Woody species composition and congregant appreciation of the cultural and spiritual services provided by cemeteries and church gardens in Grahamstown, South Africa

A thesis submitted in fulfillment of the requirements for the degree

MASTER OF SCIENCE

at

RHODES UNIVERSITY

by

PETER JAMES GERARD DE LACY

October 2014

ABSTRACT

Urbanization has increased rapidly throughout the world. The densification of urban areas has greatly reduced the number of natural areas occurring within the urban environment as well as impacting the ecosystem services that these areas provide. Urban greening and sustainable practices have been advocated as a means to once again provide the urban population with ecosystem services. Sacred natural areas that occur in surrounding forest, temple and cemetery sites have been known harbour a variety of biological diversity, as well as provide people with a number of cultural and spiritual benefits. Much of the literature on sacred natural sites comes from rural or eastern countries, leaving a large gap in the knowledge pertaining to information on these sites in both developed nations as well as urban areas. The aim of this study was to determine the abundance and composition of woody species, as well as the spiritual and cultural significance of sacred natural sites in Grahamstown. This study defined a sacred urban area as any form of garden surrounding a church, temple or mosque, as well as cemeteries. It looked at a total of 28 church gardens, one Hindu garden, one Mosque garden and five cemeteries in Grahamstown, South Africa. For each site the area was calculated and a tree and shrub inventory was done for all individuals above 1.5 m tall. Church/cemetery age, denomination and appearance were recorded as well as soil samples collected. An ordination of the data was done to summarize the community data, relating the community variation to environmental gradients. Questionnaires were completed by congregants who attended a religious building with a garden, as well as those that were not surrounded by a garden. These questionnaires were used to determine the cultural, spiritual and aesthetic value of trees and the sacred area, as well as the perceived and felt benefits that these areas provide. Those that were completed by congregants without gardens looked to find out whether or not it was believed that these areas would improve their experiences. There was an average plant density of 106.1 woody plants per hectare, with a total of 139 different species encountered. Of these, 56 % were exotic species. This is slightly lower than that of studies done elsewhere in the world, but may be due to the omission of non-woody ornamentals and lawn species in this study. Of the top 11 most frequently occurring species, only two were indigenous. There was generally low similarity between plant assemblages found at the different sites. A significantly positive

relationship was found between site size and woody plant basal area as well as the total number of woody plants. Site age and religious denomination had little influence on woody plant density, basal area, species richness or woody plant abundance. Congregants stated that a garden surrounding a religious building improved both their spiritual and aesthetic experiences. Stated spiritual and aesthetic experience was significantly influenced by basal area, while abundance significantly influenced stated aesthetic experience. Greenery was therefore important to many of the congregants, however, the species that were present were less influential. A greater sample size from a variety of religions and sacred areas within urban environments throughout the world would prove to be an interesting comparison for future research.

ACKNOWLEDGEMENTS

I would like to extend my gratitude to the following people:

My supervisor Professor Charlie Shackleton. Your support and guidance throughout my last three years of study have been invaluable. You have granted me many opportunities in the last couple of years and for this I am extremely grateful.

Craig Dargie, Rick Moolman and Ross Shackleton. Thank you for assisting with field work and data collection. You guys sacrificed your time to help me and for that I am grateful.

The whole Department of Environmental Science. Although I did not work with all of you, I feel I have gained something from each and every one of you. To those in my office, the many hours spent at the department have been an absolute pleasure due to the good times we have shared.

To my Dad, Mom, sister Faye and Gabby. Without you I would not be where I am today. Words will never express how thankful I am for all you have done for me. Often when it felt like I was not on track, your kind words and advice pulled me through. Thank you.

This work was supported by the South African Research Chairs Initiative of the Department of Science and Technology and the National Research Foundation (NRF) of South Africa. Any opinion, finding, conclusion or recommendation expressed in this material is my own and the NRF does not accept any liability in this regard.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

Introduction

1.1 URBANIZATION

Urbanization is a global multidimensional process that manifests itself through rapidly increasing human population densities and changing land cover (Elmqvist et al., 2008). The growth of urban areas is caused by a combination of four forces: natural growth, rural to urban migration, massive migration due to extreme events, and redefinitions of administrative boundaries (Elmqvist et al., 2008). The proportion of the world's population residing in urban areas has been increasing rapidly over the last few decades, so much so that by 2030 approximately two-thirds will reside in urban areas (United Nations, 2007). In southern Africa 58 % of the population are urbanized, while in South Africa it is 62 % (United Nations, 2010).

While the percentage of urban population for developing countries is not as high as that of developed ones, it is increasing rapidly. Because many developing countries contain a great deal more biodiversity than developed nations (Cities & Biodiversity Outlook, 2012), it is imperative that this biodiversity be protected (Myers et al., 2000). The increase in urban populations, as well as the increasing spatial extent of cities and towns to accommodate these urban populations, has brought about many challenges such as increased atmospheric particulates, larger ecological footprints and urban heat islands (Newman, 2006). These processes harm the native ecosystems (McKinney, 2002). Urbanization typically homogenizes the biota, replaces native ecosystems with pavements and buildings, and covers the soil with green areas dominated by non-native ornamentals (Pauchard et al., 2006). For example, the composition of communities of wildlife species found in the cities of the United States is remarkably similar despite the large variation in climate and geographical features (Elmqvist et al., 2008). McKinney (2008; 2006) found that urbanization is one of the most homogenizing of all human activities, decreasing the species richness of birds, mammals, reptiles, amphibians, invertebrates and plants. Some studies do suggest that human population is positively correlated with a variety of organisms across the tropics as well as Europe (Araujo, 2003; Balmford et al., 2001). Although there may be increases in

biodiversity due to the introduction of exotics, it has been found that overall this biodiversity will decrease across the globe (Alvey, 2006). For example, in Australia, although there had been a 30 % increase in plant and animal species overall from introductions, at least 132 species had become locally extinct (Tait et al., 2005).

Not only is species richness impacted by urbanization, but the amount of tree cover within many urban environments has been decreasing over recent decades. A study of 20 United State's cities, found 17 to have a significant decrease in tree cover (Nowak & Greenfield, 2012). The same affect has been documented in the UK, where a loss of green space in Merseyside was found in each of the 11 study sites, suggesting that although urban green spaces exist, they too are being impacted by ever-increasing populations and urban densification (Pauleit et al., 2005). The many impacts on the natural environment caused by urbanization has led to the degradation of ecosystem services that these areas once provided.

1.2 IMPACTS ON ECOSYSTEM SERVICES

The concept of ecosystem services has been used to describe the benefits that humans obtain from the environment (MEA, 2005). This includes urban environments, examples include how vegetation in urban areas may significantly reduce air pollution, mitigate the urban heat island effect, reduce noise and enhance recreational and cultural values of importance for urban citizen's well-being (Cities & Biodiversity Outlook, 2012; Elmqvist et al., 2008). The importance of these services increases in larger urban areas; however, these large areas and urbanization itself affect these services greatly. A major challenge in urban areas is how to sustain the capacity to generate ecosystem services (Elmqvist et al., 2008). These services may be divided into four groups, namely; supporting, provisioning, regulating, and cultural (MEA, 2005).

1.2.1 Supporting services

Supporting services are the foundation of the production of all other ecosystem services (Andersson, 2006). The expression of these services are either indirect or occur over a long period of time, for example soil formation, nutrient cycling, water cycling, the production of oxygen through photosynthesis and the provision of habitat (Andersson, 2006). However, as urbanization increases, many of these services may be diminished or no longer be provided.

When pavements and roads are installed during urban development, existing trees and topsoil formed through supporting services are removed and the soil is compacted (Viswanathan et al., 2011). This reduces the ability of the soil to recycle nutrients as well as reducing the production of oxygen because of the restriction of root growth due to the lack of porosity of the compacted soil (Viswanathan et al., 2011).

Diochinova et al. (2006) found that the micro-climate of urban areas and the fact that soil in urban areas has been re-used on so many occasions will greatly affect its quality. Urbanization in one area may even affect the supporting services of another, with waste disposal and air pollution not just affecting the immediate surroundings, as was found in China (Chen, 2007). Another aforementioned supporting service that is greatly impacted by urbanization is that of habitat provision (Marzluff, 2001). The destruction of habitat and the lack of ability to support much flora will reduce an ecosystem's ability to sustain much of the variety of habitats for fauna. An example of this is the impact of urbanization on birds. While the density of birds has been known to increase, richness and evenness usually decrease (Marzluff, 2001). The lack of diverse habitats due to urbanization is one of the causes of these declines (Marzluff, 2001).

1.2.2 Provisioning services

Provisioning services include all products that may be harvested from ecosystems (Andersson, 2006). These include freshwater, food, fibre, fuel and genetic resources (MEA, 2005). An increase in urbanization affects the services creating these products, therefore greatly reducing the amounts produced. For example, Hogan and Walbridge (2007) found that urbanization can degrade water quality through the alteration of watershed hydrology, directing water and nutrient flow away from natural riparian wetlands.

Urbanization as well as increasing urban populations will lead to shortages in some provisioning ecosystem services (such as agricultural production). Agricultural production is found to decrease at a rate directly proportional to the amount of new urbanization (Eigenbrod et al., 2011). Genetic resources are also at risk due to urbanization, because urbanization results in the homogenizing of biota (Emqvist et al., 2008; Pauchard et al.,

2006). This greatly reduces the genetic diversity, thereby potentially reducing the quality of the provisioning services such as food and fuel that may be produced.

1.2.3 Regulating services

Regulating services imply benefits obtained from the regulation of ecosystem processes (Andersson, 2006). These include air quality maintenance, local climate regulation, biological control, pollination, water purification and waste management (MEA, 2005). For example, wetlands provide the regulating services of water purification and reduced flooding. Wetlands serve as a means to mitigate the impact of freshwater flood events through the storage and slow release of rain water from soil and aquifers (Eigenbrod et al., 2011).

Wetlands and peri-urban ecosystems are rapidly being destroyed by urbanization, compromising the ecosystem services they provide. Pauchard et al. (2006) found that out of 32 000 ha of wetlands in Concepcion, Chile, there was a net loss to urbanization of 1 734 ha of wetlands (23 % of the original), and 1 417 ha (9 %) of agricultural, forest and shrub land cover types between 1975 and 2000. It was also found that the lack of environmental awareness is the major cause for increasing deterioration of biodiversity in the urban areas of developing nations (Pauchard et al., 2006).

1.2.4 Cultural services

Cultural services include the non-material benefits that people obtain through spiritual enrichment, cognitive development, recreation, aesthetic and educational experiences (Andersson, 2006). These include things such as cultural diversity, educational values, and cultural heritage values. Urbanization greatly impacts these services through reducing the extent of natural areas and damaging trees of importance.

Cocks and Wiersum (2003) state that much attention has been focused on the sacred and religious roles of forests as dwelling places for spirits, burial places for ancestors, sites for rural ceremonies such as initiation rites, or protection of sacred natural features such as springs and caves. These culturally protected forests therefore play an important role in the protection of native vegetation. In the same way parks, churchyards and cemeteries may protect the flora and fauna in urban areas, with sacred sites often being managed and treated

in a completely different manner to other grounds (Cooper, 2012). An example of the importance of natural areas to certain people may be found in two cultural artifacts of the *amaXhosa* and *Mfengu* people in the Eastern Cape in South Africa, namely *ubuhlanti* and *igoqo* (Cocks & Wiersum, 2003). The first, *ubuhlanti*, is a livestock enclosure, and while it has many obvious practical uses, it has also been described as a temple where the ancestral shades (spirits) reside and "brood" over their descendants with a "benevolent eye" (Cocks et al., 2006). Within these enclosures or "temples" ritual sacrifices are performed, and these actions serve as the most important and effective form of communication with ancestral spirits (Cocks et al., 2006). The rituals are performed to elicit ancestral blessings and protection from malicious forces such as sorcery. These rituals involve the slaughter of an animal, and a single erect wooden pole (*ixhanthi*), generally from the *umnquma* tree (*Olea europea* subsp. *africana*), is a permanent fixture in the centre of the enclosure to serve as an anchor for the sacrificial animal, as well as a symbolic point of contact with the ancestral spirits (Cocks et al., 2006). The *ubuhlanti* is also a venue for purging, the ritual expulsion of bodily fluid to rid a person of an illness of any sort or if sorcery is suspected (Cocks et al., 2006). *Igoqo* on the other hand is a wood stockpile to which married women attach great cultural value, as it is considered to be where the female ancestors reside (Cocks et al., 2006). The *igoqo* is also an important social venue for women and provides the women of the household with dignity because it signifies their status within the community (Cocks et al., 2006; Cocks & Wiersum, 2003).

Indian culture has evolved in their forests, and so religious beliefs and rituals are linked to the natural environment and the services it provides (Anthwal et al., 2010). Many plant species and places have been used for both medicinal as well as religious purposes by Hindus in northern India, therefore contributing to their cultural heritage (Kala et al., 2006), which in some areas has been changed with the introduction of Christianity (Ormsby, 2013).

Urbanization therefore greatly influences the functioning of ecosystems; fragmenting, isolating and degrading natural habitats, simplifying and homogenizing species composition, disrupting hydrological systems, as well as modifying energy flow and nutrient cycling (Alberti, 2005; Alberti et al., 2003). Because humans depend on the earth's ecosystems for food, water and other important processes and services, changes in the ecosystem functioning

that result from human actions in urban areas ultimately affect human health and well-being (Alberti, 2005).

1.3 ADDRESSING THE IMPACTS: GREENING CITIES FOR SUSTAINABILITY

The greening of cities and businesses has been advocated as a means to combat the erosion of ecosystem services in urban landscapes (Midilli et al., 2006). This includes, but is not restricted to more environmentally friendly transport, energy, the creation of more urban green spaces as well as more environmentally sound business operating procedures. In terms of green transport, one way in which harmful gasses have been reduced is through the use of biofuels (a substitute for fuels and is produced almost entirely from plant matter) (Demirbas, 2009). The life-cycle production of biofuels has also proven to be more environmentally friendly than that of conventional fuels, along with the reduction in agricultural surplus stock (Puppán, 2002).

Green energy sources are those which have zero or minimal environmental impacts and are therefore more environmentally benign and sustainable. These energy sources are produced from solar, wind, biomass, tidal and geothermal (Midilli et al., 2006). This energy reduces the impact of global fossil fuels use, reduces emissions from electricity generation, decreases greenhouse gasses; and in this way reduces the impact of urbanization on ecosystem services (Midilli et al., 2006). It has also been found that these sustainable energy strategies can make important contributions to the economies of countries, and so provide governments with economic incentives as well as the prospect of a sustainable future for their cities. For these sustainable energy sources to be implemented efficient policy and green power marketing need to be successful, as was the case in Germany (Wüstenhagen & Bilharz, 2006). Another example of a renewable energy success story is the wind power programme in Denmark (Saidur et al., 2010). They have a long tradition of exploiting wind power, developing new kinds of wind turbines from the late 1970s, combined with government grants aiding the wind power programme. Eighteen percent of Danish electricity consumption was supplied by wind power in 2001, as opposed to two percent in 1990 (Saidur et al., 2010).

Mounting emphasis has also been placed on urban green spaces and greening. For example pocket parks have become increasingly important in densifying cites (Nordh et al., 2009),

while various city programmes look to plant large numbers of trees, protect existing ones, and develop tree canopy goals (Nowak & Greenfield, 2012). These areas aim to conserve biodiversity, as well as provide supporting, provisioning, regulating, and cultural ecosystem services in the urban environment.

