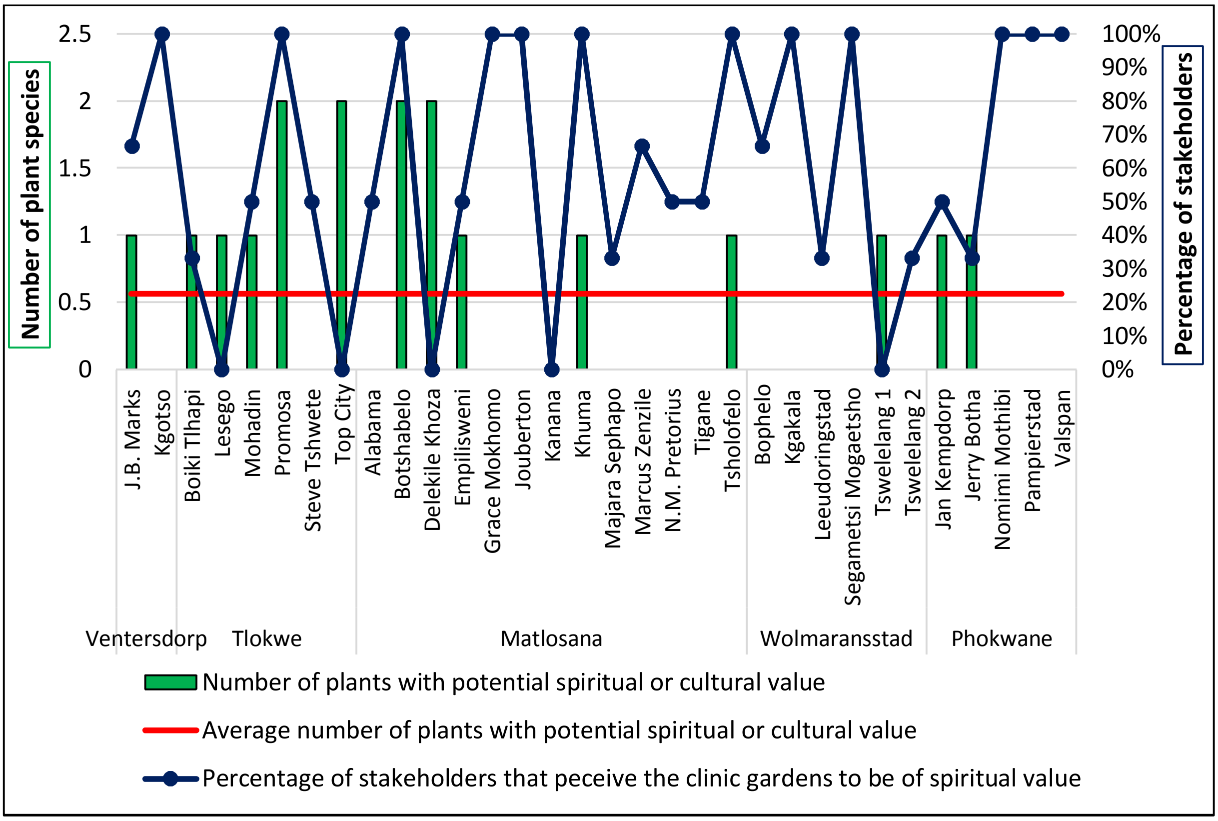


Figure 6-12: The number of plant species with potential spiritual or cultural value or importance and the percentage of stakeholders at each clinic that perceive the health clinic gardens to have spiritual value.

6.3.5 Ratings of health clinic gardens

When taking the ESs that were measured or determined and the perceptions of the stakeholders into consideration ratings as can be seen in **Figure 6-13** and **Figure 6-14** were obtained. When concerning all ESs, the Mohadin clinic had the highest rating. This clinic could, therefore, serve as an example of a clinic where there was a good link between the ESs present in the health clinic garden and the awareness thereof by stakeholders.

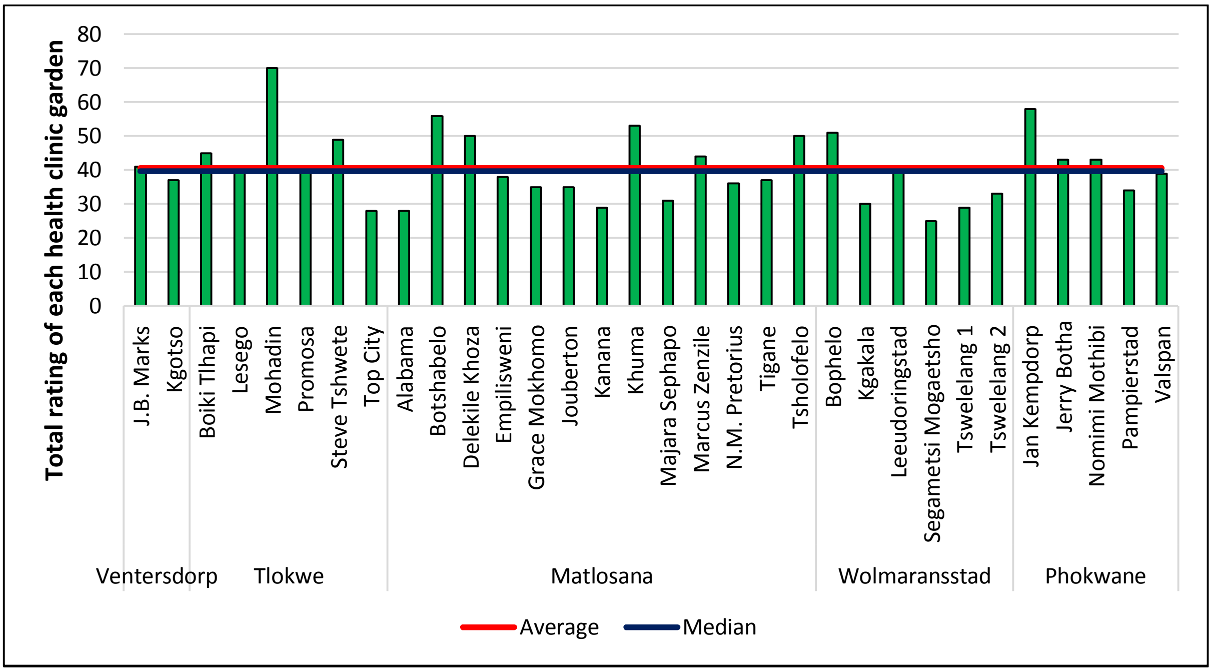


Figure 6-13: The overall rating calculated for each health clinic garden.

When comparing the actual value ratings to the perceived value ratings at most clinics the actual ratings are higher than the perceived ratings (**Figure 6-14**). There are also a few clinics where the actual and perceived value ratings are similar, possibly indicating that the stakeholders realise the importance of the ESs.

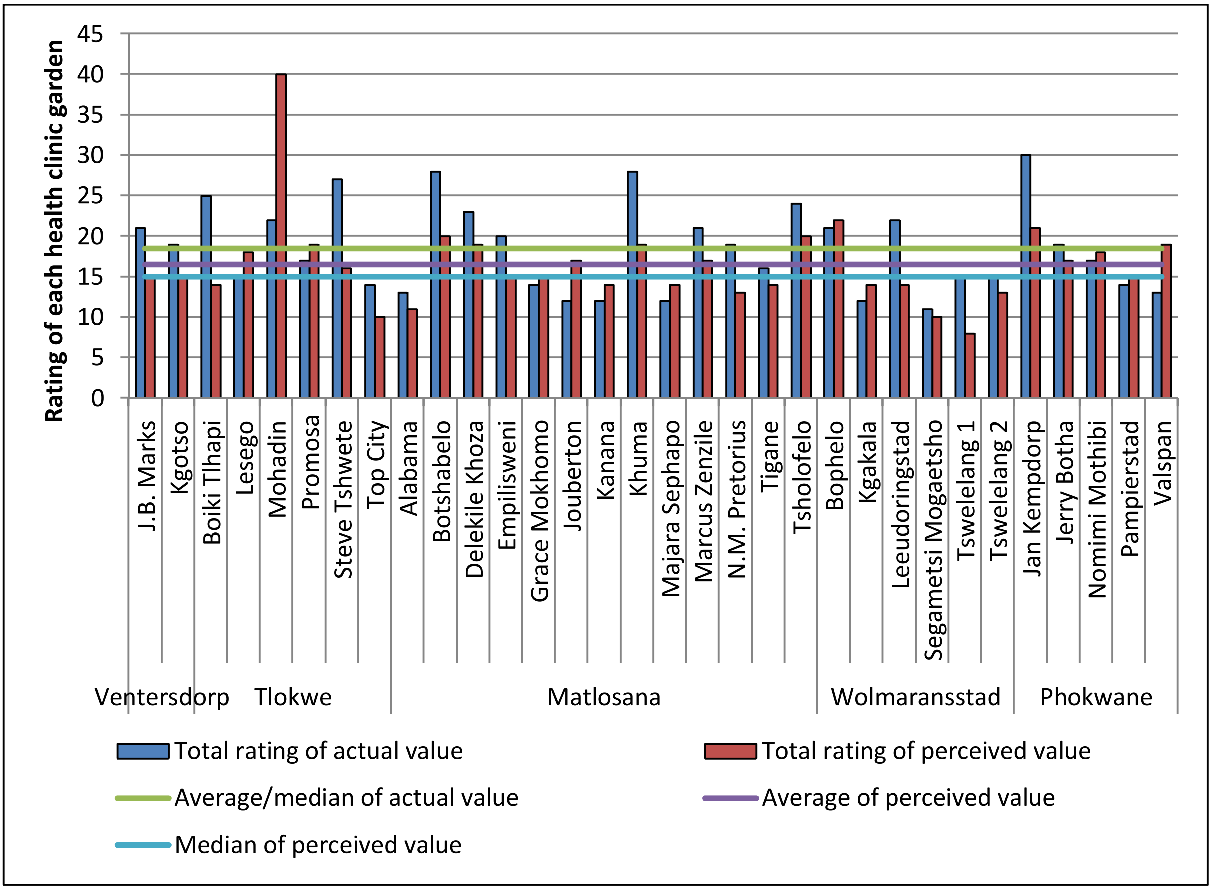


Figure 6-14: The rating for the actual value and the perceived value of ESs.

There were five clinics with high ratings in terms of economic value, namely Mohadin, Botshabelo, Delekile Khoza, Bophelo and Nomimi Mothibi (**Figure 6-15**). Of these clinics two had a higher actual economic value than perceived economic value, two had higher perceived economic value than actual economic value and only at one clinic was the actual and perceived economic values the same (**Figure 6-16**). There were seven clinics where the actual and perceived economic value ratings were the same and only 13 clinics where the actual economic rating was higher than the perceived economic rating (**Figure 6-16**).

The Mohadin clinic also had the highest rating for ecological value (**Figure 6-17**). The actual and perceived ecological value ratings were generally very similar, with Mohadin being an outlier with a high perceived ecological value **Figure 6-18**. At Mohadin there seems to be a dissonance between what is actually in the garden and what is perceived to be in the garden.

The Jan Kempdorp CHC had the highest rating for socio-cultural value (**Figure 6-19**), with the actual value having a higher rating than the perceived value (**Figure 6-20**). At most of the clinics, the actual socio-economic ratings were higher than the perceived socio-cultural ratings (**Figure 6-20**).

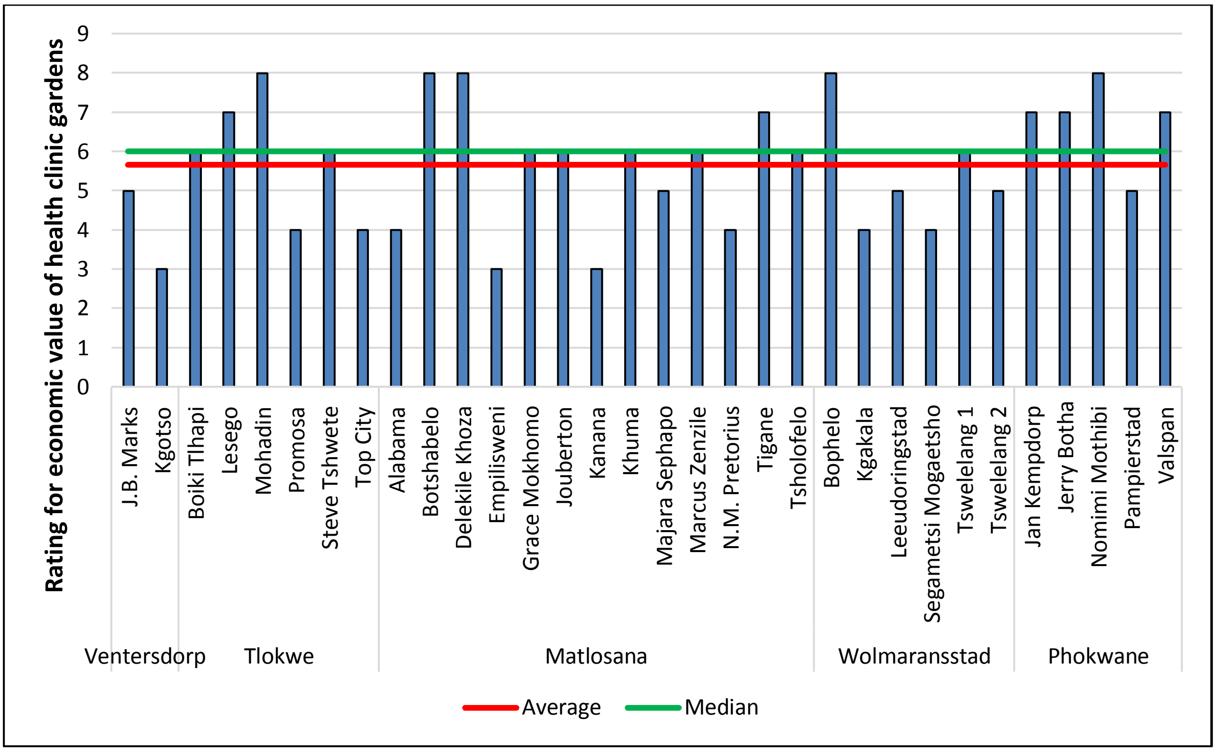


Figure 6-15: The rating for economic value calculated for each health clinic garden.