1.4 THE BENEFITS OF URBAN GREENING

Urban greening, through parks and general green areas, has been identified as an important focal point for the delivery of ecosystem services and thus ecological, economic and social benefits (Roy et al., 2012; Young, 2010). As the impacts of urbanization and threat of global climate change has become more prevalent, the public, community, and private actors at local, national and international levels have expanded and redefined these areas through recognizing them as a central component of urban areas overall "green structure" or "green infrastructure" (Young, 2010). In this way urban forests and green spaces are fundamental assets in a city's infrastructure and their importance centers around the environmental, economic and social value of ecosystem services that urban forests and green spaces provide (Young, 2010). Even many of the smallest of parks in increasingly urbanized areas have been found to provide benefits, as was the case for the pocket parks in many Scandinavian cities (Nordh et al., 2009). Many institutions are investing in efforts to increase the capacity of researchers and urban forest managers to understand and quantify the value of services these areas provide (Young, 2010).

1.4.1 Ecological benefits

Green spaces are known to provide a vast array of ecological benefits in the urban environment. These include the sequesting of carbon dioxide and the production of oxygen (Li et al., 2005; Jo, 2002). These areas help sequester greenhouse gas emissions from urban areas, therefore having a positive effect in countering climate change. Green spaces purify air and water, as well as regulate the micro-climate of a particular area (Li et al., 2005). This is done through providing a break in the concrete surroundings that attract and resonate the heat that result in urban heat islands. These areas also provide some protection of soil and soil micro-organisms (Jim, 2001). Urban green spaces harbour considerable biodiversity in the urban area (Li et al., 2005). This then in turn provides habitats for other plants and animals.

There have been many studies on the efficiency of trees in providing the ecological benefit of mitigating pollution (Escobedo et al., 2011). Escobedo and Nowak (2009) and Escobedo et al. (2008) modeled the role of urban forests in improving air quality in Santiago, Chile, and found it was 1.6 percent in areas with 26 percent tree cover to 6.1 percent in areas with 100 percent tree cover (Escobedo et al., 2011).

In some cities many important and endangered species have been found in the urban forest (Alvey, 2006). Urban green spaces provide corridors for small and medium sized mammals to connect to the different green areas (Angold et al., 2006). Urban domestic gardens also host a variety of habitats for birds to nest and feed (Davies et al., 2009). These gardens contribute significantly to urban biodiversity, hosting just less than a quarter of all trees outside the woodlands of the UK (Davies et al., 2009). Parks in San Francisco, USA, support higher mean abundances of bumblebees than parks outside the city boundary (McFrederick & LeBuhn, 2006), while populations of common frogs in Britain are declining in rural areas, however increasing in urban parks and gardens (Goddard et al., 2009; Carrier & Beebee, 2003). These ecological benefits may enhance the ecosystem services that both humans and animals receive from the urban environment.

1.4.2 Economic benefits

One way in which green spaces benefit the local economy is that they promote higher house prices or rents (Li et al., 2005). For example, in the city of Boston, the most expensive urban infrastructure project in history took place, by relocating an elevated highway underground, creating urban parks and increasing the city's green space (Tajima, 2003). Tajima (2003) found that it was desirable to be located close to a park, and that it is not desirable to be located close to a highway. This showed that a highway had a negative impact and that open green spaces have a positive impact on desirability. In this way the highway demolition and open space creation should create new economic values for the adjacent properties (Tajima, 2003). Roy et al. (2012) found that of 28 studies looking at economic benefits of urban trees, all but one confirmed positive benefits; and the most common of these was increased property value.

The insulation of buildings close to urban green spaces against temperature extremes can reduce energy use, as well as provide localized air cooling; and in this way reducing energy costs (Cameron et al., 2012). Vegetation surrounding buildings has been found to reduce energy costs at a rate of US$ 250 per tree per year (Wang et al., 2014). The removal of pollutants by urban trees may also be given an economic value. The total annual pollution removal by urban trees within the US was 711 000 metric tones, valued at $ 3.8 billon (Nowak et al., 2006).

Aesthetic, historical and recreational values of urban parks increase the attractiveness of a city and promote it as a tourist destination, and in so doing generate employment and revenues (Chiesura, 2004). Great Britain receives 16 million garden visitors annually, with this sector increasing every year since the 1970s (Connell, 2004). An example of how these areas may attract tourists is the Chelsea Flower Show, the world's most popular event in the horticultural calendar worldwide (Connell, 2004). In developing countries the same may be observed, with 750 to 1 000 pilgrimages to Marabouts (Muslim saint's tombs) being carried out every year in Morocco (Jackle et al., 2013).

Another way in which the economic benefits of urban green space may be estimated is through contingent valuation approaches, i.e. measuring the residents' willingness-to-pay to protect urban green spaces. An economic valuation of urban forest benefits in Finland found that more than two-thirds of respondents were willing to pay for the use of recreational parks (Tyrväinen, 2001). Respondents were also willing to pay a fee for three years to prevent the reduction of forested parks to other land uses (Tyrväinen, 2001). Overall, Tyrväinen (2001) showed that the monetary benefits of urban forests are much higher than the present maintenance costs. A positive emotional response from these areas invokes a positive impact on a user's willingness-to-pay, showing that there is a strong relationship between visitor attitudes and monetary valuation of the area (López-Mosquera & Sánchez, 2011).

1.4.3 Social benefits

Urban greening not only improves the appearance and the environmental quality of an area, it also impacts on social issues such as education, health, psychological well-being, community identity, and crime and safety (Keniger et al., 2013; Westphal, 2003). The presence of natural

assets such as urban parks and greenbelts and their components (i.e. trees, water) in urban environments contributes to the quality of life in many ways (Chiesura, 2004). People in urban areas are eager to access these green spaces for recreation, social interaction and to experience nature (Kemperman & Timmermans, 2014; Li et al., 2005). It may be assumed, however, that both ecological and economic benefits are in fact social benefits, as both improve the livability of urban areas. These social services also include psychological benefits such as reduced stress, enhanced contemplativeness as well as providing a sense of peacefulness and tranquility (Chiesura, 2004; Kaplan, 1983).

Green areas may have a significant restorative function as well as provide benefits to physical health and cognitive performance (Keniger et al., 2013). For example improving the recovery rate of hospital patients more rapidly than those whose views were restricted to buildings (Chiesura, 2004; Ulrich, 1984). A survey among park visitors showed a significant relationship between the use of parks and the perceived state of health; with frequent park visitors being more likely to report good health than less frequent visitors (Chiesura, 2004). Nature can encourage the use of outdoor spaces, increasing social interaction, therefore improving social ties (Chiesura, 2004). The probability of five year survival of a senior citizen increased with space for taking a stroll, parks and tree lined streets, as well as the preference to stay and live in their current community (Takano et al., 2002).

There is a positive association between species richness within urban green spaces and the well-being of green space users (Fuller et al., 2007). Their study showed that the degree of psychological benefit was positively related to species richness of plants and to a lesser extent birds, as well as green space size (Fuller et al., 2007). Consequently, they advocated that the management of these areas should emphasize a mosaic of habitats, which will enhance biodiversity, ensure ecosystem service provision and thereby improve the well-being of the human urban population (Fuller et al., 2007). Green areas surrounding schools have even been found to improve learner test scores, graduation rates, as well as having fewer occurrences of criminal behaviour (Matsuoka, 2010). The view of natural elements from one's home windows has also been found to increase an individual's satisfaction and well-being (Kaplan, 2001). Stress reduction is an important reason for visiting parks, as people felt

a reduced level of stress after visiting a green space (van den Berg et al., 2010; Bennett & Swasey, 1996).

The preceding text has highlighted many of the benefits provided by natural areas as well as urban green spaces and how they are being impacted by urbanization. What many of these studies have focused on are standard parks, gardens, and natural rural areas and the benefits they provide (Pothier & Millward, 2013; Nagendra & Gopal, 2011; Davies et al., 2009). What they have however ignored are the cultural services offered in urban settings by sacred sites such as churchyards and cemeteries.

1.5 GREEN SACRED SITES IN OFFERING ECOSYSTEM SERVICES

Green sacred sites are the gardens, spaces and lands around church buildings, or around any place of worship (Cooper, 1995), such as Christian churches, Muslim mosques or Hindu temples. While this study will include cemeteries, the definition of a churchyard provided by Cooper (1995) will be used; i.e. it is an area around church buildings where people are often buried, or around any place of worship which is used predominantly as a sacred area. Sacred sites in Morocco are numerous, with nearly every settlement having a cemetery and a local saint (Jackle et al., 2013). These areas typically contain a wide range of trees, grasses as well as lichens and mosses decorating the stonework (Cooper, 1995). They are not only good for providing habitat, but are also significant for biodiversity conservation due to their public profile. For example, the loss of biodiversity is often much less in areas that are considered sacred (Byers et al., 2001) relative to the surrounding matrix of more transformed and used landscapes. This occurs through traditional spiritual values influencing human behaviour and protecting the biodiversity (Byers et al., 2001). Beyond the people who work in these areas such as diocesan officers and maintenance officials, there are millions of people who visit churchyards and cemeteries worldwide to tend to graves or to come to worship, as well as those who may only view these areas on passing, receiving benefits subconsciously, such as relaxation and tranquility (Cooper, 1995). Visiting these areas for their intangible benefits brought about by their quiet and peaceful atmosphere or just to read old gravestones is also a popular pastime (Cooper, 1995). In recent times, mainstream religions have demonstrated an increased interest in environmental matters, aiding in the protection of sacred sites (Awoyemi et al., 2012; Bhagwat et al., 2011; Dudley et al., 2009; Palmer & Finlay, 2003). These areas

also carry a great symbolic weight because of their religious significance and their use for human burials.

1.5.1 Biodiversity

A large portion of the diversity of plants and small animals resides in human-influenced areas (Cities & Biodiversity Outlook, 2012; Barrett & Barrett, 2001). Sacred areas contribute to the storehouse of natural and cultural diversity and therefore require increased attention, understanding and preservation. Laske (1994) identified cemeteries as areas with potentially high levels of biotic diversity, especially within the human-built landscape matrix. For example, in Australia, cemeteries were identified as sites important to the conservation of plant species characteristic of the grassy white-box woodland, a biome comprising of white-box eucalyptus trees and a variety of grass species (Prober, 1996). Because urban areas are becoming extremely fragmented, it is increasingly important to observe areas where urban and natural influences and relationships can be quantified, such as in cemeteries and churchyards. These areas provide environments for some of the oldest sentinel trees within a region, state, or nation, as well as corridors for the dispersal of native species (Barrett & Barrett, 2001). They may also contain some remnants of original native flora mixed with cultivated plants, including those planted deliberately for funerary symbolism or personal associations, others that have become naturalised, and weeds (McBarron et al., 1988).

Deil et al. (2005) looked at the potential role that sacred areas may play in nature conservation. They found that Marabout grave areas are generally not protected by law, but rather as a by-product of other intentions due to the peoples' beliefs. They had high structural and floristic diversity, therefore providing a break in the monotonous deforested lowland landscape of Morocco (Deil et al., 2005). In the same way, cemeteries and churchyards provide a break in the concrete jungle, serving as aesthetically pleasing areas. Deil et al. (2005) also argued that sacred groves are the only area where natural or semi-natural forest structures and floristic composition may be found in heavily used landscapes, and therefore they may be used as models for reforestation projects in the future, although in some places local norms and restrictions are insufficient (Ormsby, 2013).

Four sacred groves in the south of India were found to host 111 plant species, from 103 different genera in 53 families (Ramanujam & Cyril, 2003). *Ficus benghalensis* L. (Aal) in sacred groves in India acts as a keystone species, providing a niche for many birds and plants (King et al., 1997). Four percent of the total plant species found in Meghalaya are confined to sacred groves, highlighting their importance in biodiversity conservation (Khan et al., 2008; Khan et al., 1997). This is also the case in Morocco, where certain forest types exist only on sacred areas (Frosch, 2010).

1.5.2 Habitat

Urban sacred areas worldwide provide habitats for many plant species. In Morocco 170 species of vascular plants were found on the few hectares studied (Deil et al., 2005). While these areas are important to many plant species, they also provide habitats for many animal species. Deil et al. (2005) stated that these fragments might even function as stepping stones for mobile organisms, or as home islands for species from which they disperse to colonize other areas. Another example of these areas providing habitat may be found in Istanbul, Turkey. Nineteenth century travelers through Istanbul frequently noted the abundant and untidy cemeteries of the city; the city has changed a great deal since then, however the cemeteries have remained more or less the same (Orstan & Kosemen, 2009). Ten species of snail were found in the cemeteries, one of which was extremely rare. Orstan and Kosemen (2009) state that the preservation of some of the original topsoil and perhaps some of the plant cover may have been crucial for the survival of snails of the area.

Sacred urban sites have been seen as bird sanctuaries for many decades (Lussenhop, 1977). McBarron et al. (1988) highlighted that cemeteries provide important refuges for dependent fauna, stating that two grasshopper species are now largely restricted to cemeteries in the Southern Tablelands of Australia due to the changes made to the original grassland (McBarron et al., 1988). Sacred urban sites are also important to horticulturalists and collectors as they offer sources of old-fashioned cultivar material (McBarron et al., 1988). McBarron et al. (1988) argued that cemeteries should be included in the small network of urban natural areas that may protect the different genotypes or variants of native species in areas where all other natural populations have disappeared. These cemeteries were found to contain a surprising number of both native and exotic species, as well as a great deal of rare

or “infrequent” species. In Tasmania, some of the plants that were once widespread may now only be found in localities such as cemeteries or roadsides (Gilfedder, 1990). Sixteen cemeteries in the US were found to harbour 238 prairie and savanna species (Betz & Lamp, 1992). The ability of these areas to host this variety of species was attributed to the soils never having been ploughed or disturbed (Betz & Lamp, 1992).

1.5.3 Carbon, aesthetics and shade

The biodiversity in sacred urban areas provide spatial and aesthetic functions in a landscape architectural context (Stoffberg et al., 2008). Therefore, in addition to their ecological value, these areas provide recreational and aesthetic needs to the people that visit these sites regularly. Unlike the protected forests in remote areas, city parks, churchyards and cemeteries constitute the green spaces managed largely for recreational or spiritual purposes, and form the largest portion of publicly available green space for urban dwellers (Nagendra & Gopal, 2011; Oleyar et al., 2008).

Therefore, in some cities, these areas may provide the only reference to “nature” for local people, providing the important social and psychological functions that substantially improve the quality of city life (Nagendra & Gopal, 2011). Urban congregations often contain a large amount of green spaces, with trees within sacred areas often being significantly larger than those found outside of the sacred areas (Salick et al., 2007). This therefore allows them to sequester more carbon and provide more shade, therefore providing the aforementioned ecological, economic and social benefits.

1.5.4 Spiritual

The complex and diverse field of spiritual, emotional, intellectual, and practical activities at the interface of religion and ecology can be observed at sacred natural places such as churchyards, cemeteries, sacred graves and temples (Deil et al., 2005). Examples of these places in society include sacred groves for Christian-Orthodox communities in Greece, in Japan where there are Shinto shrine groves, in India where there are sacred groves for local communities in the Himalayas, and in tropical Africa where there are grave/community areas with several levels of sacredness (Ormsby, 2013; Deil et al., 2005). Therefore, within sacred sites, trees became protected without being the object of protection, as these areas play such

an integral role in identifying the tribal group associated with them, for genealogy and spirituality (Deil et al., 2005). This could be due to the ever present mentioning of trees within the different religions. One may find the tree of life in the Hebrew book, the awakening of divine consciousness as a serpent ascended a tree in Hindu teachings, while Buddha is reported to have received enlightenment while sitting under the "wisdom tree" (the Bodhi or peepal tree, *Ficus religiosa*) (Dwyer et al., 1991).

An example of urban cultural ecosystem services are shrine/temple forests in Japan, which exist because both Shintoism and Buddhism have traditions of preserving vegetation in places of worship (Ishii et al., 2010). Forests function as objects of nature worship in the case of Shinto shrines, while forests have aesthetic value and are also used as places of religious training in the case of Buddhist temples (Ishii et al., 2010). Sacred trees in Iran are related to different faiths and beliefs, therefore providing spiritual enlightenment to those that view them (Khaneghah, 1998; in Khan et al., 2008).

The worship of trees and plants has been documented as part of Indian religious practice since the hunter-gatherer stage (Chandrakanth et al., 1990). The rituals of tree worship and the benefits derived therefrom are explained in "Vrathas" (Sanskrit ritual handbooks) written by the enunciators of Hindu theology (Chandrakanth et al., 1990). Particular deities are considered to be made manifest in specific plant and tree species, as was the case in Japan (Ishii et al., 2010; Chandrakanth et al., 1990). These species figure prominently in religious practice, and in addition to idols, the more easily recognized temples also contain these particular species to facilitate worship (Chandrakanth et al., 1990). The plants found within sacred areas are seen to have very high intrinsic value, often being considered divine (Anthwal et al., 2010). The very act of planting these certain species is seen as an act of worship and the exact form of the rituals of this worship depends to a large extent on the age of the person, the routine problems and the capacity to worship, and are prescribed by "astrologers" (Chandrakanth et al., 1990).

The ancient sages, who lived in an environment of trees and mountains, therefore promoted the worship of the deities represented by the trees, as had been described in ancient texts (Chandrakanth et al., 1990). This knowledge provided by the ancient sages is still handed down today, from generation to generation. To decide which temple tree/idol to worship,

people generally approach astrologers, temple priests, or knowledgeable elders (Chandrakanth et al., 1990). Reasons for worship then also differ by gender. There are three main reasons for tree worship by women: 1) unmarried women praying for a good husband, 2) married women praying for a healthy child, and 3) old women praying for self-actualisation (Chandrakanth et al., 1990). Men, and mostly farmers, generally pray for 1) a good harvest, 2) for resolution of a property or domestic quarrel in a family and 3) for health and long life for members of their family (Chandrakanth et al., 1990).

Another example of spiritual significance provided by sacred green sites may be found in the Maghreb countries where Moroccan Muslim societies are based on the appreciation of the spiritual authority of patron saints (Marabout or Marabut) (Deil et al., 2005). Initially, the faithful assembled around the living saints, however today they are expressed in collective pilgrimages, the moussem, to the saint's tombs, which are shadowed by trees (Deil et al., 2005). These trees will therefore have spiritual significance, with nobody cutting or damaging these trees as they provide shade to the deceased saint.

While many of the spiritual connections with natural areas occur in rural areas, much of the urban population hold strong personal and spiritual ties to urban green spaces (Dwyer et al., 1991), also providing these areas with protection. People associate these ties with these areas through traditions, symbolism and the inherent need to "get involved" (Dwyer et al., 1991). However, as generations pass, many of the old taboos surrounding sacred trees and forests have become less effective and so some of these areas are being destroyed. Community-based natural resource management has therefore been advocated as a means of protecting these areas, getting the community to conserve the sites by promoting the religious views that protect these areas (Ormsby & Bhagwat, 2010).

1.6 FACTORS INFLUENCING THE PROVISION OF THE ECOSYSTEM SERVICES PROVIDED BY SACRED AREAS

There are many factors that may influence the provision of the ecosystem services by urban parks and presumably also sacred urban areas. These include age, size, soil characteristics and the degree of human influence, including the introduction of exotic species. One of the

major factors influencing species composition and biodiversity may be the particular denomination or religion of the area under study.

1.6.1 Human influence

Deil et al. (2005) suggest that the main factor contributing to biodiversity of sacred areas is human influence. They found that human influence has in many cases increased biodiversity, introducing new species that would otherwise not have occurred there. The structural variability and floristic richness may be attributed to constant, but limited, disturbance by people through digging and burning, and through livestock grazing and defecating in these areas (Deil et al., 2005). The religious taboos that surround trees restrict people from damaging or cutting them down and so influences the biodiversity (Ormsby, 2013). Therefore, Deil et al. (2005) believe that protection and traditional use need to be balanced to maintain the structural and floristic diversity of sacred areas. The Moroccan study therefore found that the combination of traditional religious activities coupled with moderate land use favours biodiversity (Deil et al., 2005).

Similarly, McBarron et al. (1988) attested that the greatest factor in determining biodiversity in cemeteries was human influence. Rare species may be found in relatively "tidy" cemeteries, and they suggested that unsympathetic management is the greatest cause of biodiversity loss (McBarron et al., 1988). This was attributed to herbicide spraying and excessive maintenance. They believed that this should be avoided to ensure that biodiversity is enhanced. Gilfedder (1990) found that many of the native grassland species of Tasmania only still occurred on roadsides and in cemeteries. These sanctuaries to the native grass species have now been "tidied-up", with the native species being replaced by lawns requiring high maintenance and thus reducing biodiversity (Gilfedder, 1990).

Many shrine forests in Japan have been maintained with minimal vegetation management because it was believed that the forest would be preserved in a near-natural state by minimizing human intervention. Examples of this include how some priests believed that not altering the forest by cutting and maintenance resulted in the conservation of natural conditions, or that the planting of certain tree species helped protect their forests (Ishii et al., 2010).

Human influence has also been shown to increase floristic diversity, with the city of Christchurch in New Zealand hosting more floral diversity than the city surroundings (Stewart et al., 2004). LaPaix and Freedman (2010) stated how edge influences and historical use may affect flora. They found that low structural variability of herbaceous cover was influenced by management activities, especially derelict lands and sites managed for intense recreation (LaPaix & Freedman, 2010).

The influences of human activities are also felt in urban domestic gardens. Human values such as household income have also been shown to influence biodiversity (Kinzig et al., 2005). Hope et al. (2003) found that plant diversity increased significantly with the economic status of the residence, with plant diversity of areas above the median family income being twice that of the less wealthy areas. It has also been discovered that planting and active management of private gardens is the major influence on garden vegetation, hence the homogeneity across UK cities (Davies et al., 2009; Goddard et al., 2009).

1.6.2 Age of site

Nagendra and Gopal (2011) looked at tree diversity in the urban parks of Bangalore, India, relative to park age and history. They found that older parks had been cared for by a number of different park managers, and so provided the opportunity for more heterogeneous and diverse growth. The older parks had fewer trees, but contained trees of larger size, and of a more diverse species composition than parks that had been established more recently (Nagendra & Gopal, 2011). This paralleled changes in planting patterns of street trees in Bangalore. This was also the case in Guongzhou, China, where park managers shifted from large, shade bearing broad leaf trees in older parks, to a mix of smaller sized tree species in newly established areas (Nagendra & Gopal, 2011; Jim & Liu, 2001). Large trees provide a better habitat for other urban fauna such as birds, sequester a greater amount of carbon and contain more above ground biomass, therefore providing more effective removal of air particulate pollutants, greater shade and more effective cooling, reducing the problems caused by urbanization (Nagendra & Gopal, 2011; Newman, 2006). At a time when the initial impacts of climate change are accelerating, it is of concern that city park managers would be moving away from larger broad leafed trees, to smaller species that have narrower canopies (Nagendra & Gopal, 2011). Due to sacred areas being protected by taboos and

cultural practices, it has been found that these areas host many large trees, as well as cover greater area due to their old age (Salick et al., 2007).

Another example is the high levels of biodiversity found in the shrines and temples of Japan. Many of the shrines in Japan were established centuries ago, such as the Nikko Tosho-gu Shrine in Tochigi Prefecture, northeast of Tokyo which was built in 1617 (Ishii et al., 2010). Due to their longevity, when a study was conducted in 1970 documenting the vegetation of these shrine/temple forests in Japan, many rare plant communities were found in them (Ishii et al., 2010). These rare plant communities are remnants of the regional endemic vegetation, and large, heritage trees including trees designated as natural monuments, by local and federal governments (Ishii et al., 2010). Age of sites may, however, affect diversity in different ways. In the case of urban diversity across Central Arizona-Phoenix it was found that younger housing developments had greater plant diversity than that of older ones (Hope et al., 2003). This was attributed to the shift in preference of new home owners, preferring more native desert-adapted flora (Hope et al., 2003).

1.6.3 Alien species

Whilst the planting of exotic species may increase the level of biodiversity of a particular town or sacred area, the occurrence of these plants could be detrimental to the native flora and fauna, especially if these exotics are invasive (McKinney, 2006). Ishii et al. (2010) found that many non-native species thrive in the fragmented sacred forests of Japan, especially in edge environments.

In smaller sacred forests, invasive species can dominate over native species, affecting species composition and vegetation dynamics. Some exotic bird-dispersed species in Japan are highly shade tolerant, allowing these species to invade and dominate over the existing native understory vegetation (Ishii et al., 2010). There is a negative relationship between density of exotic woody species and bird diversity in Delhi, India (Khera et al., 2009). Some alien species are also better equipped to cope with the accumulated heat in the urban environment, therefore outcompeting the native flora. Ishii et al. (2010) suggest that active management is needed to prevent invasive species from dominating native vegetation.

1.6.4 Size

Ishii et al. (2010) reported that species richness decreased with decreasing forest size in temple forests and increasing degree of isolation. In Kyoto City, plant and bird species composition of large shrine/temple forests included most of what was found in the smaller fragments (Ishii et al., 2010). Therefore, although conservation of large forest fragments may be effective for maintaining landscape level biodiversity, smaller forest fragments and adjacent confines are sometimes important hosts of rare species that may not be found in other fragments (Ishii et al., 2010). Similarly, Lussenhop (1977) found that the number of bird species found in cemeteries increased with the increase in area, due to the fact that larger cemeteries (those larger than 25 ha) had greater structural and floristic heterogeneity. Betz & Lamp (1992) also found that factors such as soil composition and the biome in which the churchyard or cemetery occurred also impacted on the biodiversity of trees in a negative manner. The number of bird species found at a particular green space increases with increasing green space size (Khera et al., 2009). The size of the green area influences the amount of localized air cooling that it may provide, with greater areas producing a greater reduction of ambient air temperature (Dimoudi & Nikolopoulou, 2003).

In the same way, the conditions that surround the trees in the cemetery or churchyard may influence their growth rate and therefore the diversity of the area. For example, street trees grow significantly slower than garden trees, and these churchyards may have significant paving which could have a large impact (De Lacy & Shackleton, 2014). Because psychological benefits increase with increasing area and biodiversity of green space (Fuller et al., 2007), it may be assumed so too would the perceived spiritual enhancement. Therefore, as the biodiversity or area increases so too are the cultural ecosystem services likely to.

1.6.5 Denomination

Certain trees in particular cultures have importance that may not be seen in another particular culture or religion. This may be seen in the *amaXhosa* and *Mfengu* in Section 1.2.4 and the differences between Hindu and animist sacred forests in India as described by Ormbsby (2013). These people have areas of worship and reflection and contain certain species that hold greater spiritual significance than others (Ishii et al., 2010). Another example is of the

tree species recognized by devout people in India as strictly religious trees. They include *Ficus religiosa*, *Acacia ferruginea*, *Aegle marmelos* and *Ficus glomerata* (Chandrakanth et al., 1990). In the case of *F. religiosa*, it is believed that bad deeds would be forgiven if the tree is planted and an altar is built around it to enable people to worship the tree (Chandrakanth et al., 1990). This could very well be the reason for its appearance in most villages, offering a place of worship, social/religious activities, marriage, informal courts, night meetings and a resting place for roadside travelers (Chandrakanth et al., 1990). During the early hours of the day, people worship the tree by circling the tree and bowing with respect, as they believe that the tree embodies the trinity (Bramha the creator, Vishnu the protector and Shiva the destroyer) (Chandrakanth et al., 1990).

These sites are areas of worship and reflection and so certain species may provide more spiritual significance than others (Ishii et al., 2010). Certain species may even be extremely significant to a particular religion, but mean absolutely nothing to another.

While there have been studies that have mentioned the value of sacred sites within the urban environment (Nagendra et al., 2013), as well as the development of the Delos Initiative which looks to recognize sacred sites within technologically advanced areas (Mallarach & Papayannis, 2010), very few have documented the biodiversity that they harbour or the benefits that they provide. There is in particular a lack of knowledge with regards to the spiritual and cultural benefits that these sites provide urban populations (Keniger et al., 2013). The literature cited in the preceding text relating to these areas providing spiritual services comes from mostly rural communities and eastern countries. There is therefore a large gap in knowledge pertaining to information on these sites in both developed nations as well as urban areas. This project is unique because it brings together the factors of the urban environment, cultural and spiritual ecosystem services and sacred sites.

1.7 OBJECTIVES AND KEY QUESTIONS

1.7.1 Objectives

The aim of this study was to determine the abundance and composition of trees, as well as the spiritual and cultural significance, of sacred urban sites in Grahamstown.

1.7.2 Key Questions

1. What is the abundance and composition of woody plants in sacred urban sites?
2. How do the abundance and composition differ in relation to site factors such as age, size and religious denomination?
3. How do users perceive these sites and what benefits do they obtain?
4. Are user perceptions related to site attributes such as age, area, woody species richness, total basal area and total number of woody individuals?

The first to questions will highlight the level of biodiversity that these sacred areas harbor. This will be used in the flowing chapter to connect this biodiversity to the perceptions and feeling experienced by congregants in these areas. This is particularly important as it will show for the first time the impact of sacred natural sites on the urban population.

1.8 FORMAT OF THIS THESIS

This thesis has been divided up into four chapters. The first covers a range of literature as well as describes the study area of the research. The following two chapters present methodology and results. Chapter 2 highlights the vegetation characteristics of urban sacred sites throughout Grahamstown, while Chapter 3 highlights the importance of these areas in influencing the spiritual experience of church goers. In order to avoid repetition, the study area will not be repeated in each of these results chapters and all references cited will be listed at the end of the thesis. The thesis is concluded with a concluding discussion.

1.9 STUDY AREA

Grahamstown (33°18’S; 26°32’E) is located 60 kilometers inland between the two major cities Port Elizabeth and East London, in the Eastern Cape province, South Africa. It has a population of approximately 70 000 (IDP, 2011). Grahamstown has seasonal fluctuations of temperature, with mean daily maximums ranging from 5 °C in winter up to 35 °C in summer. The hottest months are December to March, while the coldest months occur during winter (June-August). Night-time frosts are not uncommon in winter in the lower lying areas of the town. It receives, on average, 669 mm of rainfall annually (State of the Environment in South Africa, 2004), with bimodal peaks in October-November and again in March-April.

Grahamstown is situated in the Sub-Tropical Thicket biome, which can be narrowed down to grassland thicket or xeric succulent thicket (McConnachie et al., 2008). South Coast Renosterveld can also be found in patches surrounding Grahamstown, along with small patches of Afromontane forest, Grassland and Nama Karoo (Voegt, 2001). Grahamstown is situated in the eastern part of the Cape Fold Belt and is underlain by folded rocks of the Cape and Karoo supergroups (Jacob et al., 2004). The clay deposits found here are related to the Grahamstown Formation silicrete, an ancient pedogenic horizon which developed across rock sequences on a broad peneplain (Jacob et al., 2004). The resistant layer of silicrete found in this area reduces erosional weathering and has preserved the remnants of this peneplain (Jacob et al., 2004).