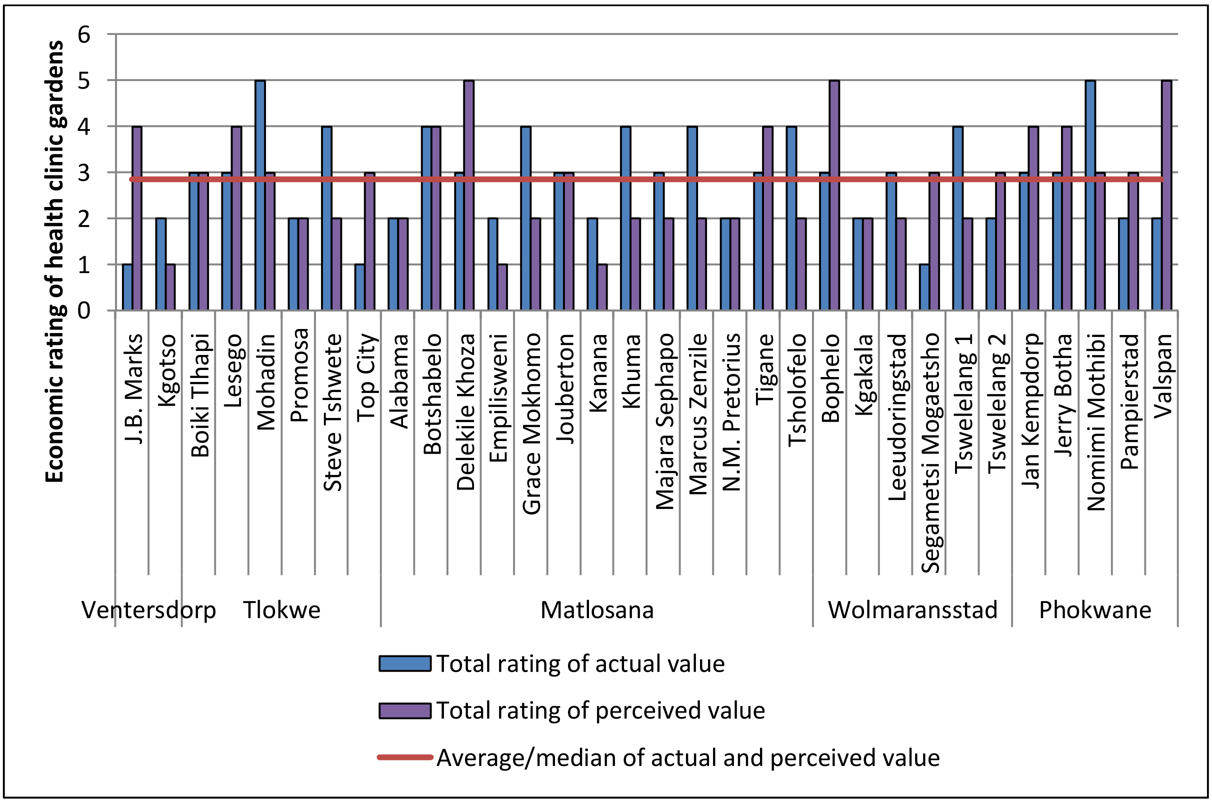


Figure 6-16: The actual economic value and perceived economic value ratings for each health clinic garden.

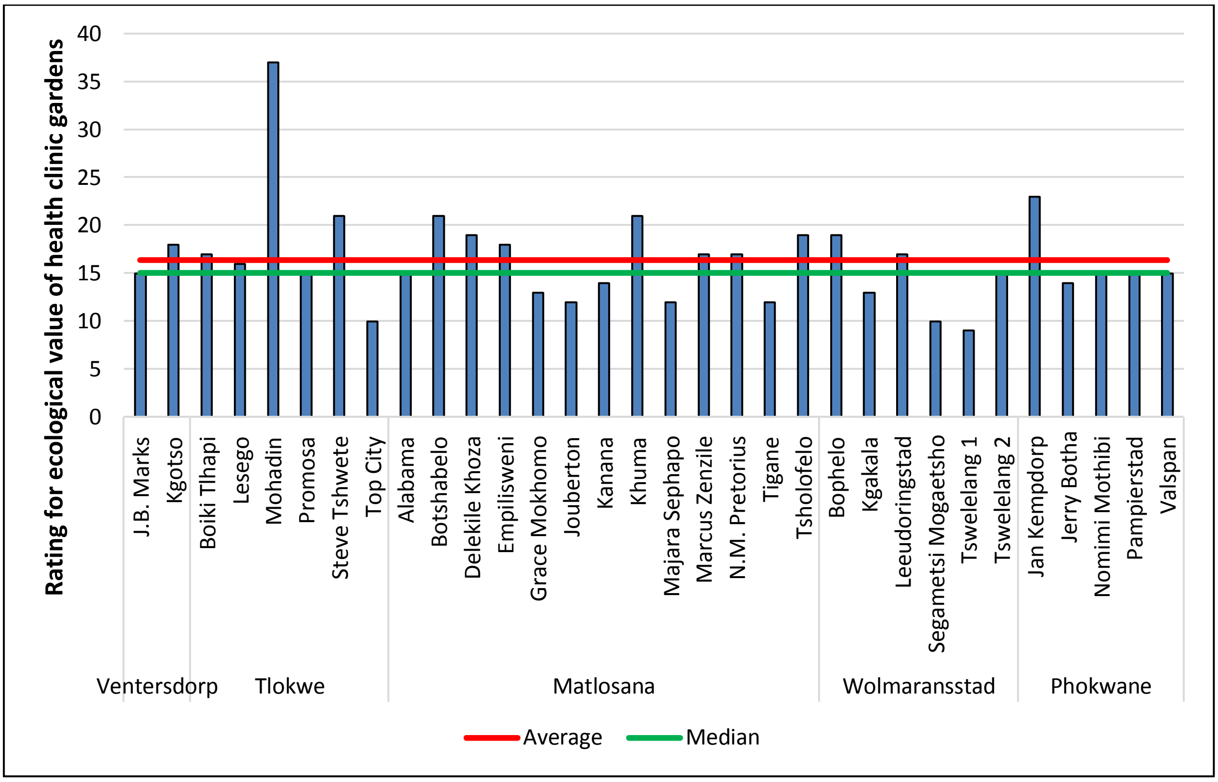


Figure 6-17: The rating for ecological value calculated for each health clinic garden.

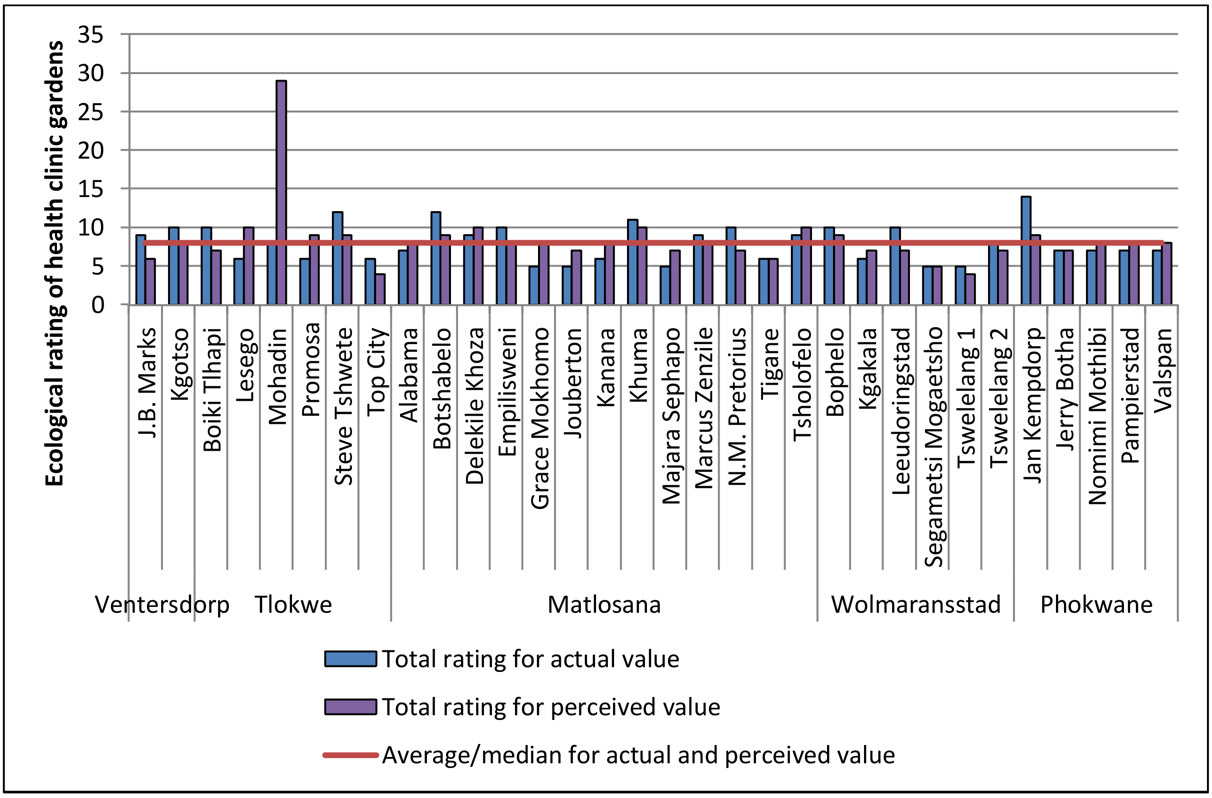


Figure 6-18: The actual ecological value and perceived ecological value ratings for each health clinic garden.

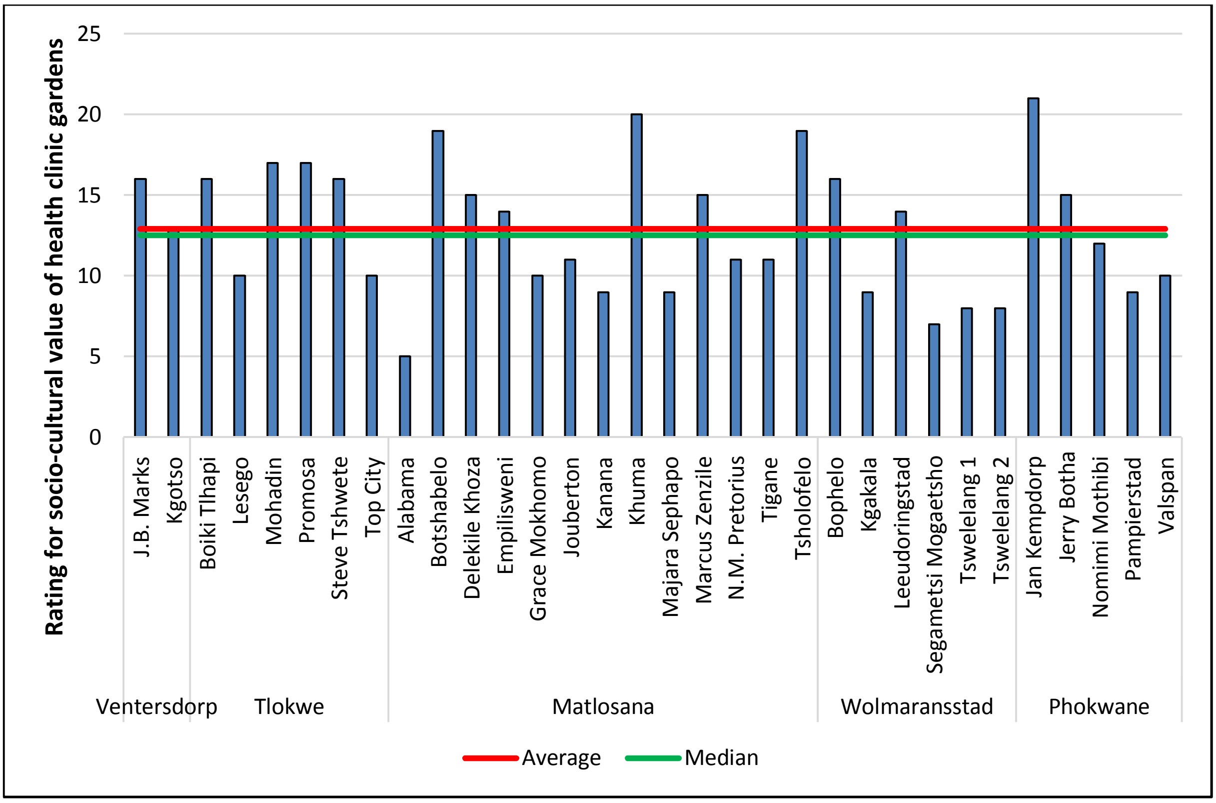


Figure 6-19: The rating for socio-cultural value calculated for each health clinic garden.

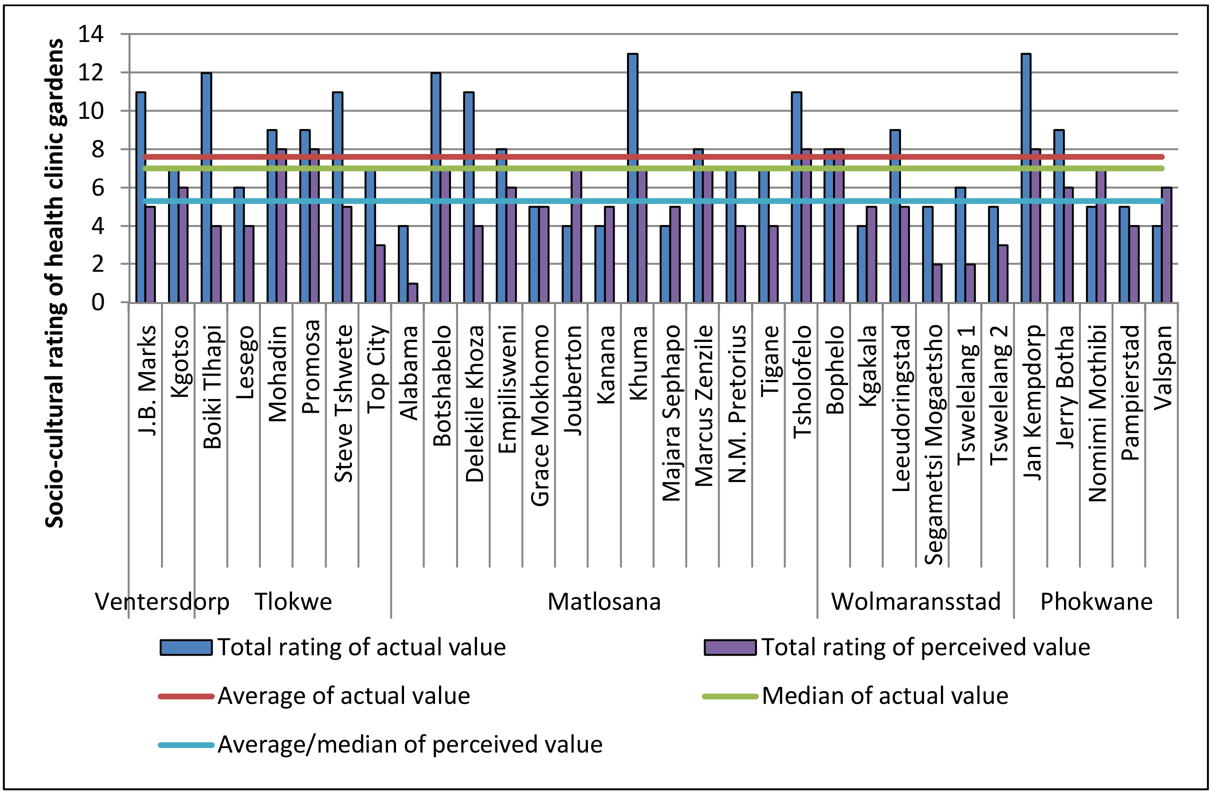


Figure 6-20: The actual socio-cultural value and perceived socio-cultural value ratings for each health clinic garden.

6.4 Conclusion

It has been determined in South Africa that even economically deprived households with few resources still tend to plant, care for, and water trees (McHale *et al*., 2013). This care about nature could indicate that people are aware of how dependent they are on the resources provided by trees, which is supported by the fact that many communities meet their needs for food, cooking energy, medicine, construction material, and water from their surrounding environment (McHale *et al*., 2013). The same could be said about health clinic gardens that were sources of many different ESs.

When concerning provisioning ESs, it was found that both Steve Tshwete clinic and Khuma clinic had among other clinics, the most potential food plants species, raw material plant species, and medicinal plant species (Chapter 3). These two clinics could, therefore, serve as good examples of clinics that maximise their provisioning services output. Even so, the perceptions of the stakeholders indicate that they were not aware of this potential, as the stakeholders at the Steve Tshwete clinic perceived only food plant species to be present, and at Khuma clinic only one stakeholder perceived raw materials and medicinal resources to be present (both perceived food to be present) (Chapter 4). The clinics with the best potential to regulate the local climate and the carbon in the atmosphere were Jan Kempdorp CHC and Botshabelo clinic. The stakeholders seemed to acknowledge this value as all the stakeholders perceived these two ES to be present. Especially the stakeholders at the Jan Kempdorp CHC seemed to fully realise the potential as both stakeholders stated that these ES were sufficiently present. The Botshabelo clinic had both many aesthetically pleasing plant species (ornamentals) and two potentially spiritual or cultural plant species, giving it a high cultural value. For the aesthetical appreciation, only one stakeholder perceived it to be insufficient, while for spiritual or cultural value all four stakeholders perceived this ES to be present, of which three stated it was sufficiently present.

The clinics that could serve as good examples of clinics where the economic value of ESs seemed to be realised were Mohadin, Botshabelo, Delekile Khoza, Bophelo and Nomimi Mothibi. The perceptions of the economic value were however different from the actual value, at only one of these clinics the actual and perceived value ratings were the same. Therefore, the perceptions of the stakeholders play an important role, as in Chapter 3 the clinics with the highest economic value ratings were Tswelelang 1 and Mohadin, while in the comparison the Botshabelo clinic was the clinic with the highest equal actual and perceived value ratings.

The Mohadin clinic could serve as a good example of a clinic where the ecological value of ESs seemed to be realised. However, the perceived value ratings are much higher than the actual value rating, possibly indicating that the stakeholders do not really realise the value of the ESs, or they might be maximising the use of the limited ESs.

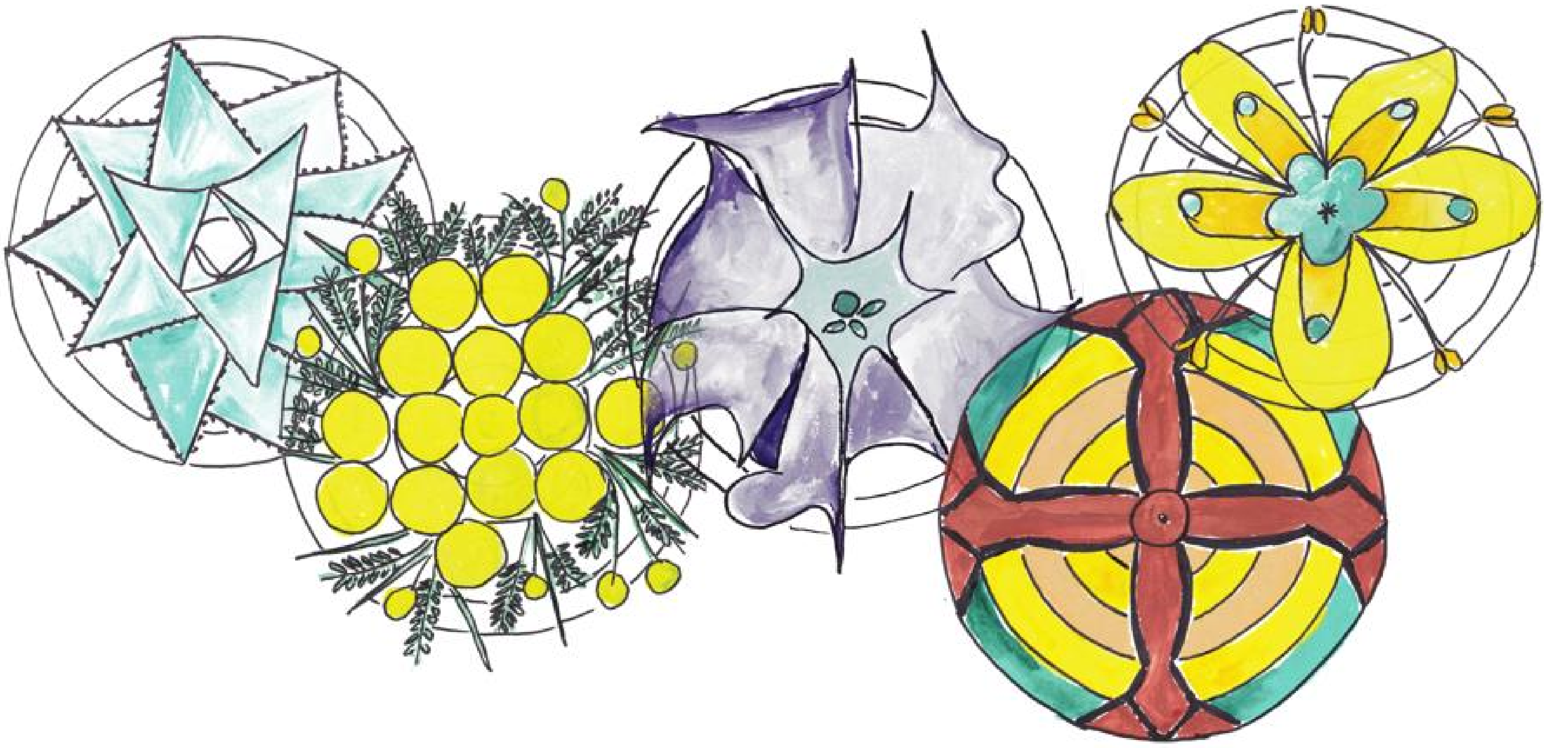
Even though it may seem that the Jan Kempdorp CHC could serve as a good example of a clinic where the socio-cultural value of ESs was realised as this clinic also had the highest ecological value rating, the actual ecological value rating is higher than the perceived ecological rating. Therefore there is still a need to inform the stakeholders of the actual ecological value of the ESs present in the clinic garden.

The values people place on ecosystem functions, structures and processes may not always express the full value, because humans are one of many species present in an ecosystem (Farber *et al*., 2002). According to Dallimer *et al*. (2014), the perceptions of the value of nature that humans have may be different from the economic value derived. Therefore, it is essential to consider both the actual value of ESs and the perceived value as stated by stakeholders. This has also indicated that the actual value of ESs has to be communicated to the stakeholders so that they are aware of the actual benefits they derive from the health clinic gardens.

The importance of the qualitative results should also be expressed as this data contributed to the understanding of the perceptions of the stakeholders and in many cases provided reasons for emerging phenomena. It would, therefore, be recommended to anyone attempting to integrate social and ecological data to include a qualitative analysis.

The aim of this chapter, to compare/test relationships between the actual and perceived values as stated by different stakeholders of ESs, was successfully achieved.

Chapter 7: Conclusion and recommendations



CHAPTER 7 - CONCLUSION AND RECOMMENDATIONS

7.1 Introduction

In this study, two main aspects of health clinic gardens were studied, namely the actual value of selected provisioning, regulating, cultural and supporting ecosystem services (ESs) and the perceived value of provisioning, regulating, cultural and supporting ESs by different stakeholders, in the Dr Kenneth Kaunda District Municipality and Phokwane Local Municipality.

In Chapter 3 the objective of conducting an ecological survey to determine the social, cultural, economic and ecological value of a variety of ESs and EDSs (actual values of ESs) was reached. It was found that the health clinic gardens in the Dr Kenneth Kaunda District Municipality and Phokwane local municipality had a variety of micro-gardens that support a variety of plant species contributing to the provisioning of ESs. The ESs provided by the clinic gardens had different values. The vegetable and fruit plant species and carbon sequestration of plant species had economic value. Carbon sequestration, local climate regulation, habitat for species, and maintenance of genetic diversity had ecological value. Raw materials, medicinal plant species, recreational opportunities, aesthetically pleasing plant species, and plant species with spiritual or cultural significance had socio-cultural value. The health clinic gardens were also rated subjectively by using a scoring system where the health clinic gardens receive a value for the different ESs comparing the gardens with each other based on median values. These ratings indicate which clinics had economic, ecological, and/or socio-cultural value. These ratings can, therefore, be used to increase the different values at the other health clinic gardens. When concerning only the ecological survey data, the clinics that had the highest rating for economic value were Tswelelang 1 and Mohadin, with Jan Kempdorp CHC achieving the highest rating for ecological and socio-cultural values.

In Chapter 4 and 5, the objective of developing and conducting a social survey to determine the social, cultural, economic and ecological value of a variety of ESs and EDSs as perceived by different stakeholders (perceived values of ESs) was reached. Stakeholder perceptions of ESs and EDSs provided by health clinic gardens were determined, which differs from one stakeholder to the next and from one clinic to the next. This demonstrates the unique knowledge and perceptions each person has which together can lead to the generating of new knowledge. This exchange of knowledge between a diversity of knowledge systems could improve the capacity to react to conditions, change, responses, and in some cases fundamental relationships in the dynamics of social-ecological systems (Tengö *et al*., 2014). Health clinic gardens can thus be seen as pockets of social-ecological innovation (Cilliers *et al*., 2018), which could promote compassion in community members (Cornelius, 2016).

In Chapter 6 the objective of comparing and testing relationships between the actual and perceived values of ESs was reached. Generally, it seems that there were no associations between the actual values and the perceived values of the stakeholders. Only a relationship was tested between these values, but there could, however, be a lack of awareness of the benefits the stakeholders could obtain from the garden or the value it has. Because there were only three cases where the actual value and perceptions of stakeholders were statistically significant. The health clinic gardens were rated by using a subjective scoring system where the health clinic gardens received a value for the ecological data and social data based on median values. These ratings indicated which clinics had economic, ecological, and/or socio-cultural value. These ratings can, therefore, be used to increase the different values at the other health clinic gardens. There are a few clinics that could serve as a starting point for developing a management strategy that could be used to ensure that all health clinic gardens provide the maximum amount of ESs to benefit the community. There is however work needed to be done at all of the health clinics concerning the ESs present in the gardens.

The health clinic gardens of the Dr Kenneth Kaunda District Municipality and the Phokwane sub-district were also compared to the health clinic gardens of the Bojanala District Municipality (Cornelius, 2016). It was found that the clinics had similar potential food plant species and potential medicinal plant species. Hedges were not common at any of the clinics. All the clinic gardens support many different species that seemed to be influenced by western and traditional practices (Tswana tshimo (Molebatsi *et al*., 2010)). Few stakeholders seemed to realise the potential of health clinic gardens to provide habitats for animals and plants, which may be due to a lack of understanding of this ES. In both studies EDSs were perceived to be a small problem, meaning that the benefits of the gardens are outweighing the disadvantages.

There were also some differences between the health clinic gardens of this study and of that conducted by Cornelius (2016). Cornelius (2016) found that the spiritual and sense of place ES was most abundant, while in this study erosion prevention and maintenance of soil fertility and health and well-being were most abundantly present. Overall the supporting ESs were perceived to be the least present in the Bojanala District Municipality (Cornelius, 2016), while in this study the provisioning ESs were perceived to be the least present and abundant. In the study by Cornelius (2016) only the presence of ESs was recorded and not the value of ESs as in this study. It, however, appeared that stakeholders valued cultural ESs most in the study of Cornelius (2016) as most stakeholders acknowledged it, while in this study most ESs were perceived to have ecological value and least ESs were perceived to have cultural value. Most of these differences could be ascribed to the fact that Cornelius (2016) did not have access to an interpreter throughout the study and did not make use of illustrations for the ESs concepts. These additions to the methods used in this study seemed to make a big difference in the understanding of the concepts by the interviewed stakeholders.