Grahamstown has 13.9 % of its total area attributed to public green space (McConnachie et al., 2008). Species richness of street trees in Grahamstown is high although highly spatially variable (Kuruneri-Chitepo & Shackleton, 2011). This is attributed to Grahamstown being established in 1812 and hosting a botanical garden that is more than 100 years old. Due to the previous Apartheid regime, South Africa (and Grahamstown is no exception) has a unique racial divide in the city (Donaldson-Selby et al., 2007). Due to this regime the eastern parts of Grahamstown remain impoverished (and is where 77 % of the population reside), while the western parts are affluent. The impoverished eastern side of Grahamstown is home of generally less educated and poorer people, living in high density housing with little public green space (McConnachie & Shackleton, 2010). In Grahamstown 80 percent of street tree species occur in the affluent residential area, while the poorer eastern part contains less than 5 percent of trees encountered by Kuruneri-Chitepo & Shackleton (2011).

Education within the municipal district of Makana (of which Grahamstown is the capital and largest town) shows that 6.2 % of adults received no schooling at all, while the greatest percentage of the population (36.1 %) received primary education (IDP, 2011). Of the total population, 11.3 % completed their schooling to the level of matric. The level of unemployment within the Makana Municipality is higher than that of the province, with a total of 34.3 %. Of those that are employed (32.1 %) 19 % hold elementary occupations, while 17 % are professionals (IDP, 2011). A total of 23 % of households subsist on an income below the poverty line. Makana does however have a higher percentage of people in

the high income brackets than the rest of the province, with an average household income of approximately R 8 418 per month (IDP, 2011).

Grahamstown has approximately 52 churches, earning itself the nickname, “the City of Saints”. Therefore, because of the high number of churches, it is an ideal setting for examination of the key questions posed in this study.

Across the entire Eastern Cape, 17.3 % of the population claim membership of Methodist churches, 11.8 % to Apostolic churches, while 10 % said they had no religious affiliations (Statistics South Africa, 2004). Islam, Hinduism and Judaism attracted much fewer members, with 0.3 %, 0.1 % and 0.1 %, respectively (Statistics South Africa, 2004).

CHAPTER 2

Vegetation characteristics of urban sacred sites

2.1 INTRODUCTION

Urbanization is increasing rapidly worldwide, so much so that by 2030 approximately two-thirds of the world's population will reside in urban areas (United Nations, 2007). This is likely to reduce the amount of natural vegetation found in urban areas due to densification. For example, 17 of 20 cities studied in the US showed a significant reduction in tree cover (4 million trees per year), an unfortunate reality of the ever urbanizing world (Nowak & Greenfield, 2012). Natural or green areas that remain provide the urban population with a host of ecosystem services, including the reduction of harmful gases, micro-climate control, as well as social and psychological benefits (Elmqvist et al., 2008). Due to the potential services that these areas provide, urban greening, through parks, trees, and general green areas, has been advocated as a means to deliver ecosystem services and thus ecological, economic and social benefits (Young, 2010).

Studies on the abundance and composition of urban plant communities and the amount of green space within the urban environment has increased over recent decades (Nowak & Greenfield, 2012; Nagendra & Gopal, 2011; Gill et al., 2008; Colding et al., 2006; Kuhn et al., 2004; Stewart et al., 2004; Jim & Liu, 2001; Nowak et al., 1996; Kunick, 1987). Gill et al. (2008) found that tree cover in the greater Manchester area was 28 % in formal open or green spaces. In US cities it was found that the percentage of urban tree cover ranged from 0.4 % to 55 %, with it being highest in areas that had been founded in naturally forested areas (Nowak et al., 1996). Recently, studies have shown that this large range in percentage tree cover is still prevalent. Nowak & Greenfield (2012) found that of 20 cities within the US the percentage tree cover ranged from 9.6 % to 53.9 %. Parks in Flanders, Belgium, were found to contain 30 % of the total wild plant species found within Belgium, again highlighting the importance of these areas (Cornelis & Hermy, 2004). In a developing area such as the city of Guangzhou, China, total tree cover makes up 1 637 ha, only 7.1 % of the total area (Jim & Chen, 2008).

Many of these studies have however neglected the vegetation within the urban environment that occurs in private gardens, a reserve that harbours a vast array of biodiversity. Davies et al. (2009) found that gardens in Sheffield contained 28.7 million trees, just less than a quarter of all trees occurring outside of woodland areas. This study showed gardens to have a mean of 2.4 trees, with a total natural tree cover of 47 402 hectares (Davies et al., 2009). In Stockholm, Sweden, 16.2 % of the total land is private gardens, while 82 % of real estate represents garden areas (Colding et al., 2006). In the UK it is estimated that private gardens make up between 22-27 % (Loram et al., 2007). In Dunedin, New Zealand, 36 % of the total urban area, and 46 % of the residential area is made up of private gardens (Mathieu et al., 2007), whilst in Leon, Nicaragua, private garden patios made up 86.2 % of all green space in the city (González-Gracía & Sal, 2008).

Another site for vegetation throughout the world is sacred sites (Khan et al., 2008). Sacred natural areas have been documented in many parts of Asia, Africa, Europe, Australia and America; including studies done in parts of Ghana, Nigeria, Syria, Turkey and Japan (Gadgil & Vartak, 1976; in Khan et al., 2008). These areas protect a variety of vegetation and are often protected by taboos and religious practices (Jackle et al., 2013; Frosch, 2010). The different spiritual beliefs and practices can affect the ecology of the site (Anderson et al., 2005). They found that sacred sites differed in useful species and endemic species composition relative to sites without sacred or religious significance (Anderson et al., 2005). Due to the old age of many of these sacred areas, they have the potential to preserve old growth trees and forest structure (Salick et al., 2007).

Most sacred areas that occur within the urban environment are overlooked when it comes to their ability to harbour biodiversity. Cemeteries and church gardens form part of the cultural heritage of urban communities (Guiamet et al., 2012), often providing environments for some of the oldest sentinel trees within a region, as well as serving as corridors for the dispersal of native species (Barrett & Barrett, 2001). In Japan, sacred groves and temple forests are considered important components of urban green space, hosting a variety of trees, with small fragmented forests often still containing many rare or infrequent species (Ishii et al., 2010). Cemeteries in Campbelltown in Sydney host 505 species, with the older cemeteries hosting more rare native species (McBarron et al., 1988). Another example found in Australia

identified cemeteries as sites important to the conservation of plant species characteristic of the grassy white-box woodland (Prober, 1996). These areas are also found to contain some remnants of original native flora mixed with cultivated plants, including those planted deliberately for funerary symbolism or personal associations (McBarron et al., 1988).

There is therefore only limited information pertaining to the vegetation of sacred sites found within the urban environment and none from sub-Saharan Africa. The aim of this chapter was to (i) characterize the woody plant structure and composition for sacred areas within Grahamstown, South Africa, and (ii) assess the factors that might influence abundance and composition. This chapter sought to answer the following questions:

- What is the abundance and composition of woody plants in sacred urban sites?
- How do abundance and composition differ in relation to site factors such as age, size and religious denomination?

2.2 METHODS

2.2.1 Sacred area identification and woody plant inventory

Thirty churches and five cemeteries in Grahamstown were identified through the use of Google Earth as well as obtaining information from the Grahamstown Historical Society. For each one the church priest/pastor/minister was contacted to obtain permission for the study. The area of each site was measured and the date that the site was established to calculate site age was obtained. A full inventory of shrubs and trees taller than 1.5 m was done. Perimeter hedges were not included in this inventory, however if a hedge occurred within the grounds it was recorded. The basal diameter (at approximately 0.3 m) was measured for each stem of all shrubs and trees using digital calipers. In the case of trees that were too large to be measured by the digital calipers, a 1.5 m measuring tape was used to determine the circumference and subsequently converted to diameter.

The garden was then divided into four quarters. In the centre of each of the four quarters, a soil sample was taken to a depth of 10 cm. The four samples were pooled and sent to Bemlab for analysis, including percentage organic matter, clay, silt, sand, stone, nitrogen as well as the pH, electrical conductivity and cation exchange capacity. In each of the quarters the

general appearance of the garden was recorded. This included recording the dominant cover (lawn, treed, paved/concrete) as well as taking note if any amenities (benches, water fountains, pathways, etc.) were present in the garden.

The age of the church was obtained from parish elders and the denomination of each site was recorded. The total hours of garden maintenance and care that the site received was also documented, as reported by the parish elders.

2.2.2 Statistical analyses

The relationship between the church/cemetery age or area and woody plant density, total basal area, species richness, species density and total individuals was explored using regression analyses. When comparing the difference in abundance and species richness between religious denominations, a one-way ANOVA was used after checking that the data were normally distributed. The appearance of gardens and presence of amenities data were not analyzed, but used to interpret results in subsequent chapters.

An ordination was performed using Primer 6. All sites that had no woody species were omitted from the ordination. Plant species that occurred in four or less of the study sites were also omitted to make the graphical representation more reliable. One site was also omitted from the analyses as this site contained no soil variables to be compared to at a later stage due to the whole site being covered in concrete. Non-metric multi-dimensional scaling was used to produce the ordination, while hierarchical clustering was used to produce the dendrogram. Once the non-metric multi-dimensional scaling and hierarchical cluster analysis were complete, one was able to link plant assemblages to the abiotic (environmental) conditions found at each of the sites. Abiotic variables looked at site age as well as the aforementioned tested soil characteristics (2.2.1).

2.3 RESULTS

2.3.1 Sacred site vegetation characteristics

The average garden size was 1.1 ha (± 2.9) while the average woody stem density was 106.1

Table 2.1: Vegetation characteristics of sacred sites sampled in Grahamstown

Church/Cemetery	Garden size (ha)	Total woody plants	Plant density (/ha)	Basal area (m^2) per garden	Species richness
Churches					
African Congregational (AFRIC)	0.07	0	0	0	0
Apostolic Faith Mission (APOST)	0.09	0	0	0	0
Christ Church (CHRCH)	0.34	75	221.2	2.96	46
Christian Centre (CHRCN)	0.34	18	53.3	1.16	10
Dutch Reformed (DUTCH)	0.14	30	219.7	1.89	16
Ethiopian Episcopal (ETHIO)	0.04	6	169	1.04	4
Full Gospel (FULLG)	0.12	26	215.3	0.60	16
Hindu Mandir (HINDU)	0.51	34	66.7	1.09	12
Jesus Christ of Latter-day Saints (CHJCL)	0.14	52	362.6	1.68	29
Lesley Hewston (LESLE)	0.20	0	0	0	0
Living Star (LIVIN)	0.10	0	0	0	0
Methodist of South Africa (METHO)	0.09	3	34.4	0.74	1
Mosque (MOSQU)	0.04	6	142.1	0.20	4
New Apostolic (NEWAP)	0.09	14	164.6	0.43	5
Old Apostolic (OLDAP)	0.23	4	17.0	0.28	4
Presbyterian (PRESB)	0.08	0	0	0	0
Seventh Day Adventist (SEVEN)	0.17	12	69.4	1.23	7
Shaw Memorial (SHAWM)	0.55	21	38.4	1.15	7
St. Augustine (STAUG)	0.13	5	39.1	1.08	4
St. Bartholomew's (STBAR)	0.05	24	454.6	0.19	11
St. Clements's (STCLE)	0.07	11	151.0	0.86	6
St. Joseph's (STJOS)	0.10	3	29.0	0.03	3
St. Mary's (STMAR)	0.15	13	89.6	1.85	6
St. Patrick's (STPAT)	0.15	36	232.8	1.27	16
St. Peter Claver's (STPET)	0.20	4	19.8	2.08	2
St. Philips (STPHI)	0.03	1	32.9	0.01	1
Trinity Presbyterian (TRINI)	0.07	15	208.0	0.64	8
Twelve Stone (TWELV)	0.25	3	12.2	0.54	2
Union Congregation (UNION)	0.09	46	519.3	0.14	2
Wesley Methodist (WESLE)	0.08	4	48.7	0.36	4
Cemeteries					
Kingswood Cemetery (KINGS)	4.91	258	52.3	40.53	21
Mayfield Cemetery (MAYFI)	12.50	14	1.1	0.02	3
New Cemetery (NEWCE)	11.86	576	48.6	177.40	25
Tjanti Cemetery (TJANT)	2.19	1	0.5	1.63	1
Mean	**1.1**	**37.6**	**106.1**	**6.9**	**7.9**
Standard deviation	**2.9**	**103.7**	**131.5**	**30.4**	**9.9**

(± 131.5) per garden. The average species richness was 7.9 (± 9.9) per garden. The churches and cemeteries will be referred to by their abbreviated name in brackets (Table 2.1). STBAR

and UNION had the greatest density of woody plants (454.5 and 519.3/ha, respectively), while a number of churches had no woody species at all (Table 2.1). The greatest total basal area was found in NEWCE and KINGS (177.4 and 40.5 m^2, respectively). However, due to the large size of many trees, the woody plant density was low (< 55.0/ha). The church garden with the greatest species richness was CHRCH (46). The highest number of woody plants occurred in the NEWCE and KINGS, containing 576 and 258 individuals, respectively (Table 2.1).

A total of 139 different species were encountered with 1 315 individuals being measured. Of the species 56 % were introduced, 32 % were indigenous and the remainder unidentified. The 11 most common species included *Cupressus sempervirens* L. This species occurred 246 times, however this was only in two of the study sties (NEWCE and KINGS). This made up a total of 18.7 % of the total plants sampled. The next two most frequent species were also *Cupressus*, namely *C. glabra* Sundw. and *C. macrocarpa* Hortw., with 186 and 155 individuals, respectively. This genus (Cupressus) made up 44.6 % of the plants sampled throughout the study sites. In the case of both of these species they were once again only found in NEWCE and KINGS, with two *C. glabra* individuals occurring at one other sample site. The top three species made up almost half of the total plants sampled (44.6 %), while the top 11 most frequent accounted for 65.9 % of the sample. Not one of the species occurred at all of the sample sites. *Ligustrum lucidum* W.T. Aiton was the next most frequently sampled species (87). In this case 45 individuals were found at one study site, but this species was also found at 12 other sampled sites. *Thuja orientalis* L. was represented by 52 stems, while *Jacaranda mimosifolia* D. Don and *Aloe ferox* Mill. were sampled a total of 37 and 26 times, respectively. The aforementioned *Cupressus* species and *T. orientalis* contributed to the most common family throughout the sample sites, that of *Cupressaceae*. This family contributed to 48.6 % of all the woody plants encountered. The last three species that compiled the top 11 species list were *Cestrum laevigatum* Schltdl. (20), *Schinus molle* L. (20), *Olea europaea* subsp. *africana* (Mill.) P.S. Green (19) and *Acacia mearnsii* De Wild. (19). Only two of the top 11 species were indigenous to South Africa, *Aloe ferox* Mill. and *Olea europaea* subsp. *africana* (Mill.). Two, *C. laevigatum* and *A. mearnsii*, are declared invasive species.

The smallest size class (stem diameter of 0-15 cm) had the greatest proportion of all stems recorded (69 %) (Figure 2.1). This could be attributed to the large number of shrubs found throughout the study sites. Large individual specimens of greater than or equal to 90 cm only made up 0.8 % of all stems measured.