The main aim of this study was to explore the actual and stakeholdersôperceived presence and value of ESs and EDSs provided by health clinic gardens in the Dr Kenneth Kaunda District Municipality and Phokwane Local Municipality. Results showed that health clinic gardens provide a variety of ESs each with a value, which when communicated to the stakeholders of the health clinic gardens could contribute to more sustainable and resilient gardening practices that could be communicated to the larger community.

7.2 Implementation of the information from this dissertation

It is important to realise that the ESs provided by health clinic gardens have different values to different people. These values need to be recognised by the stakeholders so that when they communicate with the community, this knowledge can be shared. When people are more aware of the benefits provided by nature and the value thereof, more care might be taken in conserving these ESs. Some clinics could serve as good examples of gardens that have high economic, ecological, social and cultural value. It is, however, important to realise that to have a higher value does not necessarily mean that there should be more plant species planted; it is about managing the space available and making the best use of it.

Since the gardens studied were located at health clinics, it is a good place to increase opportunities to address various aspects such as nutritional deficiencies and stress reduction. Most people in the community visit the health clinics at some or other time and could be educated about the benefits and risks of gardens.

The information in this dissertation should be communicated to the Department of Health, all involved stakeholders, and the wider community. Communication of the results should be in an easily understandable way that states all relevant information clearly and to the point. As it has been found by just by listing the services provided by a specific ecosystem can increase awareness and recognition in public policy (Costanza *et al*., 2017). A good option for communication is creating posters or pamphlets that could be distributed to the health clinics from where it is visible or obtainable for the community. The knowledge obtained from the posters or pamphlets could then be used by the stakeholders and the wider community to increase the deliverance of ESs in the health clinic gardens as well as in their private home gardens.

7.3 Future studies

There were certain limitations in this study that need to be addressed in future studies. At many health clinics, the stakeholders of the clinic gardens were not present on the day of visitation, mainly due to illness. In future studies, time should be better managed so that there is time available to re-visit clinics to complete the interviews with all the stakeholders.

Even though the illustrations of the ESs, values and EDSs were very helpful in explaining the different, often complex, concepts, they may have misled stakeholders and directed their answers. For example, the fact that an ES had an illustration may have influenced some of the stakeholders to feel that it, therefore, has to be present in the clinic gardens. In future studies, a larger variety of illustrations for each concept could be created to indicate to the stakeholders the different scenarios in which the ESs and EDSs could be present. Another option is not using any illustrations but rather using many short questions to obtain the perception of the stakeholders, instead of using three main questions for each ES (namely presence, value and willingness to pay).

In future studies, it would be a benefit, to begin with, another ES rather than food. Due to the fact that food was the first ES asked about, the stakeholders seemed to think that the following ESs only concern the vegetable garden rather than the entire yard.

When concerning the qualitative analysis of this data, the developed questionnaire has some shortcomings. The questions are mostly closed-ended and thus more quantitative than qualitative. In order to broaden the understanding of the choices stakeholders made during the interviews, more opportunity should be allowed to discuss their opinions.

The questionnaire should also be altered to only include three values, namely ecological, economic and socio-cultural value as it was found that it is difficult to distinguish between social and cultural value.

There is a dissonance between the perceptions of different stakeholders. The one seemed to take the potential into account while the other only acknowledged the state the garden was in at the time of the interview. In future, it would add clarity if a time frame is given to the stakeholders so that such problems do not occur.

In order to broaden the scope of information available on health clinic gardens, data should be collected at other health clinic gardens throughout South Africa. Through comparing the results of a variety of health clinic gardens a better perspective may be obtained of the spectrum of values offered by the gardens that may be used to create management strategies for the health clinic gardens.

Other aspects of health clinic gardens can be investigated such as including the abundance (e.g. percentage cover) of all the plant species (especially the food plant species) and not only the species richness. The inclusion of qualitative analysis in more ecological studies could also be implemented as this provides valuable information not obtained through quantitative studies.

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ANNEXURES

Appendix A: List of plant species recorded at the health clinic gardens (exotic species are indicated with an asterisk (*))

No.	Plant species	No.	Plant species
1	*Abelia grandiflora**	157	*Hypoxis hemerocallidea*
2	*Acacia melanoxylon**	158	*Hypoxis rigidula*
3	*Acanthus mollis**	159	*Indigofera daleoides*
4	*Aeonium arboreum**	160	*Indigofera hedyantha*
5	*Aeonium canariense**	161	*Indigofera sp.*
6	*Agapanthus africanus*	162	*Ipomoea batatas* (sweet-potato)*
7	*Agave sp.**	163	*Ipomoea oblongata (Turbina oblongata)**
8	*Ailanthus altissima**	164	*Ipomoea purpurea**
9	*Allium cepa (onion)**	165	*Iris germanica**
10	*Allium sativum* (garlic)*	166	*Isolepis marginata (Cyperus rothianus)*
11	*Allium wakegi* (spring onion)*	167	*Kalanchoe pinnatum**
12	*Alocasia* macrorrhizos*	168	*Lactuca* enerme*
13	*Aloe greatheadii*	169	*Lactuca sativa* (lettuce)*
14	*Aloe greatheadii* var. *davyana*	170	*Lactuca sp.**
15	*Alternanthera pungens**	171	*Lagerstroemia indica**
16	*Amaranthus hybridus**	172	*Ledebouria petiolata (Drimiopsis maculata)*
17	*Amaranthus viridis**	173	*Ledebouria* sp.
18	*Anredera cordifolia**	174	*Leonotis pentadentata (Leucas capensis)*
19	*Araujia serecifera**	175	*Lepidium bonariense**
20	*Arctotis arctotoides*	176	*Ligustrum ibota**
21	*Argemone ochroleuca**	177	*Ligustrum lucidum**
22	*Aristida congesta* subsp. *congesta*	178	*Limeum viscosum*
23	*Artemisia afra*	179	*Liriope spicata**
24	*Asparagus sp.*	180	*Lotononis listii*
25	*Aster laevis**	181	*Malva parviflora**
26	*Berberis thunbergii**	182	*Malvastrum coromandelianum**
27	*Beschorneria yuccoides**	183	*Manihot esculenta**
28	*Beta vulgaris* (beetroot)*	184	*Medicago lupulina**
29	*Bidens bipinnata**	185	*Medicago sativa**
30	*Bidens pilosa**	186	*Melaleuca citrina (Callistemon citrinus)**
31	*Boerhavia erecta**	187	*Melaleuca viminalis* subsp. *Viminalis (Callistemon viminales)**
32	*Bolusanthus speciosus*	188	*Melia azedarach**
33	*Brachychiton populneus**	189	*Melinis repens*
34	*Brassica oleracea* (cabbage)*	190	*Mentha arvensis**
35	*Buddleja saligna*	191	*Mentha longifolia*
36	*Bulbine frutescens*	192	*Mirabilis jalapa**
37	*Buxus sempervirens**	193	*Modiola caroliniana**
38	*Canna x generalis**	194	*Momordica balsamina*
39	*Capsella bursa-pastoris**	195	*Monsonia angustifolia*
40	*Capsicum annuum* (pepper)*	196	*Morus alba/nigra**
41	*Capsicum* sp. (chilli)*	197	*Myrtus communis**
42	*Carpobrotus edulis*	198	*Nandina domestica**

43	*Carya illinoinensis* (pecan)*	199	*Nerium oleander**
44	*Casuarina cunninghamiana**	200	*Nidorella anomala*
45	*Catharanthus roseus**	201	*Notoscordum inodorum**
46	*Cedrus deodara**	202	*Oenothera lindheimeri (Gaura lindheimeri)**
47	*Celtis africana*	203	*Oenothera tetraptera**
48	*Celtis australis**	204	*Olea europaea* subsp. *Africana*
49	*Celtis sinensis**	205	*Ornithogalum tenuifolium*
50	*Cenchrus ciliaris*	206	*Osteospermum scariosum (Tripteris aghillana)*
51	*Ceratonia siliqua**	207	*Oxalis corniculata**
52	*Cestrum laevigatum**	208	*Oxalis sp.*
53	*Chamaecrista mimosoides*	209	*Panicum maximum*
54	*Chamaecyparis lawsoniana**	210	*Paspalum dilatatum**
55	*Chenopodium album**	211	*Paspalum distichum*
56	*Chenopodium carinatum**	212	*Pelargonium zonale*
57	*Chloris gayana*	213	*Pennisetum clandestinum**
58	*Chloris pycnothrix*	214	*Pennisetum setaceum**
59	*Chloris virgata*	215	*Pentarrhinum insipidum*
60	*Chlorophytum capense*	216	*Pentzia globosa*
61	*Chlorophytum comosum* 'Vittatum'	217	*Phaseolus vulgaris* (beans)*
62	*Chrysanthemum frutescens**	218	*Phoenix canariensis**
63	*Cirsium vulgare**	219	*Physalis viscosa**
64	*Citrullus lanatus* (wild watermelon)	220	*Pittosporum undulatum**
65	*Citrus aurantiifolia* (lime)*	221	*Plantago lanceolata*
66	*Citrus limon* (lemon)*	222	*Platanus hybridus**
67	*Citrus reticulata* (tangerine)*	223	*Plumbago auriculata*
68	*Citrus sinensis* (orange)*	224	*Poa annua**
69	*Citrus sinensis x reticulata* (tangerine-orange crossing)*	225	*Pollichia campestris*
70	*Citrus x paradisi* (grape fruit)*	226	*Portulaca grandiflora*
71	*Cleome gynandra*	227	*Portulaca kermesina*
72	*Combretum erythrophyllum*	228	*Portulaca oleracea**
73	*Commelina benghalensis*	229	*Portulaca quadrifida*
74	*Convolvulus mauritanicus**	230	*Prunus armeniaca* (apricot)*
75	*Convolvulus sagittatus*	231	*Prunus persica* (peach)*
76	*Conyza bonariensis**	232	*Pseudognaphalium undulatum*
77	*Conyza podocephala*	233	*Punica granatum* (pomegranate)*
78	*Corchorus asplenifolius*	234	*Pyracantha angustifolia**
79	*Cordyline australis**	235	*Pyrus communis* (pear)*
80	*Coreopsis maritima**	236	*Quercus robur**
81	*Cotula australis*	237	*Raphanus sativus* (radish)*
82	*Cotyledon orbiculata*	238	*Rhynchosia* sp.
83	*Crassula* sp.	239	*Richardia brasiliensis**
84	*Crinum bulbispermum*	240	*Robinia pseudoacacia**
85	*Crocosmia aurea*	241	*Rosa* sp.*
86	*Cucurbita maxima* (pumpkin)*	242	*Rumex sp.*
87	*Cucurbita moschata* (butternut squash)*	243	*Ruta graveolens**
88	*Cyclospermum leptophyllum**	244	*Salsola kali**
89	*Cymbopogon citratus* (lemon grass)*	245	*Salvia runcinata*
90	*Cynodon dactylon*	246	*Salvia sp.**

91	*Cynodon hirsutus*	247	*Saponaria officinalis**
92	*Cyperus eragrostis**	248	*Schinus molle**
93	*Cyperus esculentus*	249	*Schkuhria pinnata**
94	*Cyperus involucratus (Cyperus alternifolius)*	250	*Searsia lancea*
95	*Cyperus* sp. 1	251	*Searsia pendulina*
96	*Cyperus* sp. 2	252	*Selago densiflora (Walafrida densiflora)*
97	*Dactyloctenium aegyptium*	253	*Senecio consanguineus*
98	*Dahlia pinnata**	254	*Senecio serratuloides*
99	*Dais cotinifolia*	255	*Senegalia caffra*
100	*Datura stramonium**	256	*Senegalia galpinii*
101	*Daucus carota* (carrot)*	257	*Setaria pumila (Setaria pallide-fusca)**
102	*Dichondra micrantha**	258	*Setaria verticillata*
103	*Dietes bicolor*	259	*Sida dregei*
104	*Dietes grandiflora*	260	*Sida spinosa*
105	*Digitaria sanguinalis**	261	*Sisymbrium orientale**
106	*Digitaria ternata*	262	*Solanum campylacanthum* subsp. *panduriforme*
107	*Dimorphotheca sinuata*	263	*Solanum incanum**
108	*Dodonaea viscosa* var. *angustifolia*	264	*Solanum lycopersicum* (tomato)*
109	*Dovyalis caffra*	265	*Solanum melongena* (eggplant)*
110	*Dysphania ambrosioides (Chenopodium ambrosioides)**	266	*Solanum tuberosum* (potato)*
111	*Echeveria elegans**	267	*Sonchus oleraceus**
112	*Echinochloa holubii*	268	*Sphagneticola trilobata**
113	*Elaeagnus pungens**	269	*Spinacia oleracea* (spinach)*
114	*Eleusine indica*	270	*Spiraea cantoniensis**
115	*Emex australis*	271	*Sporobolus africanus*
116	*Enneapogon cenchroides*	272	*Sporobolus fimbriatus*
117	*Eragrostis chloromelas*	273	*Syagrus romanzoffiana**
118	*Eragrostis echinochloidea*	274	*Tagetes erecta**
119	*Eragrostis lehmanniana*	275	*Tagetes minuta**
120	*Eragrostis obtusa*	276	*Talinum sp.*
121	*Eragrostis plana*	277	*Taraxacum officinale**
122	*Eragrostis superba*	278	*Tecoma stans**
123	*Eragrostis tef**	279	*Tipuana tipu**
124	*Eragrostis trichophora*	280	*Tradescantia spathacea**
125	*Eucalyptus camaldulensis**	281	*Tragus berteronianus*
126	*Eucalyptus sideroxylon**	282	*Tragus racemosus*
127	*Euonymus japonicus**	283	*Tribulus terrestris*
128	*Euphorbia hirta**	284	*Trifolium repens**
129	*Euphorbia inaequilatera*	285	*Tulbaghia simmleri*
130	*Euphorbia peplus**	286	*Ulmus parvifolia**
131	*Euphorbia prostrata**	287	Unknown species*
132	*Felicia muricata* subsp. *muricata*	288	*Urochloa mosambicensis*
133	*Ficus carica**	289	*Urochloa panicoides*
134	*Flaveria bidentis**	290	*Urochloa stolonifera*
135	*Fragaria x ananassa* (strawberry)*	291	*Vachellia erioloba*
136	*Fraxinus angustifolia**	292	*Vachellia karroo*
137	*Fraxinus pennsylvanica**	293	*Vachellia tortilis*
138	*Fraxinus velutina**	294	*Vangueria infausta*