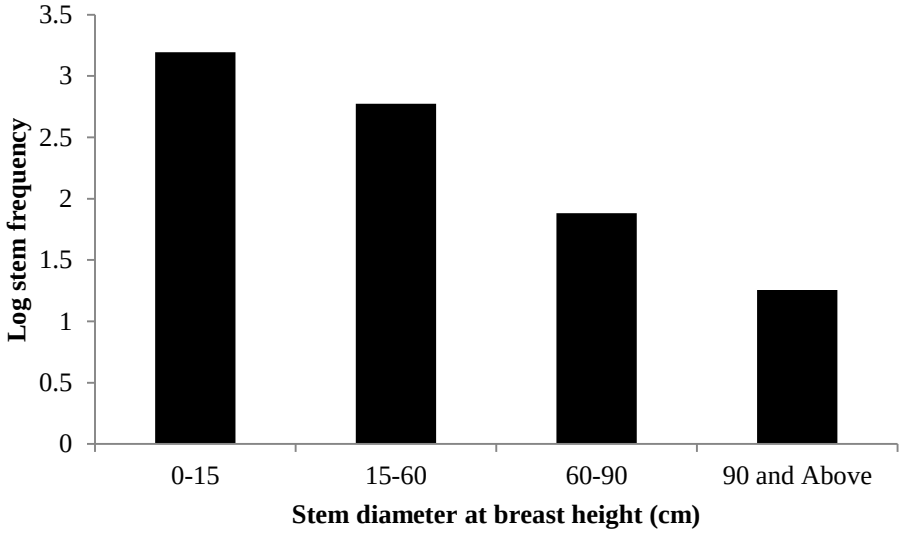

Figure 2.1: Size class profile of all woody plants

2.3.2 Relationships between vegetation and sacred site attributes

In some cases cemetery data were omitted from the analyses to see if their large area had an effect on the overall results. However, in the case of both woody plant density and species richness it did not improve the relationship to any meaningful extent. When the cemetery data were removed to observe the relationship between size and species richness, the CHRCH site was also removed. This was done as it had an extremely high species richness (46), impacting the regression. When this site was removed the overall relationship was not significant. A significant relationship was observed between size and total basal area (m^2) (r^2=0.46, p<0.001). When the two outliers of NEWCE and KINGS were removed, there was no significant relationship (r^2= 0.02, p=0.40). Another relationship that proved to be statistically significant was that of church garden or cemetery size and total number of individuals found (r^2=0.44, p<0.001). The removal of two outliers (NEWCE and KINGS) once again made the relationship not significant (r^2=0.01, p=0.84). Of the 12 sites for which

reliable maintenance data could be obtained, a mean of 6.5 (± 5.8) hours maintenance per week was found.

Table 2.2: Regression results between site and vegetation characteristics (significant results in bold)

Variables	r^2	p value
Church/cemetery age and:		
• Woody plant density (/ha)	0.01	0.45
• Total basal area (m^2)	0.08	0.09
• Species richness	0.08	0.09
• Species richness/area	0.03	0.30
• Total number of woody plants	0.06	0.15
Church/cemetery size and:		
• Woody plant density (/ha)	0.04	0.21
• Woody plant density (/ha) (excluding cemetery)	0.04	0.28
• Total basal area (m^2)	**0.46**	**< 0.001**
• Total basal area (m^2) (excluding NEWCE & KINGS)	0.02	0.40
• Species richness	0.03	0.29
• Species richness (excluding cemetery & CHRCH)	0.03	0.31
• Total number of woody plants	**0.44**	**< 0.001**
• Total number of woody plants (excluding NEWCE & KINGS)	0.01	0.84

The density of woody plants (/ha) for sites of different denominations were analyzed. These denominations included Anglican, Catholic, Apostolic, Methodist, Presbyterian, other Christian denominations and non-Christian religions (Muslim and Hindu). The Anova showed that there was no significant difference in tree density between the different denominations ($F= 0.69$, $df= 6, 23$, $p= 0.66$). It was also found that there was no significant difference of species richness between the different denominations ($F= 0.59$, $df= 6, 23$, $p= 0.73$).

2.3.3 Community composition of church/cemetery gardens

There was generally a low level of similarity between the gardens as depicted by the high scatter (Figure 2.2). A number of church gardens and cemeteries have both 20 and 30 percent levels of similarity. This is illustrated by the sites being circled with a solid or broken line. Certain sites displayed less than 20 percent level of similarity with all of the other sites (TWELV, METHO, STBAR AND TJANT). The stress level for this two dimensional plot (0.12) suggests that it is a useful representation. Hierarchical clustering is used to determine the exact levels of similarity.

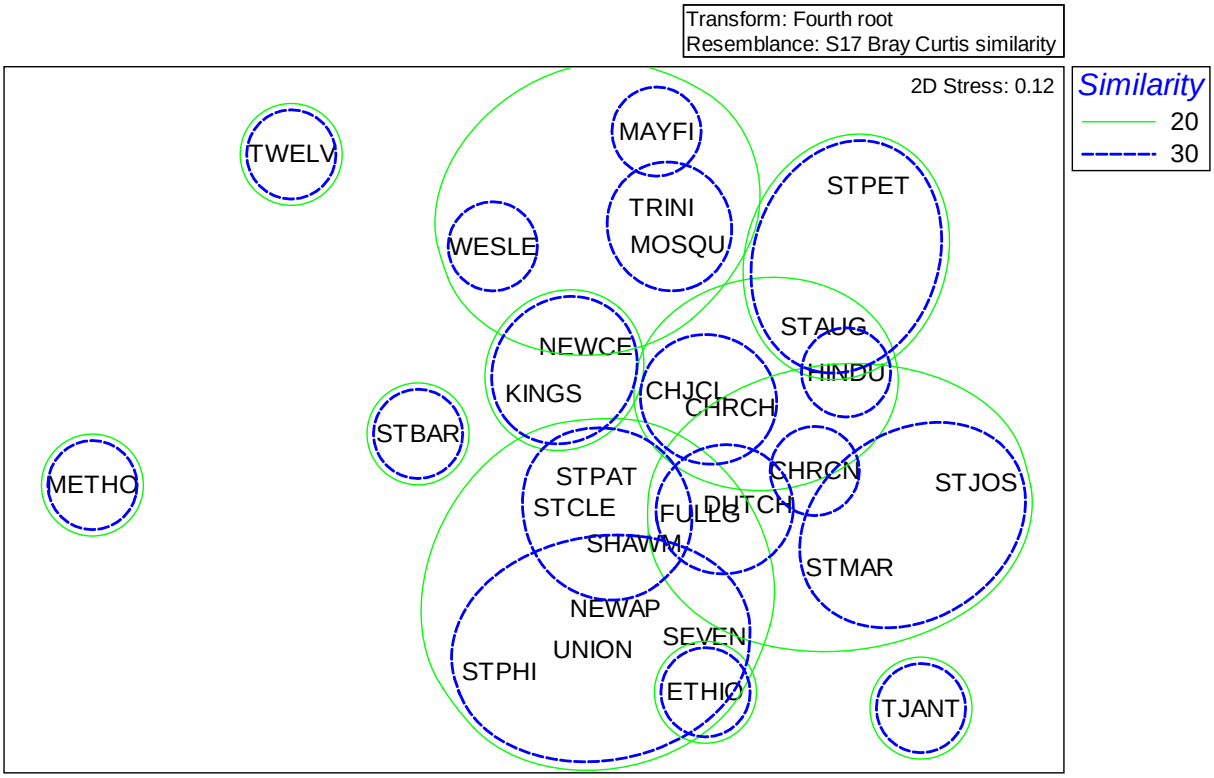

Figure 2.2: Ordination plot of the sample sites and their level of similarity (site abbreviations correspond to those in Table 2.1) (n=28)

Overall there was a low level of similarity between the sites. The hierarchical clustering showed that the two sites that had the greatest level of similarity are NEWAP and SEVEN, at 59.6 %. This is followed by NEWCE and KINGS at 52.0%. The next two most similar plant assemblages occurred at 51.8 %, found between STPAT and STCLE (Figure 2.3). There are

four broader groups discernible at approximately the 20 % level of similarity. Namely, group one (NEWCE, KINGS, HINDU, CHRCH, CHJCL), two (STMAR, STJOS, CHRCN, DUTCH, FULLG), three (ETHIO, SHAWM, STPAT, STCLE, STPHI, UNION, NEWAP, SEVEN) and four (TRINI, MOSQU, WESLE, MAYFI). There were also outliers with very low similarity to any other garden, represented by METHO, TWELVE, TJANT, STPET, STAUG and STBAR. There was no significant difference between the groups with regards to garden age, woody plant density, site size and total basal area. Group one was significantly different from the other four groups in terms of species richness ($F= 10.71$, $df= 4, 23$, $p< 0.001$). The same was found between group one and all other groups when comparing total number of individuals ($F= 3.86$, $df= 4, 23$, $p= 0.01$).

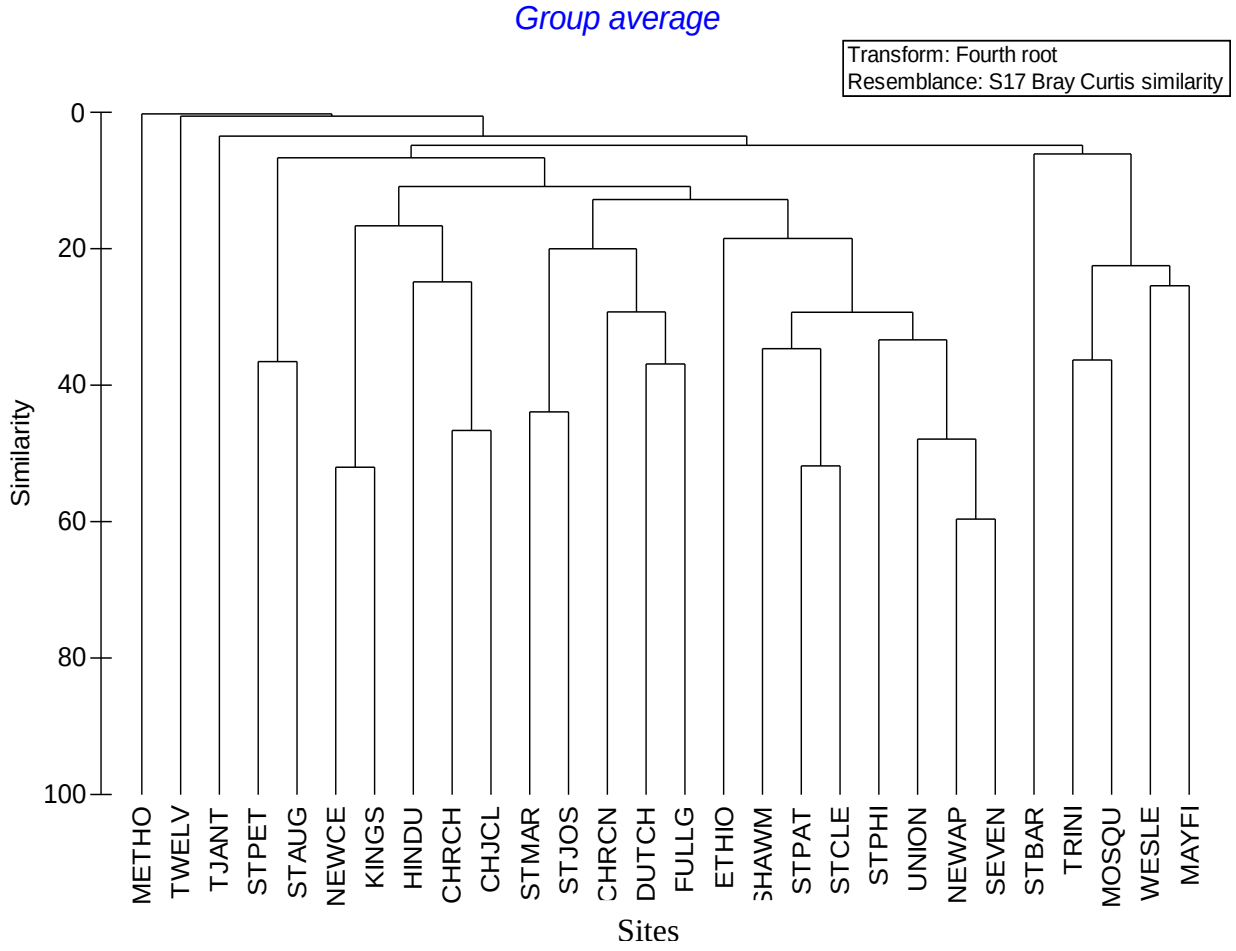

Figure 2.3: Dendrogram of the plant communities in Grahamstown church gardens and cemeteries (n=28)

The regression looking at the influence of abiotic variables on plant assemblages showed that p was optimized (at 0.22) for the seven variables age, electrical conductivity, clay, silt, stone, nitrogen, and CEC. When a statistical significance test was done on the results of this relationship between biotic and abiotic variables, a p value of 0.20 was produced. This then concludes that the abiotic (environmental) variables had no significant association with specific plant assemblages and so the abiotic variables may not be used to characterise the plant assemblages at a particular site.

2.4 DISCUSSION

There was a large range in vegetation abundance and composition across the various sample sites. This is similar to what has been documented throughout the world, with urban green sites and the vegetation they harbour being affected by human influence including different management strategies and the introduction of alien species (Nagendra & Gopal, 2011; Chandrashekara & Sankar, 1998; Kunick, 1987). Just as human influence may determine the biological characteristics of an area, so too do the natural variables such as size of the site (Ishii et al., 2010), soil characteristics (Betz & Lamp, 1992) and the conditions of the site before the urbanization began (Nowak et al., 1996). The effects of these site characteristics will be discussed in further detail.

2.4.1 Sacred site vegetation

Five of the sites had no woody plant species over 1.5 m tall. All of these sites were located in Grahamstown east, a part of Grahamstown that remains impoverished due to the Apartheid regime, a regime that brought about the racial divide and neglect that is evident throughout South African cities (Donaldson-Selby et al., 2007). These poorer areas have less public urban green space and higher housing density than that of the more affluent western parts of Grahamstown (McConnachie & Shackleton, 2010). Street tree prevalence in Grahamstown also favours Grahamstown west, with the eastern parts containing less than five percent of trees recorded by Kuruneri-Chitepo & Shackleton (2011). Tree vandalism and damage by livestock contribute to reasons for the limited vegetation in these areas (Richardson & Shackleton, 2014). The five church gardens found without vegetation are all, however privately managed; therefore the lack of vegetation may be attributed to the harsh climate of

the area (low rainfall and highly seasonal fluctuations of temperature) coupled with low maintenance. The lower income levels of this area would also influence the vegetation, with congregants using their money for reasons other than garden maintenance. The former vegetation of a city before urbanization has an impact on its percentage tree cover (Nowak et al., 1996). Nowak et al. (1996) found that cities that developed in forested areas had 31 % urban tree cover, while grassland cities had 19 % and desert cities 10 %. Therefore, Grahamstown's Sub-Tropical Thicket biome (McConnachie et al., 2008) may be the reason for the lack of vegetation, with gardens containing plants not as tolerant as Thicket-based species found naturally in these areas. The use of non-native species (needing much attention during long periods without rain) coupled with low maintenance would promote the lack of vegetation. Due to the browsing by livestock in these areas, the lack of secure fencing surrounding these church gardens and cemeteries, any plant that did establish would soon be eaten or possibly perish due to exposure (Richardson & Shackleton, 2014).

CHRCH was found to have the greatest species richness (46), which may be attributed to the long hours of maintenance that it receives, a great deal more than that of other gardens. It had a garden committee comprising of three people, as well as a gardener that came three days a week and spent a whole day caring for the garden. The mean for the other gardens was 4.9 hours per week. The garden was also one of the largest, allowing for a large variety of plants to be planted and maintained. The effect of three separate maintenance regimes on tree species composition and vegetation structure of sacred groves of India revealed that each regime yielded different outcomes (Chandrashekara & Sankar, 1998). They found that those areas managed by individual families were more disturbed than those maintained by groups of families or statutory agencies (Chandrashekara & Sankar, 1998). LaPaix & Freedman (2010) looked at the effect of anthropogenic stressors on compositional and structural indicators of vegetation within urban parks of Nova Scotia, Canada. They found that historical use and edge influences were significantly related to variation in vegetation composition within semi-natural forests, while natural disturbance (a hurricane in this case) strongly influenced plant communities (LaPaix & Freedman, 2010). The harsh climate of Grahamstown requires a great deal of management and care to have an urban garden that could support a variety of woody plant species. CHRCH's 24 hours of maintenance per week would therefore influence the vegetation positively, promoting survival of planted species.

The number and kind of non-prairie and non-savanna species found in cemeteries in Illinois and Indiana was dependent (among other things) on the past management of the cemetery, being affected by practices such as mowing, grazing by livestock and the number of plants that had been planted for decorative purposes (Betz & Lamp, 1992). The use of herbicides and excessive clearing of vegetation have been known to greatly reduce the rare or 'infrequent' species that may also be found in sacred urban sites such as cemeteries (McBarron et al., 1988). The management techniques of different generations have also been found to have an effect on the vegetation composition (Nagendra & Gopal, 2011). Older parks were found to have had many different managers, and so had a greater variety of trees when compared to parks that had been established more recently (Nagendra & Gopal, 2011). The preferences of current park managers were also seen to have shifted from large canopied species to small sized trees, reducing the available habitats for bird species in the urban environments, as well as reducing the effective removal of air particulate pollutants found in the city (Nagendra & Gopal, 2011). Smith et al. (2006) found that a number of factors influenced domestic garden vegetation of individual households, but that the preference of garden owners has a much greater determining factor on floral richness. The maintenance received on the few sample sites would therefore have influenced the vegetation in different ways. While the average hours of maintenance of each site was 6.5 per week, the high variation between gardens (± 5.8) shows that it may not have been enough for some of the gardens, influencing species richness, as well as the abundance of plants present.

The total area of churchyards and cemeteries was 38.2 ha, with 139 different woody plant species being found. Four sacred groves that were studied in the Pondicherry region of South India found 111 different species across a total of 15.6 ha (Ramanujam & Cyril, 2003). Of the species that were recorded in my study, 56 % were introduced, 32 % indigenous and the remainder unidentified (albeit assumed to be introduced). Thompson et al. (2003) found that in 60 domestic gardens in Birmingham, UK, 67 % of the floral species were aliens. Similarly, of the 61 urban, domestic gardens surveyed in Sheffield, UK, 70 % of plants were alien (Smith et al., 2006). In this study only 27 % was made up of shrubs and trees, the rest comprising of annuals and biennial/perennials (Smith et al., 2006). In the case of Mexico City, 750 plant species were sampled and 70 % were alien (Smith et al., 2006). This percentage dropped when it came to the well-studied flora of one Leicestershire garden that

contained 60 % alien species (Owen, 1991; in Smith et al., 2006). A study showed that the percentage native woody vegetation was significantly higher in natural and semi-natural habitats of Halifax, Nova Scotia (with 100 % and 94 % natives, respectively) than that found in three residential neighbourhoods (19 %, 33 %, and 38 %) (Turner et al., 2005). In parks of Bangalore, India, of the 80 tree species that Nagendra & Gopal (2011) encountered 66 % were introduced, while only 34 % were native. Therefore, this shows that not only ecological factors, but human influence has a large impact on species composition in urban gardens (Kunick, 1987). The maintenance received by these gardens, would have influenced the proportion of exotics, with church elders and people in positions of authority choosing plants of their preference. An example of this is the fact that ornamental plants have been found to comprise of more than 40 % of widespread invasive plant species, exceeding any other reason for plants being introduced (Weber, 2003; in Smith et al., 2006). This would most certainly be the case for cemeteries and gardens of remembrance, with people planting the favourite plants of the departed loved ones. This is illustrated by the high presence of *Cupressus* in the cemeteries, but not churchyards. The reasons for the slightly lower percentage of aliens within Grahamstown sites could be attributed to the fact that 12 % were unidentified, most of which are likely to be exotics.

The top three species throughout the sample sites made up almost half of the total sample population (45 %), while the top 11 species made up 66 %. This was similar to findings in India where the top five tree species of the parks in Bangalore made up close to half the population (Nagendra & Gopal, 2011). No species occurred at all of the sample sites of my study, something that was similar in the cemeteries of Campbelltown, where only one species was recorded at every site (McBarron et al., 1988). The four sacred groves examined in the Pondicherry region also found only two species occurring in each grove (Ramanujam & Cyril, 2003). This may have been attributed to the different classification of the groves (a memorial grove, two were select species groves and the last an ideal grove) (Ramanujam & Cyril, 2003). The domestic gardens of Sheffield also showed this phenomenon, with only 2.7 % of the species occurring in more than half of the gardens, and with many of these widespread species being lawns (Smith et al., 2006).

Millward and Sabir (2010) suggest that to promote biodiversity and resilience 40 % of the urban tree population should be in a size class with a diameter at breast height range of 0-15 cm, 30 % from 15-60 cm, 25 % from 60-90 cm and five percent in the category of 90 cm and above. The majority (69 %) of stems recorded in this study occurred in the smallest diameter size class. This occurred because many of the woody plants encountered were shrubs. The proposed classes would allow managers to allocate annual maintenance costs uniformly over many years and reduce establishment-related mortality (Milward & Sabir, 2010). Diversity of the urban forest is of vital importance to avoid risk from pests and diseases, climate change, as well as supply continuous ecosystem services (Kendal et al., 2014). This has led to the acceptance of the 10/20/30 rule of Santamor (1990), which suggests that urban forests should not comprise of more than ten percent of any one species, 20 % of any genus, and 30 % of any particular family. The most common species (*Cupressus sempervirens*, 18.7 %), genus (*Cupressus*, 44.6 %), and family (*Cupressaceae*, 48 %) in this study surpassed the suggested ratios. Kendal et al. (2014) also suggest generally these ratios are much higher at species level, but more comparable at that of the genus or family scale, however this is once again not the case in this study. This may have occurred because of the large majority of these specimens being located in the large cemeteries of Grahamstown.

Hierarchical clustering revealed that there was a low level of similarity across the sample sites, with the highest being 60 % (NEWAP and SEVEN), while there was a 52 % similarity between NEWCE and KINGS, which could be explained by the large abundance of conifers present at the latter two sites. The low levels of similarity found throughout the sample sites were no surprise, considering not one species occurred at all of the sites. Just as the sacred areas of the Maghreb countries are influenced by human uses (Deil et al., 2005), so too are sacred gardens of Grahamstown, suiting the needs and preferences of the congregation.

2.4.2 Relationships between vegetation and site attributes

Due to the large variation in vegetation composition and abundance between the sample sites, it was important to explore what may underlie these variations. Throughout the world there are many different factors that have influenced plant density, species richness and the number of individuals that occur within an urban green space or sacred site.

Although there was no significant relationship between age of the site and vegetation characteristics, many studies have found otherwise. Age could in fact influence the effect of historical uses over time (through management regimes) and therefore had an influence on variation in vegetation composition within semi-natural forests of Nova Scotia (LaPaix & Freedman, 2010). Salick et al. (2007) found that due to the restrictions placed on timber extractions in Tibetan sacred sites, they have stored significantly larger trees and greater tree cover than non-sacred sites, making them effective in protecting old growth trees when compared to other areas. When considering the effect of neighbourhood age on species richness in Halifax, Nova Scotia, an ordination and cluster analysis revealed no obvious groupings, suggesting that age had no significant effect on neighbourhood species (Turner et al., 2005). Nagendra & Gopal (2011) looked at the biodiversity and distribution of trees within urban parks of Bangalore. They divided the parks into three age categories, namely old, intermediate and recent. The older parks (those established prior to 1970) were found to have fewer trees than the other two categories, however, older parks had significantly larger trees compared to those of more recent establishment (Nagendra & Gopal, 2011). Similar to my study there was no significant difference in species richness among the different age categories (Nagendra & Gopal, 2011). The size class diversity was found to be significantly greater in the older parks (Nagendra & Gopal, 2011); however this was not the case when it came to the relationship between sacred area age and basal area in this study. This may have been attributed to the date of church establishment being used to calculate age, and not the actual age the garden was developed.

There were no significant relationships between the size of the sacred site and woody plant density or species richness. There was, however, a significant relationship between site size and total basal area (r^2=0.46, $p< 0.001$) and total number of individuals (r^2=0.44, $p<0.001$). These relationships were due to the two outliers NEWCE and KINGS, and if they were removed there were no statistically significant relationships. This is different to what was observed by Smith et al. (2006) who found that domestic garden area significantly influenced species richness. This was, however, largely due to the increase in the size of lawns when gardens increased in size (Smith et al., 2006), which is positively related to richness of lawns (Thompson et al., 2004; in Smith et al., 2006). It was also found that the species density of gardens decreased with garden size (Smith et al., 2006). In sacred shrine/temple forests of

Japan species richness was found to decrease with decreasing area (Ishii et al., 2010). It was also noted that smaller forests still play a vital role in conserving species diversity in urban environments as they often store rare and infrequent species (Imanishi et al., 2007, 2005; in Ishii et al., 2010). One of the smallest sample sites, STBAR, stored a large variety of species as well as a high density of woody plants, showing that small sites do have the potential to store a great deal of plant diversity. Angold et al. (2006) found a positive relationship between site species richness and site area. The lack of these relationships in my study could be due to the fact that many of the smaller gardens were well looked after and had high values for most of the garden attributes (for example STBAR and TRINI), while some of the larger sites scored very low due to the largely lawned areas (SHAWM), or areas cemented over for parking (OLDAP).

There was no significant effect of religious denomination on woody species density or plant species richness. This differs to Anderson et al. (2005) who found that religious beliefs affected the ecology of sacred sites and that sacred sites differed in useful species and endemic species composition when compared to non-sacred sites. In the case of Shinto shrines and Buddhist temples in Japan, shrines are seen as the object of nature worship, receiving little management and human access is discouraged (Ishii et al., 2010). Buddhist temples on the other hand are intensely managed and are often used for places of religious training (Ishii et al., 2010). This has therefore influenced forests in these areas, with temples having less area of forest cover than that of shrines (Hashimoto et al., 2006; in Ishii et al., 2010). Certain tree species in India are recognized as being strong religious symbols, with certain species believed to confer forgiveness to the planter (Chandrakanth et al., 1990). One of the reasons for there being little variation between denominations could be due to the fact these areas are not rural sacred sites (Anderson et al., 2005) or forested areas (Ishii et al., 2010), but rather treated as urban gardens by the congregation. The aforementioned examples highlight people that have a religious connection with these areas, whereas much of the gardens found in my study would have been treated much the same as a domestic garden found at one of the congregants' houses.

The effects of environmental variables such as age and soil characteristics were also found to not have a significant influence on plant assemblages. In this way the abiotic variables may

not be used to characterise the plant assemblages at a particular sacred site in Grahamstown. This is contrary to what was found in cemeteries of the US. Betz and Lamp (1992) found that the soil present in the cemeteries had shallow A horizons, as well as showed no evidence of ever having been ploughed. The differences in soil type in these cemeteries were found to influence species composition and relative abundance (Betz & Lamp, 1992). The differences in species composition of the groves of the Pondicherry region could also be attributed to soil characteristics, with one of the groves occurring in a swampy area, while two others on clayey soils, and the last on a sandy loam (Ramanujam & Cyril, 2003). The lack of the tested variables having an influence on the plant communities resulted in the inability to distinguish what separated the four groups of sites that formed at the 20 % level of similarity.

2.4.3 Major influences on the vegetation of urban sacred sites

Abundance and composition of woody plants varied considerably across the sample sites. This is a common feature throughout green spaces worldwide, with sacred sites and urban gardens containing many different species, but very few occurring at each site (Smith et al., 2006; Anderson et al., 2005; Ramanujam & Cyril, 2003; McBarron et al., 1988).

Age and area were seen to have little effect on woody vegetation abundance and composition. While these findings are not universal when it comes to area (Ishii et al., 2010; Angold et al., 2006; Smith et al., 2006), when it comes to the effect of age on vegetation attributes many studies have found similar results (Nagendra & Gopal, 2011; Turner et al., 2005).

Denomination was shown to have no influence on woody species density or on species richness. While different religions and religious beliefs may have an influence on species richness and forest cover in the sacred areas of eastern countries (Ormsby, 2013; Ishii et al., 2010; Anderson et al., 2005) that is not the case in the urban sacred areas of Grahamstown.

The lack of similarity between plant assemblages was a result of very few species occurring at each of the sample sites. This may be due to user preferences or to the large variety of plants that found within urban gardens (Smith et al., 2006). Plant assemblages were not affected by the environmental variables at the study sites, something that has been used to

predict vegetation in other parts of the world (Ramanujam & Cyril, 2003; Betz & Lamp, 1992).

The major factor that is repeated throughout much of the literature is the impact of human influence on vegetation, whether in urban or rural settings. Nowak et al. (1996) mentioned how urban tree cover was affected by the natural environment and the land use of the area, while the practices of garden owners and their preferences were thought to be the strongest influence on domestic garden diversity in Sheffield (Smith et al., 2006). When it came to cemeteries much of the same was found with past management regimes and the excessive use of herbicides and clearing drastically changing the vegetation (Betz & Lamp, 1992; McBarron et al., 1988). Even in the more natural sacred areas of the world management practices were found to have a large effect on the vegetation (Ishii et al., 2010; Chandrashekara & Sankar, 1998). The maintenance that was received by the sample sites would therefore in some way influence the woody species planted, and how well they were looked after.

2.5 CONCLUSION

The study showed that urban sacred sites had a wide variety of woody plant species composition and abundance, with more than half of the species being exotic. This variation could in part be due to the climate of Grahamstown, as well as the influence of maintenance on preferred species. Factors such as site age, area and denomination had no significant influence on vegetation characteristics, indicating that urban sacred sites show characteristics more similar to urban domestic gardens than that of rural sacred groves or sacred groves of eastern countries or religions. Environmental characteristics had no impact on the plant assemblages throughout the sample sites, with sites showing very little similarity. The only factor that may have had any influence is that of human influence, showing that maintenance and congregant preference were likely to be the most significant determination of the garden vegetation.

CHAPTER 3

Congregant use and appreciation of urban sacred sites

3.1 INTRODUCTION

Urbanization is increasing rapidly throughout the world, especially in developing nations (UN, 2007). This increase in the built-up areas of the world has reduced the amount of natural land. This reduction in turn has impacted many natural processes that provide humans and other components of the natural environment with services. Although there has been much documented on how natural areas provide ecosystem services (for example Constanza et al., 2006), one of the most important that is being diminished in urban environments is that of human interaction with nature (Keniger et al., 2013; Turner et al., 2004). This connection is of vital importance as this relationship has been formed over many millennia, with some suggesting that humans have an inherent need to be in contact with other species, a phenomenon that has become known as biophilia (Wilson, 1984). This may be because natural environments are filled with characteristics necessary for restorative experiences that humans subconsciously desire (Kaplan, 1995). This biophilic response is something that extends beyond purely aesthetic preferences (Miller, 2005), with most people feeling a deep connection with natural environments. However, as urbanization and biodiversity loss increases, the ability to recognize and appreciate this loss is reduced (Kahn & Kellert, 2002). This is because the environmental conditions that one encounters during the early stages of life determine the baseline from which one measures biodiversity loss in later life (Kahn & Kellert, 2002). As each generation becomes less exposed to and hence connected to the natural environment, so too will the recognition of the loss of many of the aforementioned species and ecosystem services.