139	*Galinsoga parviflora**	295	*Vepris undulata**
140	*Gardenia jasminoides**	296	*Verbena aristigera (Verbena tenuisecta)**
141	*Gazania krebsiana*	297	*Verbena bonariensis**
142	*Gladiolus x hortulanus**	298	*Verbena x hybrida**
143	*Gleditsia triacanthos**	299	*Verbesina encelioides**
144	*Gomphrena celosioides**	300	*Vigna unguiculata* (cowpea)
145	*Guilleminea densa**	301	*Vinca major**
146	*Hedera helix**	302	*Viola odorata**
147	*Helichrysum aureonitens*	303	*Vitis vinifera* (grape)*
148	*Helminthotheca echioides (Picris echiodes)**	304	*Wahlenbergia caledonica**
149	*Hemerocallis aurantiaca**	305	*Washingtonia filifera**
150	*Hemerocallis* fulva*	306	*Xanthium strumarium**
151	*Hermannia depressa*	307	*Yucca* sp.*
152	*Heteropogon contortus*	308	*Zantedeschia aethiopica*
153	*Hibiscus trionum**	309	*Zea mays**
154	*Hymenocallis littoralis**	310	*Zephyranthes candida**
155	*Hyparrhenia hirta*	311	*Zinnia peruviana**
156	*Hypertelis cerviana (Mollugo cerviana)*	312	*Ziziphus mucronata*

Appendix B: Interview Schedule

Presence, value and willingness to pay for ecosystem services and disservices

Interviewer: Marlize Muller

Interpreter: Christinah Mahlonoko

Section 1: General information

Participant number	

A. Clinic name and GPS coordinates

Name	
GPS	

B. Date of interview

Starting time	:	:

Section 2: Demographic information of the participant

C. Participant's **occupational role**

1 Groundskeeper	2 Caregiver	3 Facility manager	4 Patient	5 Traditional Health Practitioner	6 CWP	7 Volunteers	8 Other __________

D. Participant's current **age**

E. Participants **gender**

1 Male	2 Female

F. Participant's **home language**

1 English	2 Afrikaans	3 Setswana	4 isiZulu	5 isiXhosa	6 Sesotho	7 Other __________

G. Participant's highest level of education (**Literacy level**)

1 None	2 Some primary	3 Completed primary	4 Some secondary
5 Completed secondary	6 Post-school qualification (diploma, trade, etc.)	7 University degree	8 Other

H. **Participant's religious or philosophical orientation**

Do you belong to a church?

1	2
Yes	No

I. How many times a week do you meet and how are you involved at the church?

J. **Health**: how often do you visit the clinic?

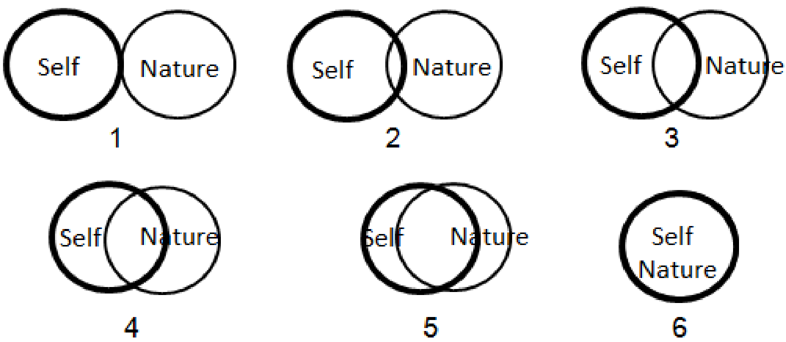
K. What do you think is the role of the clinic to you?

L. What does **politics** mean to you?

M. **Economic status**: where does your income come from?

N. Do you receive a social grant?

O. Connectedness to nature:



Section 3: Ecosystem services and disservices

Ecosystem services		Presence			Values Values from 1 to 4 depending on importance as chosen by the participant (1 most important and 4 least important)				Willingness to pay		
		Don't know	Not sufficient	Sufficient	Economic	Environment	Social	Cultural	No	Yes	Amount (ZAR)
P	**Provisioning services**										
1	**Food** (Do you think the clinic garden/yard provides food such as fruit and vegetables to you?)										
2	**Raw materials** (Do you think the clinic garden/yard can provide materials such as wood for building or fires, thatch grass for roofs or making objects, fodder for animals etc.)										
3	**Freshwater** (Do you think there are water reservoirs, rivers or other water bodies in the clinic garden/yard?)										
4	**Medicinal resources** (Do you think there are plants in the clinic garden/yard that can be used as medicine?)										
Q	**Regulating services**										
5	**Local climate and air quality regulation** (do you think trees/otter plants provide shade to regulate the heat?) (Do you think the trees protect you from wind/sun?)										
6	**Carbon sequestration and storage** (Do you think plants/trees in the clinic garden/yard use carbon dioxide to produce oxygen?) (Do you think the plants in the clinic garden/yard can remove pollutants/bad substances from the air?)										
7	**Moderation of extreme events** (Do you think the plants/trees of the clinic garden/yard protect the buildings and humans from floods, winds, fires, etc.?)										
8	**Wastewater treatment** (Do you think plants of the clinic garden/yard can clean water that is not good?)										
9	**Erosion prevention and maintenance of soil fertility** (Do you think plants in the clinic garden/yard protect soil from being washed away by rain/floods?, and keeps the soil healthy?) (Do you think the clinic garden/yard has good vegetation cover to slow the flow of rainwater and protect the soil?) (Are there earthworms in the soil?)										
1 0	**Pollination** (Do you think there are any insects that pollinate the plants in the clinic garden/yard?) (Are there birds and insects such as bees, wasps, beetles and butterflies sitting on the flowers?)										
1	**Biological control** (Do you think there are any plants or										

1	animals in the clinic garden/yard that control plant or animal pests?) (Are there birds and insects such as bees, wasps, beetles and butterflies sitting on the flowers?)										
R	**Habitat and supporting services**										
1 2	**Habitats for Species** (Do you think the clinic garden/yard provides living space for plants, animals, insects, birds, etc.?) (Are there any birds, animals or insects living in the clinic garden/yard?)										
1 3	**Maintenance of genetic diversity** (Do you think this clinic garden has a little number of different species, has average number of different species, or has many different species?) (Are there any plants here, that you don't have in your home garden or that you don't see anywhere else in the community?)										
S	**Cultural services**										
1 4	**Recreation** (Do you enjoy spending time in the clinic garden?) (Are there sometimes children playing in the clinic garden/yard?)										
1 5	**Health and well-being** (Do you think it is good for your health to be in the clinic garden?)										
1 6	**Aesthetic appreciation** (Do you think the clinic garden is beautiful?) (Do you think other come to the clinic garden because it is beautiful?)										
1 7	**Inspiration for culture, art and design** (Does the clinic garden/yard inspire you to create something? Tell me how)										
1 8	**Spiritual experience and sense of place** (Do you experience God when you are in the clinic garden? Do you feel connected to God when you are in the clinic garden? How? Do you feel proud of the clinic garden?) (Do you like to be in the clinic garden? Do you enjoy working in the clinic garden?)										

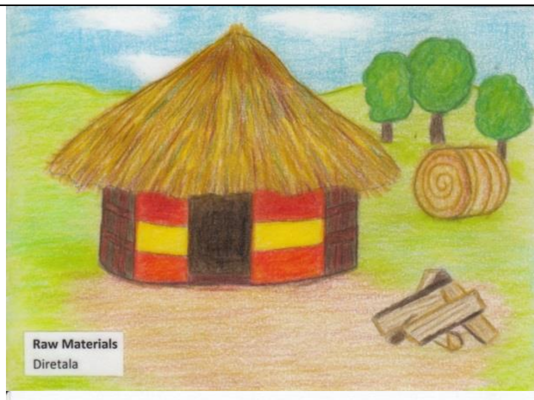
Ecosystem disservices		Presence				Elaboration
		Don't know	No	Average	Abundant	
T	**Allergies (decline in health)** (Do you think any of the plants in the garden can make you sick/ill/allergic?)					
U	**Pests** (Do you think there are any pest/harmful species in the garden?)					
V	**Accidents** (Do you think any of the plants in the garden can harm you e.g. branches falling on you?)					
W	**Damage to buildings or other structures** (Do branches of trees fall on the roof of the building? Do fallen leaves clog the gutters? Do you think plant roots cause damage to buildings?)					
X	**Fear and stress** (Do you feel save in the garden?)					
Y	**Blockage of view** (Do you think the garden obstructs your view?)					
Z	**Do you think there are other bad things that the garden contains or does?**					

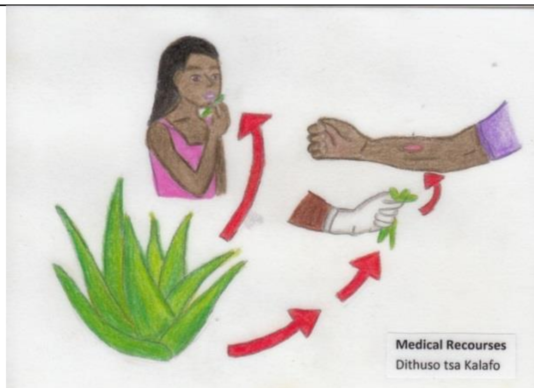
Finishing time	:	:

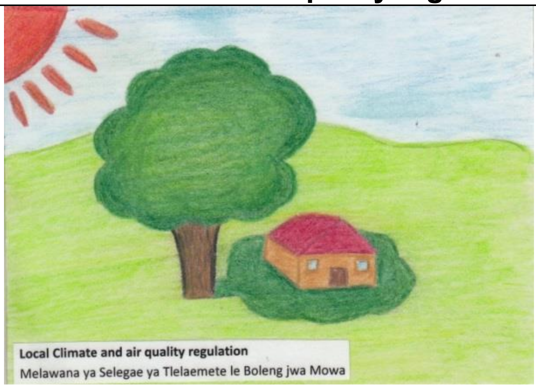
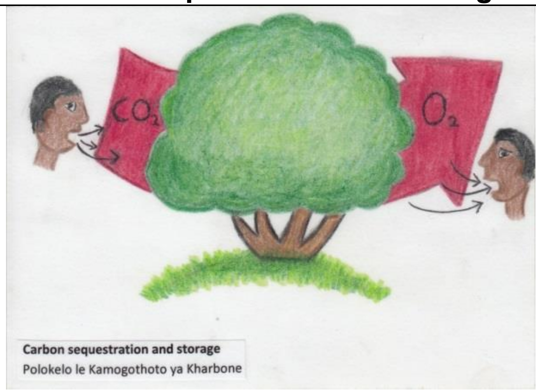
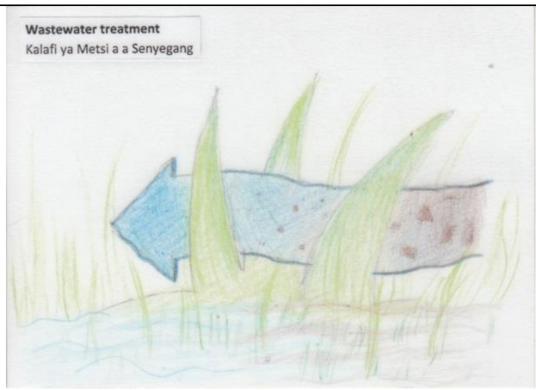
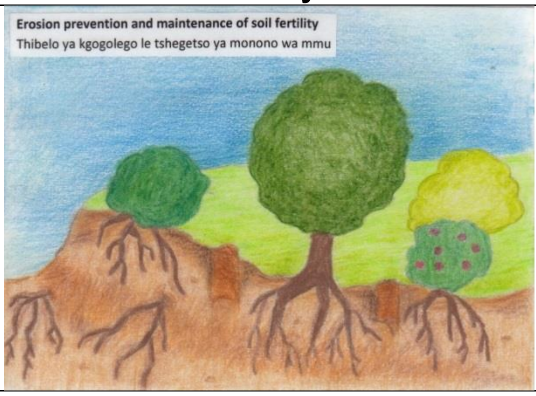
Thank you very much for your time!

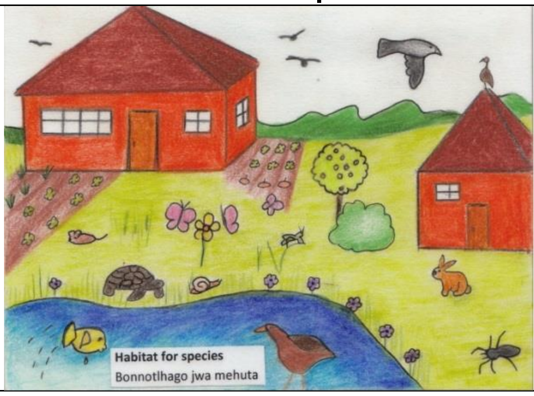
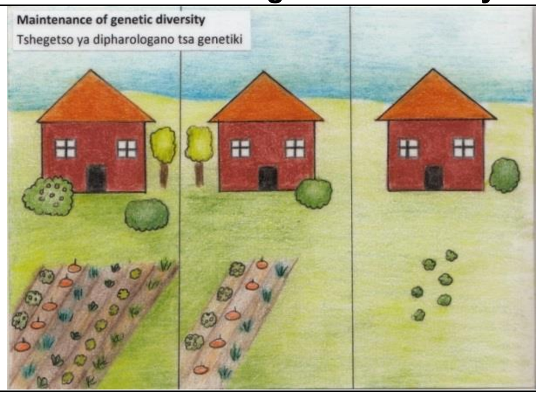
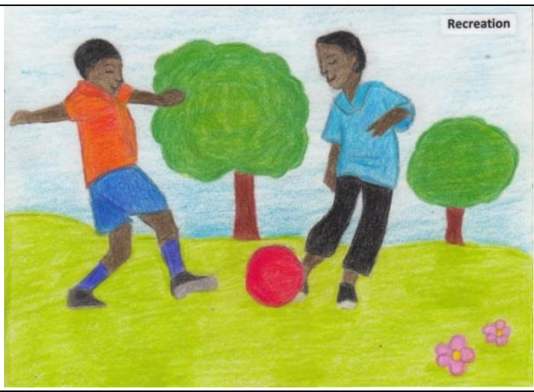
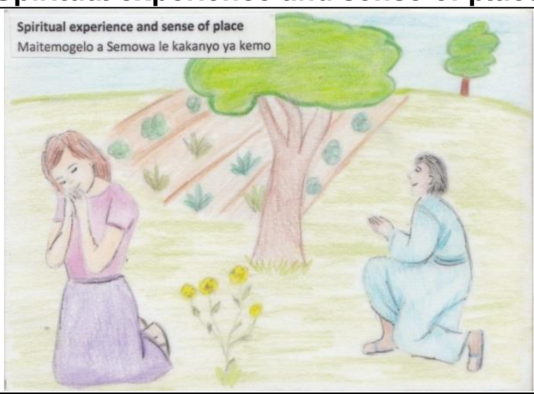
Appendix C: Illustrations used during interviews

Appendix C1: Illustrations of ecosystem services

<table>
<tr><th colspan="2">Provisioning ecosystem services</th></tr>
<tr><th>Food</th><th>Raw materials</th></tr>
<tr><td></td><td>

</td></tr>
<tr><th>Freshwater</th><th>Medicinal resources</th></tr>
<tr><td></td><td>
</td></tr>
<tr><td colspan="2"></td></tr>
</table>

Regulating ecosystem services	
Local climate and air quality regulation	**Carbon sequestration and storage**
	
Moderation of extreme events	**Wastewater treatment**
	
Erosion prevention and maintenance of soil fertility	**Pollination**
	
Biological control	
	

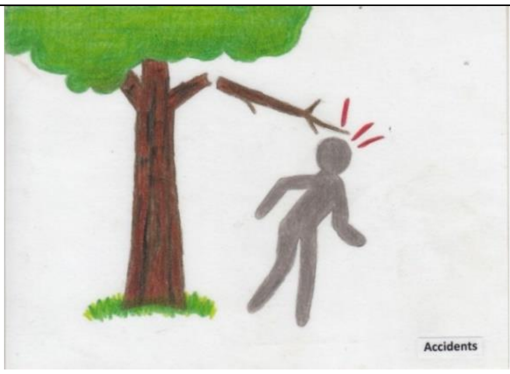
<table>
<tr><th colspan="2">Supporting ecosystem services</th></tr>
<tr><th>Habitats for species</th><th>Maintenance of genetic diversity</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><th colspan="2">Cultural ecosystem services</th></tr>
<tr><th>Recreation</th><th>Health and well-being</th></tr>
<tr><td>
</td><td></td></tr>
<tr><th>Aesthetic appreciation</th><th>Inspiration for culture, art and design</th></tr>
<tr><td>
</td><td></td></tr>
<tr><th>Spiritual experience and sense of place</th><th></th></tr>
<tr><td>
</td><td></td></tr>
</table>

Appendix C2: Illustrations of ecosystem disservices

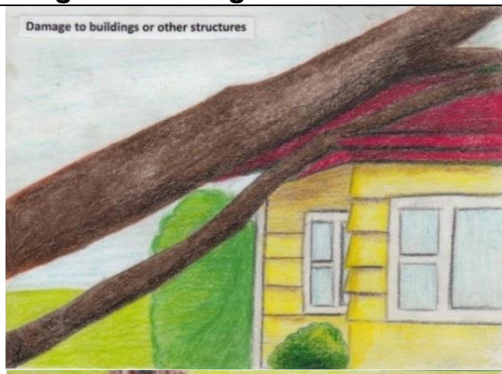
Allergies

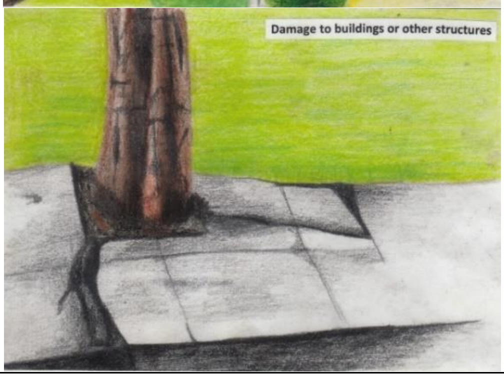
Pests

Accidents



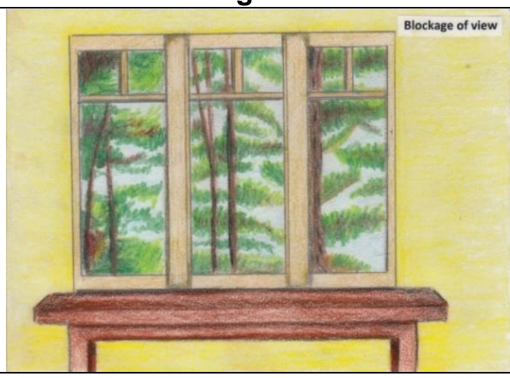
Damage to buildings or other structures



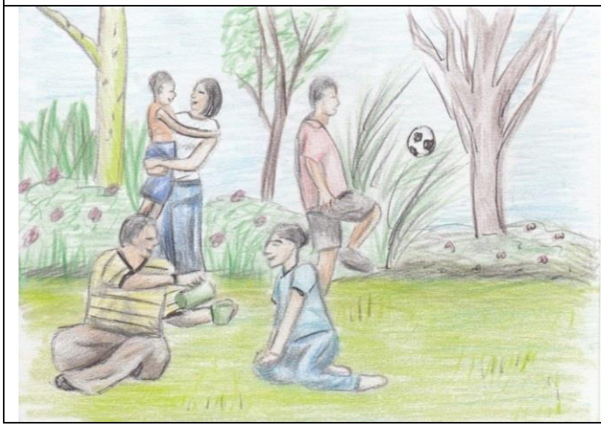


Fear and stress

Blockage of view



Appendix C3: Illustrations of values

Economic	Ecological
	
Social	**Cultural**
	

APPENDIX D: ATLAS.ti output documents

Appendix D1: Codes and descriptions of each code as contained in the comments on ATLAS.ti

	Code	Comment	Grounded	Density	Code Groups
[	A-*ANTHROPOGENIC/ HUMAN	The theme "Anthropogenic/ Human" includes the categories "Clinic responsibility", "Economic", "Government responsibility", "Politics", and "Stakeholders". These categories all have the human factor in common.	0	5	
[	A-CLINIC RESPONSIBILITY	Clinic responsibility includes codes that have to do with actions that the clinics are involved with. Codes include "Accidents avoided by cutting and pruning" - this will prevent accidents where branches fall on people. "Assists the community" - the clinic is there to assist the community when they are sick or have any other medical enquiries. "Easily accessible" - community members can easily get to the clinics, it is not necessary to make use of public transport. "Education" - the clinic provides the community with information, people need to be educated about the garden, the participants want to learn, and there is a need for education between the groundskeeper and the community. "Not allowed to cut trees" - people are not allowed to cut the trees to obtain wood or other raw materials. "Provides food to orphans" - orphans in the	0	8	

		community receive food from the clinic. "Source of income" - people are employed by the clinic, and therefore the clinic is a source of income to employees.			
	A-Clinic responsibility-Accidents avoided by cutting and pruning	Accidents are avoided in the garden by cutting and pruning trees	1	2	Clinic responsibility
	A-Clinic responsibility-assists the community	The clinics according to the participants are there to assist the community when they are sick or have any other medical enquiries.	28	1	Clinic responsibility
	A-Clinic responsibility-easily accessible	Community members can easily get to the clinics. It is not necessary to make use of public transport.	2	1	Clinic responsibility
	A-Clinic responsibility-Education	The clinic provides the community with information. People need to be educated about the garden. The participants want to learn. There is a need for communication between the groundskeeper and the community.	28	2	Clinic responsibility Cultivation necessities
	A-Clinic responsibility-Not allowed to cut trees	They are not allowed to cut the trees in order to obtain raw materials.	1	2	Clinic responsibility
	A-Clinic responsibility-provides food to orphans	Orphans in the community receive food from the clinic.	2	1	Clinic responsibility
	A-Clinic responsibility-source of income	The participant is employed by the clinic, and therefore the clinic is their source of income.	2	1	Clinic responsibility

	A-ECONOMIC	The category economic contains codes that have to do with money. The following codes are included: "ES cannot be bought" - one cannot pay for the ecosystem services (ES) because it is obtained for free. "Food sold" - food is sold to employees of the clinic, or to the community to receive an income. "Money is saved" - money is saved because a service does not need to be bought. "Money needed" - money is needed to achieve or obtain something. "Not sold" - ES are not sold, this includes food and raw materials. "Not willing to pay out of own pocket" - participants are not willing to pay for a service with their own money. "Seeds have to be bought" - in order for the clinic to have plants in the garden, seeds have to be bought. "Wood sold" - wood is sold to make some money.	0	9	
	A-Economic-ES cannot be bought	One cannot pay for the ES it is obtained for free	4	1	Economic
	A-Economic-Food sold	Food was sold for the participant to have an income.	1	2	Food production Economic
	A-Economic-Money is saved	Money is saved, because something does not need to be bought.	22	2	Economic
	A-Economic-Money needed	Money is needed to achieve or obtain something	6	1	Economic
	A-Economic-Not sold	ES are not sold, includes food and raw materials.	5	1	Economic
	A-Economic-Not willing to pay out of own pocket	The participant said that he is at the clinic to work and not to make donations. The participant feels that he will receive nothing if he pays.	3	1	Economic

	A-Economic-Seeds have to be bought	Seeds have to be bought to have plants in the garden	2	1	Economic
	A-Economic-Wood sold	Wood is sold to receive an income	1	2	Economic Benefits of plants
	A-GOVERNMENT RESPONSIBILITY	According to some participants the government has some responsibilities when concerning the clinic gardens. Codes include: "Government should pay for more plants" - the participant feels that if he/she was the government he/she would provide money to buy plants. "Seeds provided by Department of Agriculture" - the Department of Agriculture provides the clinic with seeds.	0	3	
	A-Government responsibility-Government should pay for more plants	The participant feels that if he/she was the government he/she would provide money to buy plants.	1	1	Government responsibility
	A-Government responsibility-Seeds provided by Department of Agriculture	The Department of Agriculture provides the clinic with seeds.	1	1	Government responsibility
	A-POLITICS	The category politics contains the responses of the participants about their interest in politics. Codes include: "Interested in politics" - Participant is interested in politics and follows it. "Not interested in politics" - politics means nothing, or the participant is not interested in politics. "Politics are running the country" - politicians are in charge of making decisions that impact the country. The country is ruled by a political party, without political parties there are no politics. Politics control our land. Politics are where policies are developed on how to govern and run the country. Politics have transformed the health	0	4	

		service department. They change lives. They provide free services to the community. Everything involves politics. Politics shape our world and prepares us for the future.			
	A-Politics-Interested in politics	Participant is interested in politics and follows it.	1	1	Politics
	A-Politics-Not interested in politics	Politics means nothing, or the participant is not interested in politics.	9	1	Economic Politics
	A-Politics-Politics are running the country	The country is ruled by a political party, without political parties there are no politics. Politics control our land. Politics are where policies are developed on how to govern and run the country. Politics have transformed the health service department. They change lives. They provide free services to the community. Everything involves politics. Politics shape our world and prepares us for the future.	7	1	Politics
	A-STAKEHOLDERS	The category stakeholders contain the three main groups of stakeholders interviewed. The codes include: "Community member" - the participant is a community member: CWP, CHW, or volunteer. "Facility manager" - the participant is the facility manager or the acting facility manager. "Groundskeeper" - the participant was a groundsman or grounds lady.	0	4	
	A-Stakeholders-Community member	The participant is a community member. CWP, CHW, and volunteers are included.	6	2	Cultivation necessities Stakeholders
	A-Stakeholders-Facility manager	The participant is the facility manager or the acting facility manager.	6	2	Cultivation necessities Stakeholders

	A-Stakeholders-Groundskeeper	The participant is a groundskeeper.	6	2	Cultivation necessities Stakeholders
	C-*CONNECTION BETWEEN NATURAL AND ANTHROPOGENIC	The theme "Connection between natural and anthropogenic" includes the activities/factors that can be obtained from a relationship between humans and nature. Categories that are included are "Cultivation necessities", "Emotions/feelings towards the garden", "Food production", "Home remedy/medicinal uses", and "Reasons for not having a garden".	0	5	
	C-CULTIVATION NECESSITIES	The category "Cultivation necessities" includes factors that have to be present in order for the clinic garden to be successful. These factors include: education, community members, facility manager, groundskeeper, plants and equipment, pollination, pest control (birds eating pests), plants protecting the soil, water (preferably from a borehole) and love for the garden.	0	12	
	C-EMOTION/FEELINGS TOWARDS THE GARDEN	The category "Emotion/Feelings towards the garden" contains codes that have to do with the feelings/emotions that people have about the clinic garden. Codes include: "Beautiful garden makes one feel better" - a beautiful garden makes you feel better if you are sick. "Peace of mind" - participant experiences peace of mind when in the garden. "Garden can inspire" - the garden can inspire people to draw, make	0	17	

		art, take photos. Artists can sit in the garden and think deep. Youth are taught about art and culture and informed about bursaries. People are willing to come to the garden to take wedding photos. "Garden improves health" - being in the garden makes people feel better, it improves their health. People receive healthy food and they inhale clean air. People re inhaling fresh air. "Garden is beautiful" - People have said the garden is beautiful. Some people want to know how to make their gardens more beautiful. Or the participant thinks the garden is beautiful. Other clinics want to know how to make their gardens more beautiful. "Garden makes me happy" - being in the garden makes them happy, they enjoy being in the garden. Everyone can be happy and social when in the garden. "Garden might be a place to have spiritual experience" - the garden might attract people to do their spiritual activities in the garden. "Loves the garden" - the participants love the garden. "One with nature" - Loves nature, volunteered to work in the garden, lives of the land, does not eat meat. Trees protect from the sun and food is obtained from nature. Can't live without the garden. "Pastors/priests visit clinics" - pastors or priests have visited some clinics, they were invited or went on their own. "People brought			