One way in which urban planners and designers are trying to counteract this decrease in the human-nature connectedness is through urban parks and greening. This has brought about many ecological (Escobedo & Nowak, 2009; Li et al., 2005), economic (Cameron et al., 2012; Chiesura, 2004; Tajima, 2003), and social benefits (Chiesura, 2004; Westphal, 2003). One of the most important psychological benefits provided by green spaces is the restorative function that these places provide (Keniger et al., 2013; Kaplan, 2001; Ulrich, 1984).

Hospital patients recovering from surgery that had a view of a green or natural environment improved quicker (shorter postoperative hospital stays and fewer negative evaluative comments from nurses) than those that had a view of a brick wall (Ulrich, 1984). It has been suggested that better health is associated with more social contacts with friends and neighbours (Kemperman & Timmermans, 2014). There is a positive relationship between the perceived level of green space and the amount of social contact among neighbours (Kemperman & Timmermans, 2014; Sullivan et al., 2004), therefore improving the health of the individuals who believed that they had a greater availability of green space. The benefits that people receive when visiting green space in times of heat stress showed that longer and more frequent visits have a significant effect on the perceived benefits and well-being that that individual receives (Lafortezza et al., 2009). It has even been shown that green areas reduce depression and anxiety of visitors (Macintyre et al., 2003). Takano et al. (2002) looked at the probability of five year survival of senior citizens, finding that the probability increased with the increase in space for the elderly to take a stroll, visit parks and be surrounded by streets that were lined with trees. It was also found that wanting to stay in a particular community improved the probability of survival, and wanting to stay in the community was influenced by these same "green" parameters (Takano et al., 2002). van den Berg et al. (2010) examined the proximity of green space on stress, health and perceived health, finding that all three were moderated by the amount of green space found within a three kilometer radius.

While many urban environments have been found to host an array of biodiversity (Ishii et al., 2010; Smith et al., 2006; Turner et al., 2005; Stewart et al., 2004), most residents reside in areas of impoverished biodiversity (Turner et al., 2004). Although this may be the case, benefits from home gardens and gardening (Clayton, 2007) have shown that one may receive benefits from many different forms of nature. Aldridge & Sempik (2002) found that social and therapeutic horticulture increased self-esteem, self-confidence, general well-being as well as social interaction. Reasons for these positive associations could be that often people engage in gardening because of their appreciation of nature (Clayton, 2007). Having said this, respondents in Clayton's (2007) study did not make a strong connection between their own garden and the natural environment. Although these benefits have been shown in many different settings, they are improved or heightened if the individual has had a higher level of

engagement with the natural beauty or natural area (Zhang et al., 2014). This suggests that many of the aforementioned benefits would occur to an even greater extent in sacred areas, with visitors benefiting simultaneously from the aesthetic and sacredness of the area surrounding them.

Jackle et al. (2013) mention some of the social benefits provided by sacred natural sites such as the identification of specific tribal groups for genealogy and for mythical purposes. These sites also provide space for individuals to resolve conflicts, with people discussing common problems in such sacred areas (Jackle et al., 2013). The Shinto shrines found in the fragmented urban forests of Japan serve as the object of nature worship, while the Buddhist forest temples are used as areas for religious training, as well as serve as an area in which people connect with their spiritual feelings (Ishii et al., 2010). In India, certain deities are considered to be manifest in specific plant and tree species, with these species figuring prominently in religious practice (Chandrakanth et al., 1990).

While several studies have documented the conservation potential of sacred natural sites around the world (Khan et al., 2008; Sheridan & Nyamweru, 2008; Salick et al., 2007; King et al., 1997), most studies have focused on eastern countries and religions with an emphasis on rural settings. Although these studies are plentiful, they have often neglected the spiritual, religious and psychological benefits that such sites provide those that use them. Indeed, Keniger et al. (2013) comment on the relative dearth of studies and understanding of spiritual benefits from urban green spaces. An additional knowledge gap pertains to the benefits provided to urban populations by sacred sites within the urban environment. This project is unique because it brings together the three dimensions, i.e. the urban environment, cultural and spiritual ecosystem services and sacred sites. The aim of this chapter was to determine the perceived and felt benefits of sacred urban sites in Grahamstown, South Africa. This chapter seeks to answer the following questions:

- How do users perceive these sites and what benefits do they obtain?
- Are user perceptions related to sacred area attributes such as age, area, species richness, total basal area and total number of woody individuals?

3.2 METHODS

3.2.1 Questionnaire structure and administration

A structured questionnaire was administered to assess the perceived and felt benefits the congregants gained from their church garden. The first questionnaire was aimed at the congregants of churches that had church gardens. It considered how often congregants visited their church gardens as well as if they believed that these gardens were necessary as part of their religious experience. The next section sought to determine the spiritual, aesthetic, and cultural value of trees in the sacred area, as perceived by the respondents. This included all the intangible benefits that the respondents believed they receive from church gardens. The next asked the respondents about their overall level of satisfaction with their church garden.

A section investigated the core or basic values that influenced people's attitudes towards their natural environment. Basic values could determine how people rated a particular sacred area and was achieved using a range of statements with against which they were required to select Likert scale responses of strongly agree to strongly disagree as well as not sure options, following Downs & Stea (1977) who recorded attitudes, beliefs and values towards urban green spaces. The questionnaire concluded with a section on the demographic and socio-economic profile of the respondent, considering gender, occupation, age as well as level of education, home language, income bracket and race.

A different questionnaire was designed for congregants of churches without gardens, but was structured in a similar manner. It initially asked respondents whether they believed that a garden would enhance their spiritual experience or not, and if a garden was desired what amenities they would want it to contain. Respondents were also asked which benefits they believed a garden would provide. It investigated the core or basic values that influenced peoples' attitudes towards their natural environment, based on a Likert scale of responses. This questionnaire concluded with questions about demographic and socio-economic profile of the respondents.

In both cases a box of blank questionnaires was left at the back of the church and the congregants were informed of the study at the end of a church service. These boxes, and the completed questionnaires, were collected three weeks later, giving all congregants a chance

to return their completed questionnaires. Additionally online versions were created and sent out to various church mailing lists as well as the different religious societies associated with Rhodes University.

A prompt sheet was produced for discussions with the priest, pastor or church elders of the congregation to determine background information such as the age of the church, how the garden is maintained and who maintained it, what the specific uses of the garden are (e.g. weddings), does the garden have any specific attributes to draw people to it (e.g. benches, fountains, etc.), why do they have a garden, and did they think it fulfills its objective.

3.2.2 Statistical analyses

The options of the Likert scale chosen by respondents were summarized for the different congregations. A chi-squared test was done to determine if there was any relationship between the size of the respondent's private gardens at home and the stated preferred size of a church garden. A principal component analysis (PCA) was used to determine the relationship between ecological data (species richness, total basal area, total number of individuals from Chapter 2) and questionnaire responses, as well as the influence that socio-economic and demographic factors had on responses. Regression analyses were used to further investigate the relationships between seemingly related variables identified in the PCA.

3.3 RESULTS

3.3.1 Responses from congregants that had sacred green areas

The majority of the respondents believed that their church garden had the right abundance of trees as well as the right abundance of green space surrounding their church/temple or mosque (78 and 79 %, respectively). Of the options provided, the greatest percentage of respondents visited their garden on a weekly basis (40 %). It may be assumed that this was before or after the respondents were attending church. A total of 23 % of the respondents visited their church garden between two and four times a week. Some individuals visited their church garden twice a month (8 %), monthly (5 %), or once or twice a year (10 %). Although some of the respondents attended a church that was surrounded by a garden, they

did not explicitly visit the garden (14 %). Of these respondents, the reasons for not spending time in the garden included that the garden was not easily accessible, they had no time, or that they felt that there was no need.

Eighty-seven percent of the respondents felt that a church garden was necessary. Reasons why included that it (1) added to the sense of peace and tranquility, (2) helped the respondents pray, (3) was aesthetically pleasing, (4) made the church look more homely and (5) being in nature helped one relax. The majority of the respondents (60 %) felt that if there was no garden surrounding their church, it would diminish the atmosphere in terms of it being a place of spiritual reflection and prayer. This was because the garden provided the congregants a place to step away and ready themselves for the service or prayer. Twenty-seven percent of the respondents did not believe that loss of the church garden would diminish their experience, because they felt that the church was where they connected with their God, as well as worship being in the word of God, a state of mind, of which they believed the garden had no influence. Fifty percent of the respondents said that church and family functions were held in the garden, while 17 % were unsure of whether or not functions took place. This mostly included social functions such as fetes, braais and teas. There were, however, other religious celebrations such as an Easter Sunday procession, Palm Sunday as well as Holi that took place in the gardens. While many of the religious rituals took place in the church (confirmations, weddings, etc.) the garden was often used as a place to gather after the ceremonies, with people taking photos or having refreshments.

Eighty-eight percent of the respondents agreed that a garden was necessary as it reminded them of the beauty created by God. A total of 89 % felt that the garden adds character to the church. With respect to the church garden signifying peace and tranquility, the majority of the respondents agreed (95 %). The statement of the garden enhancing one's religious experience showed a number of the respondents (32 %) choosing the neutral option, however the majority (57 %) agreed with the statement. A total of 40 % of the respondents said that they were neutral about the garden being a place that promoted the remembrance of departed loved ones, with only 34 % agreeing with the statement. Respondents from the two churches that had a garden of remembrance (Trinity Presbyterian and Christ Church) showed 100 % agreement for the statement that their garden promotes remembrance of departed ones. Most

respondents (82 %) agreed that these sacred areas provided them with an area to sit and reflect. Overall, 76 % of the respondents agreed that a church garden is necessary (Table 3.1).

Table 3.1: Respondents' level of agreement as to why they felt a church garden was necessary or not (percentages may not total to 100 due to rounding) (n=92)

	Response (%)				
A church garden is necessary because:	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
It reminds me of the beauty created by God	61	27	12	0	0
It adds character to the church	53	36	10	1	0
It signifies tranquility and peace	63	32	5	0	0
It enhances ones religious experience	27	29	32	9	3
It promotes remembrance of departed ones	17	17	40	20	5
It provides reflection space	39	42	15	2	1
It is not necessary at all	1	5	17	23	53

The respondents were asked whether or not they felt a church garden would improve their spiritual, cultural, or aesthetic experience. In terms of a garden improving their aesthetic views and experience, the majority of the respondents (68 %) agreed. Most respondents (54 %) also agreed that a garden improved their spiritual experience. This was however not the case when it came to a garden improving the cultural experience of the congregants, with only 33 % agreeing with the statement (Figure 3.1). When asked if a larger garden would improve these experiences, the majority did not agree. This too was the case when it came to a garden that had a wider variety of plants, and a garden that had certain tree species or amenities (Figure 3.1).

Questions that were specific to spirituality showed that only 40 % of the respondents believed that it was easier to connect with God and pray when in the garden. Ways in which the respondents felt that gardens may have influenced their spiritual experience included the flowers and different colours of the garden making them feel welcome, bringing them a sense

of calmness, which in turn allowed them to connect with God a lot easier. It was also stated

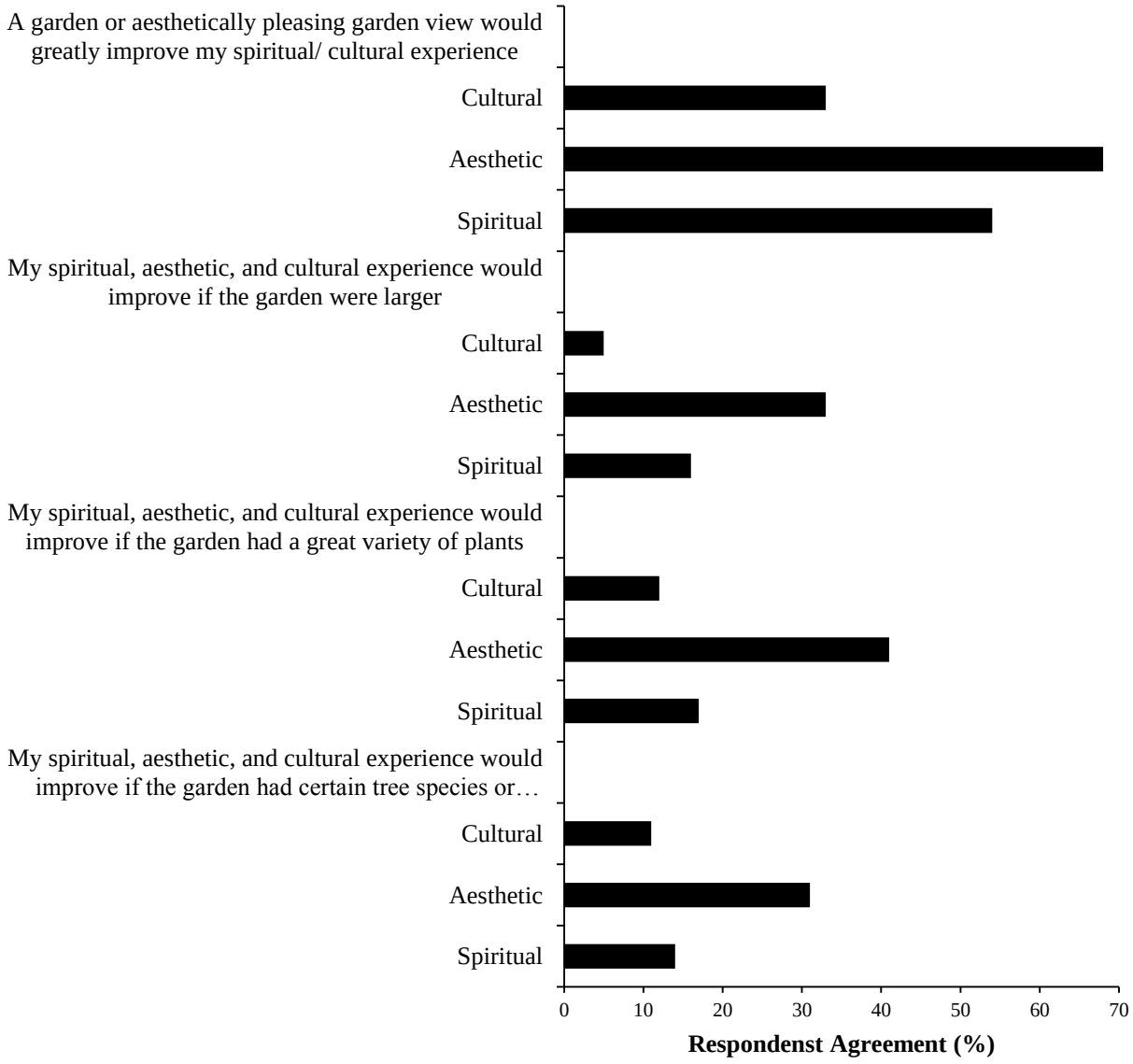

Figure 3.1: Respondents' level of agreement with perceived spiritual, aesthetic, and cultural benefits provided by their church garden (n=92)

that the seclusion of the garden allowed them to anchor their spirit, also helping to connect with God in prayer. Amenities and tree species that the respondents believed would improve their spiritual experience included things such as roses and other colourful plants. Some also mentioned how deciduous trees would improve their spirituality, "because they show the season of the year", reminding the respondents they too will "wither away". A bench was

also mentioned by a number of the respondents, as it would have provided the respondents with a place to sit in comfort and reflect.