		together to socialize" - socialization can occur as people are brought together at the clinic garden. "Play" - children can play in the garden. There is space for children to play. "Prayer" - one can pray anywhere. Some people go to special places (e.g. mountains) to pray. Prayer meetings are organized, priests are invited. Prayer promotes socialization, because people do not pray alone. "Reduces stress" - no treatment for stress required, thus an economic benefit. "Relax" - people relax in the clinic garden.			
	C-Emotion/feelings towards the garden-Beautiful garden makes one feel better	A beautiful garden makes you feel better if you are sick	1	1	Emotion/Feelings towards garden
	C-Emotion/feelings towards the garden-Garden can inspire	The garden can inspire people to draw, make art, and take photos. Artists can sit in the garden and think deep. Youth are taught about art and culture and informed about bursaries. People are willing to come to the garden to take wedding photos.	4	1	Emotion/Feelings towards garden
	C-Emotion/feelings towards the garden-Garden improves health	Being in the garden makes people feel better, it improves their health. People receive healthy food and they inhale clean air. People are inhaling fresh air.	8	1	Emotion/Feelings towards garden
	C-Emotion/feelings towards the garden-Garden is beautiful	People have said the garden is beautiful. Some people want to know how to make their gardens more beautiful. Or the participant thinks the garden is beautiful. Other clinics want to know how to make their gardens more beautiful.	16	1	Emotion/Feelings towards garden
	C-Emotion/feelings towards the garden-Garden makes me happy	Being in the garden makes them happy, they enjoy being in the garden. Everyone can	3	1	Emotion/Feelings towards garden

		be happy and social when in the garden.			
	C-Emotion/feelings towards the garden-Garden might be a place for people to have spiritual experience	The garden might attract people to do their spiritual activities in the garden.	1	3	Emotion/Feelings towards garden
	C-Emotion/feelings towards the garden-Loves the garden	The participants love the garden.	4	2	Emotion/Feelings towards garden
	C-Emotion/feelings towards the garden-One with nature	Loves nature. Volunteered to work in garden. Lives of the land. Does not eat meat. Trees protect from the sun and food is obtained from nature. Can't live without the garden. The garden is a paradise.	5	1	Emotion/Feelings towards garden
	C-Emotion/feelings towards the garden-Pastors/Priests visit clinics	Pastors or priests have visited some clinics. They were invited or went on their own.	2	2	Emotion/Feelings towards garden
	C-Emotion/feelings towards the garden-Peace of mind	Peace of mind	1	1	Emotion/Feelings towards garden
	C-Emotion/feelings towards the garden-People brought together to socialize	Socialization can occur as people are brought together at the clinic garden.	8	3	Emotion/Feelings towards garden
	C-Emotion/feelings towards the garden-Play	Children can play in the garden. There is space for children to play.	6	1	Emotion/Feelings towards garden
	C-Emotion/feelings towards the garden-Prayer	One can pray anywhere. Some people go to special places (e.g. mountains) to pray. Prayer meetings are organized, priests are invited. Prayer promotes socialization, because people do not pray alone.	5	4	Emotion/Feelings towards garden
	C-Emotion/feelings towards the garden-Reduces stress	Not treatment is necessary for stress, thus is an economic benefit.	1	1	Emotion/Feelings towards garden
	C-Emotion/feelings towards the garden-Relax	People relax in the clinic garden.	4	1	Emotion/Feelings towards garden
	C-Emotion/feelings towards the garden-Social well-being	To improve social well-being, people come together.	3	2	Emotion/Feelings towards garden

	C-FOOD PRODUCTION	The category "Food production" includes the food produced and also what is done with the produced food. Codes include: "Food given away" - food given to patients and to funerals. Food given to unemployed and sick people to combat malnutrition. "Food tunnel" - a food tunnel will make it easier to protect plants, from example bad weather. "Fruit" - fruit produced in the clinic gardens includes lemons, oranges, tangerines and peaches. "Provides energy to make one more active" - food provides energy to make one active. Is nutritious, food such as spinach provides proteins. "Yield reduced" - Pests reduce the amount of food produced.	0	7	
	C-Food production-Food given away	Food given to patients and to funerals. Food given to unemployed and sick people to combat malnutrition.	7	1	Food production
	C-Food production-Food tunnel	A food tunnel will make it easier to protect plants, from example bad weather.	2	1	Food production
	C-Food production-Fruit	Fruit produced in the clinic gardens, includes lemons, oranges, tangerines, and peaches.	15	1	Food production
	C-Food production-Provides energy to make one more active	Food provides energy to make one active. Is nutritious. Food such as spinach provides proteins.	6	1	Food production
	C-Food production-Yield reduced	Pests reduce the amount of food produced.	2	1	Food production

	C-HOME REMEDY/MEDICINAL USES	The category "Home remedy/Medicinal uses" includes home remedies and plants used to treat different ailments. Codes include: "Aloe" - aloe plants are present in the garden, aloes are especially used as medicinal resource, and aloes treat high blood pressure. "Home remedies" - a mixture is made with sugar, water and lemon juice and given to people with 'flu.	0	3	
	C-Home remedy/medicinal uses-Aloe	Aloe plants are present in the garden. Aloes are especially used as medicinal resource. Aloes treat high blood pressure	4	1	Home remedy/Medicinal uses
	C-Home remedy/medicinal uses-Home remedies	A mixture is made with sugar, water and lemon juice and given to people with 'flu. It contains vitamin C.	1	1	Home remedy/Medicinal uses
	C-REASONS FOR NOT HAVING A GARDEN	The category "Reasons for not having a garden" includes different reasons given by participants from different clinics for not having a vegetable garden. Codes include: "Food stolen" - people stole from the garden so the garden was stopped. "Garden was destroyed" - people destroyed the garden. "Lack of sunlight" - a lack of sunlight is the reason why there is not a vegetable garden, there is walls and trees that provide too much shade. "Needs plants and/or equipment" - the clinics need seeds/plants and/ or equipment in order to have and maintain the garden. They asked us to provide them with seeds and equipment. The lack of seeds/plants led to some clinics not having gardens. They	0	8	

		need sponsors to provide plants/equipment. "Small garden" - the garden is too small to have enough of a service. "Lack of water" - clinics are struggling due to a lack of water.			
[	C-Reasons for not having a garden-Food stolen	People stole from the garden.	1	1	Reasons for not having a garden
[	C-Reasons for not having a garden-Garden was destroyed	People destroyed the garden.	1	1	Reasons for not having a garden
[	C-Reasons for not having a garden-Lack of sunlight	A lack of sunlight is the reason why there is not a vegetable garden. There are walls and trees that provide too much shade.	1	1	Reasons for not having a garden
[	C-Reasons for not having a garden-Lack of water	Clinics are struggling due to a lack of water.	2	2	Reasons for not having a garden Water
[	C-Reasons for not having a garden-Needs plants and/or equipment	The clinics need seeds/plants and/or equipment in order to have and maintain the garden. They asked us to provide them with seeds and equipment. The lack of seeds/plants led to some clinics not having gardens. They need sponsors to provide plants/equipment.	13	2	Reasons for not having a garden Cultivation necessities
[	C-Reasons for not having a garden-Small garden	The garden is too small to have enough of a service.	12	1	Reasons for not having a garden Constraints by plants
[	N-*NATURAL/ ENVIRONMENTAL	The theme "Natural/Environmental" contains factors that are present in nature that serve an important function. Codes include "Animals", "Benefits of plants", "Constraints by plants" and "Water".	0	4	
[	N-ANIMALS	The category "Animals" contains all animal sightings and services provided by animals. Codes include: "Animals are bad" - animals are bad, they damage, destroy, are a problem. Animals eat the plants. "Ants" - ants	0	15	

		are present in the garden, they are mostly a problem. "Bird pollination" - birds pollinate plants, it is an important function. "Birds eat pests" - birds eat pests and therefore contribute to biological control. When birds eat the pests, vegetables can grow. "Birds present in the garden" - birds live in the garden, they love and enjoy the garden. Birds spread seeds. "Fear of snakes" - the participant is afraid of snakes. "Feed for animals" - raw materials are given to animals as food, especially grass. "Insect pollination" - butterflies, bees and other insects pollinate flowers, it is an important function. "Mice/rats" - mice/rats have been observed in the garden, sometimes they are pests. Rats go into the pharmacy of one clinic and ate medication. "Pest control" - pest control needed to get rid of pests, they spray chemicals. "Pigeons" - pigeons are considered to be pests, because their droplets block the gutters. "Sheep" - sheep eat food from clinic garden, especially cabbage. "Snakes" - snakes observed in the garden but not that often. "Spiders" - spiders observed in the clinic garden, there is a fear of not knowing how harmful the spiders are.			
	N-Animals-Animals are bad	Animals are bad, they damage, destroy, are a problem. Animals eat the plants.	11	9	Animals
	N-Animals-Ants	Ants are present in the garden, they are mostly a problem.	4	3	Animals

	N-Animals-Bird pollination	Birds pollinate plants, it is an important function.	2	2	Animals Cultivation necessities
	N-Animals-Birds eat pests	Birds eat pests and therefore contribute to biological control. When birds eat the pests, vegetables can grow.	8	2	Animals Cultivation necessities
	N-Animals-Birds present in the garden	Birds live in the garden. Birds love and enjoy the garden. Birds spread seeds.	7	2	Animals Cultivation necessities
	N-Animals-Fear of snakes	The participant is afraid of snakes.	1	3	Animals
	N-Animals-Feed for animals	Raw materials given to animals as food. Especially grass is given to animals.	3	1	Animals
	N-Animals-Insect pollination	Butterflies, bees and other insects pollinate flowers. It is an important function.	4	2	Animals Cultivation necessities
	N-Animals-Mice/rats	Mice/rats have been observed in the garden. Sometimes they are a pest. Rats got into the pharmacy of one clinic and ate medication.	6	3	Animals
	N-Animals-Pest control	Pest control needed to get rid of pests. They spray chemicals.	6	5	Animals
	N-Animals-Pigeons	Pigeons are considered to be pests, because their droplets block the gutters.	1	4	Animals
	N-Animals-Sheep	Sheep eat food from clinic garden, especially cabbage.	1	2	Animals
	N-Animals-Snakes	Snakes observed in the garden but not that often.	5	3	Animals
	N-Animals-Spiders	Spiders observed in the clinic garden, there is a fear of not knowing how harmful the spiders are.	6	2	Animals
	N-BENEFITS OF PLANTS	The category "Benefits of plants" contains all mentioned benefits the participants perceive the clinic gardens to have. Codes include: "Compost made from grass" - cut grass used to make compost for the garden. "Environment benefits" - the environment will be nice, there will be better growth of plants, they will be more nutritious,	0	13	

		the environment is protected, nourished, healthy, preserved. "Firewood" - wood obtained from clinics used to make fires, which are used to prepare food. "Garden grows even though it is not maintained" - the garden grows well even though it is not watered or maintained by the clinic staff. "Plants convert CO2 to oxygen" - fresh air is obtained from plants. Carbon sequestration improves smell and health. Plants inhale carbon dioxide. Carbon dioxide emitted by cars is taken up by plants. "Plants protect soil" - erosion is not occurring because plants protect the soil. "The impurities are trapped in the grass" - impurities from wastewater are trapped in the grass which keeps harmful things from children. "Trees protect against extreme events" - trees protect against extreme events, such as rain, strong winds, reduces wind. "Trees regulate climate" - trees regulate the climate, plants provide shade, when it is very hot people can sit under trees in the shade. "Wind pollination" - wind pollinates the plants and distributes the seeds. "Wood" - wood is obtained from trees as raw material.			
	N-Benefits of plants-Compost made from grass	Cut grass used to make compost for the garden.	2	1	Benefits of plants
	N-Benefits of plants-Environment benefits	The environment will be nice. There will be better growth of plants, they will be more nutritious. The environment is protected, nourished,	12	1	Benefits of plants

		healthy, preserved.			
	N-Benefits of plants-Firewood	Wood obtained from clinics used to makes fires, which are used to prepare food with.	5	1	Benefits of plants
	N-Benefits of plants-Garden grows even though it is not maintained	The garden grows well even though it is not watered or maintained by the clinic staff.	1	1	Benefits of plants
	N-Benefits of plants-Plants convert CO2 to oxygen	Fresh air is obtained from the plants. Carbon sequestration improves smell and health. Plants inhale carbon dioxide. Carbon dioxide emitted by cars is taken up by plants.	9	1	Benefits of plants
	N-Benefits of plants-Plants protect soil	Erosion not occurring because plants protect the soil	3	2	Cultivation necessities Benefits of plants
	N-Benefits of plants-The impurities are trapped in the grass	Impurities from wastewater are trapped in the grass which keeps harmful things from children.	2	1	Benefits of plants
	N-Benefits of plants-Trees protect against extreme events	Trees protect against extreme events. Protection against rain, strong winds, reduces wind.	7	1	Benefits of plants
	N-Benefits of plants-Trees regulate climate	Trees regulate the climate. Plants provide shade, when it is very hot people can sit under trees in the shade.	10	1	Benefits of plants
	N-Benefits of plants-Wind pollination	Wind pollinates the plants and distributes the seeds.	1	1	Benefits of plants
	N-Benefits of plants-Wood	Wood is obtained from trees as raw material.	4	1	Benefits of plants

[	N-CONSTRAINTS BY PLANTS	The category "Constraints by plants" contains the negative thing caused by plants in the clinic gardens. Codes include: "Drain blocked b plants" - plants block the drain, people have to unblock it. "Old trees" - trees are old and could cause problems, for example falling on people, cars and buildings. "Plants will die when exposed to wastewater" - wastewater contains chemicals which could kill the plants. "Pollen allergies" - grass and flowers are causing allergies in the clinic gardens. "Received plants did not grow" - the clinic received plants, but they did not grow. "Roots crack paving" - tree roots are cracking the pavement. "Trees not accessible" - trees are at the back of the building where people cannot go and benefit from them. "Trees small" - trees are too small to have a specific function/service, such as providing shade.	0	9	
[	N-Constraints by plants-Drain blocked by plants	Plants block the drain, people have to unblock it.	1	1	Constraints by plants
[	N-Constraints by plants-Old trees	Trees are old and could cause problems, for example falling on people or structures.	2	1	Constraints by plants
[	N-Constraints by plants-Plants will die when exposed to wastewater	Wastewater contains chemicals which could kill the plants.	1	1	Constraints by plants
[	N-Constraints by plants-Pollen allergies	Grass and flowers are causing allergies.	5	1	Constraints by plants
[	N-Constraints by plants-Received plants did not grow	The clinic received plants, but they did not grow.	1	2	Constraints by plants
[	N-Constraints by plants-Roots crack paving	Roots of trees are cracking pavement.	3	1	Constraints by plants

	N-Constraints by plants-Trees not accessible	Trees are at the back of the building where people cannot go and benefit from them.	1	1	Constraints by plants
	N-Constraints by plants-Trees small	Trees are too small to have a specific function, such as providing shade.	9	1	Constraints by plants
	N-WATER	The category "Water" contains the source of water used at the clinics. Codes include: "From a borehole" - water is pumped from a borehole and used in the garden. "From municipality" - water used in the garden is from the municipality. The water is obtained from a tap.	0	4	
	N-Water-From a borehole	Water is pumped from a borehole and used in the garden.	2	2	Water Cultivation necessities
	N-Water-From municipality	Water used in garden is from the municipality. Water obtained from a tap.	13	1	Water

Appendix D2: Relationships identified between codes

	Source		Relation		Target
	A-CLINIC RESPONSIBILITY		is part of		A-*ANTHROPOGENIC/HUMAN
	A-Clinic responsibility-Accidents avoided by cutting and pruning		is part of		A-CLINIC RESPONSIBILITY
	A-Clinic responsibility-assists the community		is part of		A-CLINIC RESPONSIBILITY
	A-Clinic responsibility-easily accessible		is part of		A-CLINIC RESPONSIBILITY
	A-Clinic responsibility-Education		is associated with		C-CULTIVATION NECESSITIES
	A-Clinic responsibility-Education		is part of		A-CLINIC RESPONSIBILITY
	A-Clinic responsibility-Not allowed to cut trees		is part of		A-CLINIC RESPONSIBILITY
	A-Clinic responsibility-Not allowed to cut trees		contradicts		A-Clinic responsibility-Accidents avoided by cutting and pruning
	A-Clinic responsibility-provides food to orphans		is part of		A-CLINIC RESPONSIBILITY
	A-Clinic responsibility-source of income		is part of		A-CLINIC RESPONSIBILITY
	A-ECONOMIC		is part of		A-*ANTHROPOGENIC/HUMAN
	A-Economic-ES cannot be bought		is part of		A-ECONOMIC
	A-Economic-Food sold		is part of		A-ECONOMIC

A-Economic-Food sold	is associated with	C-FOOD PRODUCTION
A-Economic-Money is saved	is part of	A-ECONOMIC
A-Economic-Money needed	is part of	A-ECONOMIC
A-Economic-Not sold	is part of	A-ECONOMIC
A-Economic-Not willing to pay out of own pocket	is part of	A-ECONOMIC
A-Economic-Seeds have to be bought	is part of	A-ECONOMIC
A-Economic-Wood sold	is associated with	N-BENEFITS OF PLANTS
A-Economic-Wood sold	is part of	A-ECONOMIC
A-GOVERNMENT RESPONSIBILITY	is part of	A-*ANTHROPOGENIC/HUMAN
A-Government responsibility-Government should pay for more plants	is part of	A-GOVERNMENT RESPONSIBILITY
A-Government responsibility-Seeds provided by Department of Agriculture	is part of	A-GOVERNMENT RESPONSIBILITY
A-POLITICS	is part of	A-*ANTHROPOGENIC/HUMAN
A-Politics-Interested in politics	is part of	A-POLITICS
A-Politics-Not interested in politics	is part of	A-POLITICS
A-Politics-Politics are running the country	is part of	A-POLITICS
A-STAKEHOLDERS	is part of	A-*ANTHROPOGENIC/HUMAN
A-Stakeholders-Community member	is part of	A-STAKEHOLDERS
A-Stakeholders-Community member	is associated with	C-CULTIVATION NECESSITIES
A-Stakeholders-Facility manager	is part of	A-STAKEHOLDERS
A-Stakeholders-Facility manager	is associated with	C-CULTIVATION NECESSITIES
A-Stakeholders-Groundskeeper	is part of	A-STAKEHOLDERS
A-Stakeholders-Groundskeeper	is associated with	C-CULTIVATION NECESSITIES
C-CULTIVATION NECESSITIES	is part of	C-*CONNECTION BETWEEN NATURAL AND ANTHROPOGENIC
C-EMOTION/FEELINGS TOWARDS THE GARDEN	is part of	C-*CONNECTION BETWEEN NATURAL AND ANTHROPOGENIC
C-Emotion/feelings towards the garden-Beautiful garden makes one feel better	is part of	C-EMOTION/FEELINGS TOWARDS THE GARDEN
C-Emotion/feelings towards the garden-Garden can inspire	is part of	C-EMOTION/FEELINGS TOWARDS THE GARDEN
C-Emotion/feelings towards the garden-Garden improves health	is part of	C-EMOTION/FEELINGS TOWARDS THE GARDEN
C-Emotion/feelings towards the garden-Garden is beautiful	is part of	C-EMOTION/FEELINGS TOWARDS THE GARDEN

C-Emotion/feelings towards the garden-Garden makes me happy	is part of	C-EMOTION/FEELINGS TOWARDS THE GARDEN
C-Emotion/feelings towards the garden-Garden might be a place for people to have spiritual experience	is part of	C-EMOTION/FEELINGS TOWARDS THE GARDEN
C-Emotion/feelings towards the garden-Loves the garden	is associated with	C-CULTIVATION NECESSITIES
C-Emotion/feelings towards the garden-Loves the garden	is part of	C-EMOTION/FEELINGS TOWARDS THE GARDEN
C-Emotion/feelings towards the garden-One with nature	is part of	C-EMOTION/FEELINGS TOWARDS THE GARDEN
C-Emotion/feelings towards the garden-Pastors/Priests visit clinics	is part of	C-EMOTION/FEELINGS TOWARDS THE GARDEN
C-Emotion/feelings towards the garden-Pastors/Priests visit clinics	is associated with	C-Emotion/feelings towards the garden-Garden might be a place for people to have spiritual experience
C-Emotion/feelings towards the garden-Peace of mind	is part of	C-EMOTION/FEELINGS TOWARDS THE GARDEN
C-Emotion/feelings towards the garden-People brought together to socialize	is part of	C-EMOTION/FEELINGS TOWARDS THE GARDEN
C-Emotion/feelings towards the garden-Play	is part of	C-EMOTION/FEELINGS TOWARDS THE GARDEN
C-Emotion/feelings towards the garden-Prayer	is associated with	A-Economic-Money is saved
C-Emotion/feelings towards the garden-Prayer	is associated with	C-Emotion/feelings towards the garden-Garden might be a place for people to have spiritual experience
C-Emotion/feelings towards the garden-Prayer	is associated with	C-Emotion/feelings towards the garden-People brought together to socialize
C-Emotion/feelings towards the garden-Prayer	is part of	C-EMOTION/FEELINGS TOWARDS THE GARDEN
C-Emotion/feelings towards the garden-Reduces stress	is part of	C-EMOTION/FEELINGS TOWARDS THE GARDEN
C-Emotion/feelings towards the garden-Relax	is part of	C-EMOTION/FEELINGS TOWARDS THE GARDEN
C-Emotion/feelings towards the garden-Social well-being	is part of	C-EMOTION/FEELINGS TOWARDS THE GARDEN
C-Emotion/feelings towards the garden-Social well-being	is associated with	C-Emotion/feelings towards the garden-People brought together to socialize
C-FOOD PRODUCTION	is part of	C-*CONNECTION BETWEEN NATURAL AND ANTHROPOGENIC
C-Food production-Food given away	is part of	C-FOOD PRODUCTION
C-Food production-Food tunnel	is part of	C-FOOD PRODUCTION
C-Food production-Fruit	is part of	C-FOOD PRODUCTION
C-Food production-Provides energy to make one more active	is part of	C-FOOD PRODUCTION
C-Food production-Yield reduced	is part of	C-FOOD PRODUCTION
C-HOME REMEDY/MEDICINAL	is part of	C-*CONNECTION BETWEEN

	USES				NATURAL AND ANTHROPOGENIC
	C-Home remedy/medicinal uses-Aloe		is part of		C-HOME REMEDY/MEDICINAL USES
	C-Home remedy/medicinal uses-Home remedies		is part of		C-HOME REMEDY/MEDICINAL USES
	C-REASONS FOR NOT HAVING A GARDEN		is part of		C-*CONNECTION BETWEEN NATURAL AND ANTHROPOGENIC
	C-Reasons for not having a garden-Food stolen		is part of		C-REASONS FOR NOT HAVING A GARDEN
	C-Reasons for not having a garden-Garden was destroyed		is part of		C-REASONS FOR NOT HAVING A GARDEN
	C-Reasons for not having a garden-Lack of sunlight		is part of		C-REASONS FOR NOT HAVING A GARDEN
	C-Reasons for not having a garden-Lack of water		is associated with		N-WATER
	C-Reasons for not having a garden-Lack of water		is part of		C-REASONS FOR NOT HAVING A GARDEN
	C-Reasons for not having a garden-Needs plants and/or equipment		is associated with		C-CULTIVATION NECESSITIES
	C-Reasons for not having a garden-Needs plants and/or equipment		is part of		C-REASONS FOR NOT HAVING A GARDEN
	C-Reasons for not having a garden-Small garden		is part of		C-REASONS FOR NOT HAVING A GARDEN
	N-ANIMALS		is part of		N-*NATURAL/ENVIRONMENTAL
	N-Animals-Animals are bad		is part of		N-ANIMALS
	N-Animals-Ants		is cause of		N-Animals-Animals are bad
	N-Animals-Ants		is cause of		N-Animals-Pest control
	N-Animals-Ants		is part of		N-ANIMALS
	N-Animals-Bird pollination		is part of		N-ANIMALS
	N-Animals-Bird pollination		is associated with		C-CULTIVATION NECESSITIES
	N-Animals-Birds eat pests		is associated with		C-CULTIVATION NECESSITIES
	N-Animals-Birds eat pests		is part of		N-ANIMALS
	N-Animals-Birds present in the garden		is part of		N-ANIMALS
	N-Animals-Fear of snakes		is part of		N-ANIMALS
	N-Animals-Fear of snakes		is cause of		N-Animals-Animals are bad
	N-Animals-Feed for animals		is part of		N-ANIMALS
	N-Animals-Insect pollination		is associated with		C-CULTIVATION NECESSITIES
	N-Animals-Insect pollination		is part of		N-ANIMALS
	N-Animals-Mice/rats		is cause of		N-Animals-Animals are bad
	N-Animals-Mice/rats		is part of		N-ANIMALS
	N-Animals-Mice/rats		is cause of		N-Animals-Pest control
	N-Animals-Pest control		is part of		N-ANIMALS
	N-Animals-Pest control		is cause of		N-Animals-Animals are bad

N-Animals-Pigeons	is part of	N-ANIMALS
N-Animals-Pigeons	is part of	N-Animals-Birds present in the garden
N-Animals-Pigeons	is cause of	N-Animals-Pest control
N-Animals-Pigeons	is cause of	N-Animals-Animals are bad
N-Animals-Sheep	is part of	N-ANIMALS
N-Animals-Sheep	is cause of	N-Animals-Animals are bad
N-Animals-Snakes	is cause of	N-Animals-Animals are bad
N-Animals-Snakes	is part of	N-ANIMALS
N-Animals-Snakes	is cause of	N-Animals-Fear of snakes
N-Animals-Spiders	is part of	N-ANIMALS
N-Animals-Spiders	is cause of	N-Animals-Animals are bad
N-BENEFITS OF PLANTS	is part of	N-*NATURAL/ENVIRONMENTAL
N-Benefits of plants-Compost made from grass	is part of	N-BENEFITS OF PLANTS
N-Benefits of plants-Environment benefits	is part of	N-BENEFITS OF PLANTS
N-Benefits of plants-Firewood	is part of	N-BENEFITS OF PLANTS
N-Benefits of plants-Garden grows even though it is not maintained	is part of	N-BENEFITS OF PLANTS
N-Benefits of plants-Plants convert CO2 to oxygen	is part of	N-BENEFITS OF PLANTS
N-Benefits of plants-Plants protect soil	is associated with	C-CULTIVATION NECESSITIES
N-Benefits of plants-Plants protect soil	is part of	N-BENEFITS OF PLANTS
N-Benefits of plants-The impurities are trapped in the grass	is part of	N-BENEFITS OF PLANTS
N-Benefits of plants-Trees protect against extreme events	is part of	N-BENEFITS OF PLANTS
N-Benefits of plants-Trees regulate climate	is part of	N-BENEFITS OF PLANTS
N-Benefits of plants-Wind pollination	is part of	N-BENEFITS OF PLANTS
N-Benefits of plants-Wood	is part of	N-BENEFITS OF PLANTS
N-CONSTRAINTS BY PLANTS	is part of	N-*NATURAL/ENVIRONMENTAL
N-Constraints by plants-Drain blocked by plants	is part of	N-CONSTRAINTS BY PLANTS
N-Constraints by plants-Old trees	is part of	N-CONSTRAINTS BY PLANTS
N-Constraints by plants-Plants will die when exposed to wastewater	is part of	N-CONSTRAINTS BY PLANTS
N-Constraints by plants-Pollen allergies	is part of	N-CONSTRAINTS BY PLANTS
N-Constraints by plants-Received plants did not grow	is part of	N-CONSTRAINTS BY PLANTS
N-Constraints by plants-Received plants did not grow	is part of	C-REASONS FOR NOT HAVING A GARDEN
N-Constraints by plants-Roots crack paving	is part of	N-CONSTRAINTS BY PLANTS

	N-Constraints by plants-Trees not accessible		is part of		N-CONSTRAINTS BY PLANTS
	N-Constraints by plants-Trees small		is part of		N-CONSTRAINTS BY PLANTS
	N-WATER		is part of		N-*NATURAL/ENVIRONMENTAL
	N-Water-From a borehole		is part of		N-WATER
	N-Water-From a borehole		is associated with		C-CULTIVATION NECESSITIES
	N-Water-From municipality		is part of		N-WATER