The aesthetically pleasing views that a garden provide were seen to reduce respondents' (77 %) stress as well as making respondents (57 %) feel healthy once they had left the sacred area. Seventy-six percent of the respondents agreed that they enjoyed their garden as it attracted birds and butterflies. It was also interesting to note that the majority of the respondents (61 %) disagreed with the statement that these areas should only be open to the congregation and their guests. The same was found when the majority (65 %) disagreed with the statement that the costs of maintaining the garden could be put to better use. This implies that the aesthetically pleasing views of the garden provide the majority of the respondents with benefits, and that they believe that these areas should be available to the public. Other ways in which respondents believed that an aesthetically pleasing garden influenced their experience was that the beauty made it a lot easier for them to get into the right frame of mind to meditate and connect with God. The fact that aesthetically pleasing space made this easier was highlighted by a number of respondents. One respondent mentioned how they felt that the tidiness of the garden showed respect for their deity, therefore respect for their God.

In terms of improving their cultural experience, respondents once again mentioned colourful flowers, as well as water features. In this case there was also an emphasis on indigenous plant species, as they were stated to be good for the environment as well as better equipped to handle the local climate. Once again, deciduous trees were mentioned, as well as biblical trees such as *Cupressus* and sycamores (*Platanus*). Some mentioned how paths within a garden would allow for a stroll to appreciate the different trees and flowers found there. The respondents did not agree that their cultural practices and experiences would be enhanced if they took place within a church garden. A number of the respondents emphasized that their experience in these areas was more spiritual and religious, and they did not feel that this had anything to do with their culture. Some, however, did feel that they had cultural experiences in the gardens, such as the Easter Vigil and bringing people together and in so doing creating a cultural community. One respondent stated that they felt that if the garden were open all the time it would become a greater part of their culture. Only a handful of respondents stated that

amenities and specific tree species would improve their cultural experience, mentioning biblical and indigenous trees, as well as benches and water features.

A total of 74 % of the respondents agreed that they were satisfied with the size of their church garden. The majority of the respondents (65 %) felt that they were satisfied with the appearance of their garden. Seventy-one percent were satisfied with the tidiness of their church garden. It was also found that the majority of the respondents (53 %) agreed with the statement that they were satisfied with the abundance of trees in their gardens (Table 3.2).

Table 3.2: Respondents' overall level of satisfaction with their church garden (percentages may not total to 100 due to rounding) (n=92)

Overall level of satisfaction	**Response (%)**				
Characteristic	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
I am satisfied with the size of my church garden	13	61	15	8	3
I am satisfied with the appearance of my church garden	11	54	14	17	3
I am satisfied with the tidiness of my church garden	14	57	18	9	2
I am satisfied with the amenities (benches, fountains, etc.) in my church garden	5	27	45	20	3
I am satisfied with the extent of use of my church garden	8	35	36	22	0
I am satisfied with the abundance of trees in my church garden	10	43	30	16	0

The majority of the respondents felt that their sacred area provided all the stated social benefits (Table 3.3). The same was found for all the stated ecological benefits; however the majority of the respondents had not previously considered their garden mitigating climate change or diminishing strong winds. Most respondents were not familiar with all the potential economic benefits of sacred areas (Table 3.3).

Table 3.3: The social, ecological and economic benefits perceived (or not) from sacred areas (percentages may not total to 100 due to rounding) (n=92) (Adapted from: Chinyimba, 2012)

	Benefits	Provided (%)	Not previously considered (%)
Social	As a place to meet that promotes social interaction among congregants	71	29
	Improve an individual's mood and relieves stress	70	30
	Improve the aesthetic beauty of the religious area	72	28
	Offer cultural, spiritual and aesthetic fulfillment	57	44
Ecological	Remove pollutants from the air	63	37
	Provide a home for birds, insects and small animals	79	21
	Help to reduce excessive water loss and run-off from concrete areas and protect soils from erosion	55	45
	Purify air and water of an area	58	42
	Reduce temperatures by providing shade (regulate micro-climate)	73	27
	Help reduce the noise levels	50	50
	Mitigation of climate change	38	62
	Diminish the intensity/force of strong winds	45	55
Economic	Increase house or rent price of houses near the area	29	71
	Make the area (and town) a tourist attraction, resulting in employment and revenues	37	63
	Reduce energy use (air conditioners, etc.) through regulation of the micro-climate	25	75

There was a strong consensus among respondents about environmental issues. The majority of the respondents agreed with all value items except for one (Table 3.4). The only statement that did not get a majority agreement from the respondents (45 %) was regarding humans having the right to modify the environment to suit their needs. Other reasons for the environment being important to the respondents included it providing humans with everything they needed to exist, as well as a number of respondents mentioning a verse from the Bible where God said "Be fruitful and multiply and fill the earth and subdue it, and have dominion over the fish of the sea and over the birds of the heavens and over every living thing that moves on earth" (Genesis 1:28). Many believed that it was their religious duty to protect any sort of natural environment. The natural environment was also seen as a place where one could get in touch with memories from childhood, as well as respondents stating that it was it was humankind's duty to look after the natural environment for the betterment of future generations.

The greatest number of respondents came from the group other Christian denominations (29). This group comprised of Dutch Reformed, the Church of Jesus Christ of Latter-day Saints,

Pentecostal, Christian Charismatic and Seventh Day Adventist respondents. This was followed by the Catholic denomination (27). The group 'Other Religions' comprised of the Hindu and Muslim faith, and had a total of 15 respondents. The lowest number of responses came from the Methodist denomination (three). The demographic and socio-economic profiles of the respondents had no significant influence on any of the spiritual, cultural, or aesthetic experiences felt by the respondents.

Table 3.4: How respondents felt towards their natural environment (percentages may not total to 100 due to rounding) (n=92) (Adapted from: Chinyimba, 2012)

	Response (%)					
Value Item	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**	**Not Sure**
Humans have the right to modify the natural environment to suit their need	5	40	22	23	9	1
Laws to protect the environment do not limit my choices and personal freedom	15	42	25	15	1	1
Claims that humans are changing the climate are correct	32	51	13	3	0	1
Environmental protection will help people have a better quality of life	28	64	8	0	0	0
Taking good care of the environment is my responsibility to provide a better world for me, my children and others	49	45	7	0	0	0
Modern development threatens wildlife and natural resources	57	34	10	0	0	0
Plants and animals have as much right to exist as humans	50	44	5	0	0	0
As human beings, we need to protect certain plant and animal species from extinction	63	30	6	1	0	0
Development should not happen at the expense of nature	46	40	12	1	0	1

A total of 64 % of the respondents said that they had a garden at their homes. Of these 26 had a garden that was smaller than that at their church; 12 (19 %) had a garden of similar size at

their homes, while 17 larger and 9 significantly larger were noted. Personal garden size had no significant influence on preferred church garden size (X^2= 2.96; p= 0.22).

The average age of the respondents from churches with a garden was 52 years (± 25), with 53 % being women and 47 % male. A total of 58 of the 92 respondents were white (63%). Both the black and Indian respondents represented 14 %, while there were seven couloured respondents. There was a large variety of occupations across the respondents as well as many different levels of education. There were 12 different home languages recorded, with the majority of the respondents speaking English. The majority of the respondents (78 %) subscribed to the lowest SARS income bracket (≤ R 150 000 per annum).

3.3.2: Responses from congregants that did not have sacred green areas

Forty responses from respondents who attend churches that do not have a garden were received. The majority of the respondents (60 %) agreed that sitting in a garden would make it easier for them to connect with God. The same was found with 68 % of the respondents agreeing with the statement that a garden would provide an area for spiritual functions to take place. Although the majority of respondents agreed with these statements, it was interesting to note that approximately half (53 %) agreed with the statement that a garden was not necessary and that not having one did not influence their spiritual/religious experience (Table 3.5). For those respondents who felt that specific tree species or amenities would improve their religious/spiritual experience they mentioned evergreen trees to remind congregants of the promised eternal life, indigenous trees to bring other native life such as birds, and water features to bring calmness when one is spending time in the garden. When asked what functions would take place in the garden, a number of respondents stated that religious celebrations such as confirmations, weddings, etc. would use this area after the ceremonies had been completed in the church. Other gatherings for social or religious purposes were also mentioned by the respondents, with some stating that a garden could be used for religious retreats.

The majority of the respondents (80 %) agreed that a garden is necessary as it reminds them of the beauty created by God. This is contradictory to what was stated earlier, with 53 % of the respondents agreeing with the statement that a garden is not necessary at all. Eighty

Table 3.5: Potential benefits a church garden would provide as perceived by congregants of churches currently without a garden (percentages may not total 100 due to rounding) (n=40)

	Response (%)				
Benefit	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
A church garden would greatly improve my religious/spiritual experience	10	33	27	15	15
Sitting in a garden would make it easier for me to connect with God	23	27	38	10	2
This connection would be improved if the garden was large	3	37	33	25	2
For a garden to improve my religious/spiritual experience, it must contain certain tree species or amenities (benches, fountains, etc.)	8	22	30	30	10
The garden would provide an area for spiritual functions (weddings, confirmations, etc.) to take place	25	43	15	17	0
A garden is not necessary and not having one does not influence my religious/spiritual experience	13	40	18	20	10

percent also agreed with the statement that a garden would add character to the church. The statement that a garden would signify tranquility and peace brought an 88 % agreement with the respondents. In terms of a garden enhancing one's religious experience, only 43 % of the respondents agreed with the statement. Eighty-eight percent of the respondents also felt that a garden would provide them with a place for reflection. Interestingly, the majority of the respondents did not feel that a garden promotes remembrance of departed ones. Forty-seven percent of the respondents disagreed that a garden was not necessary at all, with 35 % being neutral (Table 3.6). This indicates that the respondents believed that a garden would provide them with a number of benefits. Respondents also felt that a garden was necessary as it was part of the church's tradition, that it would add a great deal of aesthetic beauty, and that it would be a great gathering place for events and socials, while some individuals stated once again that they did not believe it was necessary at all.

Table 3.6: Respondents' level of agreement as to why they believed a church garden was necessary or not (percentages may not total 100 due to rounding) (n=40)

	Response (%)				
A church garden is necessary because:	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
It reminds me of the beauty created by God	48	32	18	2	0
It adds character to the church	30	50	13	5	2
It signifies tranquility and peace	35	53	12	0	0
It enhances ones religious experience	10	33	35	17	5
It promotes remembrance of departed ones	5	23	52	20	0
It provides reflection space	18	70	12	0	0
It is not necessary at all	0	18	35	30	17

The majority of the respondents stated that they perceived a sacred area to provide the mentioned social benefits. However, half the respondents felt that a sacred area provided cultural, spiritual, and aesthetic fulfillment, while the other half had not previously considered that. The majority of the respondents recognized that a garden and the associated trees would provide the mentioned ecological benefits. In terms of these areas reducing noise levels or diminishing the intensity/force of strong winds, the majority of the respondents stated that they had not considered these benefits. The majority of the respondents (53 %) stated that they perceived these areas as being a tourist attraction, while they had not previously considered the other stated economic benefits (Table 3.7).

The majority of the respondents agreed with all the stated value items (Table 3.8). Once again there was not however a majority agreement with the statement that humans have the right to modify the environment to suit their needs.

Eighty percent of the respondents from churches without gardens were female, while 20 % were male. The average age of these respondents was 44 years (± 22). Of the respondents, 26 were white, 13 black and 1 Indian. There were three different home languages among respondents with the majority (83 %) speaking English. The majority of the respondents (63 %) fell under the first SARS income bracket (≤ R 150 000 per annum).

Table 3.7: Perceived social, ecological and economic benefits that respondents believed a sacred area and the trees they harbour would provide, or that they had not previously considered (percentages may not total to 100 due to rounding) (n=40) (Adapted from: Chinyimba, 2012)

	Benefits	Provided (%)	Not previously considered (%)
Social	As a place to meet that promotes social interaction among congregants	83	17
	Improve an individual's mood and relieves stress	70	30
	Improve the aesthetic beauty of the religious area	80	20
	Offer cultural, spiritual and aesthetic fulfillment	50	50
Ecological	Remove pollutants from the air	73	27
	Provide a home for birds, insects and small animals	80	20
	Help to reduce excessive water loss and run-off from concrete areas and protect soils from erosion	67	33
	Purify air and water of an area	60	40
	Reduce temperatures by providing shade (regulate micro-climate)	77	23
	Help reduce the noise levels	43	58
	Mitigation of climate change	63	38
	Diminish the intensity/force of strong winds	43	57
Economic	Increase house or rent price of houses near the area	30	70
	Make the area (and town) a tourist attraction, resulting in employment and revenues	53	48
	Reduce energy use (air conditioners, etc.) through regulation of the micro-climate	43	58

Of the respondents, a total of 16 were from the Anglican denomination, 12 from the Pentecostal and 10 from the Baptist denomination. The lowest number of responses came from the Methodist denomination. A total of 85 % of the respondents had a garden at their private homes, while 15 % did not. Analyses once again revealed that demographic and socio-economic profiles of the respondents had no influence on their responses.

3.3.3 The effect of garden attributes on user perceptions

There was a significant relationship between the overall level of satisfaction of respondents with regards to the number of trees found in their respective gardens and their level of satisfaction with the tidiness of the garden (Figure 3.2). The same was found with these two statements and the respondents' satisfaction with the overall level of appearance. This would be expected as all three of those attributes refer to the way a garden looks. It was interesting to note that there was no relationship between the overall level of satisfaction with the appearance of the garden and species richness, abundance, or basal area. The PCA revealed

Table 3.8: How respondents felt towards their natural environment (percentages may not total to 100 due to rounding) (n=40) (Adapted from: Chinyimba, 2012)

	Response (%)					
Value Item	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**	**Not Sure**
Humans have the right to modify the natural environment to suit their need	8	28	25	25	13	3
Laws to protect the environment do not limit my choices and personal freedom	15	58	5	15	8	0
Claims that humans are changing the climate are correct	60	35	0	3	0	3
Environmental protection will help people have a better quality of life	63	35	3	0	0	0
Taking good care of the environment is my responsibility to provide a better world for me, my children and others	68	30	3	0	0	0
Modern development threatens wildlife and natural resources	58	40	3	0	0	0
Plants and animals have as much right to exist as humans	43	30	13	13	0	3
As human beings, we need to protect certain plant and animal species from extinction	65	30	5	0	0	0
Development should not happen at the expense of nature	58	20	18	3	0	0

that there was a relationship between the respondents stated spiritual and aesthetic satisfaction and species richness, basal area and total individuals.

In terms of stated spiritual experience (stating that a garden enhances one's spiritual experience), there was no significant relationship when it came to species richness (r^2= 0.14; p= 0.22) (Figure 3.3 b) or number of woody plants (r^2= 0.19; p= 0.15) (Figure 3.3 d). There was, however, a significant relationship between stated spiritual experience and basal area found within the garden (r^2=0.37, p=0.04) (Figure 3.3 f). The relationship between the stated aesthetic experience and species richness yielded no significant relationship (r^2=0.30, p=0.06) (Figure 3.3 a). However, due to the small sample size because of poor responses, if

alpha was increased to 0.1, the relationship would be significant. If the responses from St. Mary's Church were removed from the data set, there was then a significant relationship between aesthetic experience and species richness (r^2=0.50, p=0.01). There was a significant relationship between the stated aesthetic experience and the number of woody plants found within a garden (r^2=0.41, p=0.02) (Figure 3.3 c), while the same was found for stated aesthetic experience and basal area of the garden (r^2=0.49, p=0.01) (Figure 3.3 e). Size of the garden had no impact on the respondents' experiences, while the number of years that a respondent had been attending the sacred area yielded the same results.

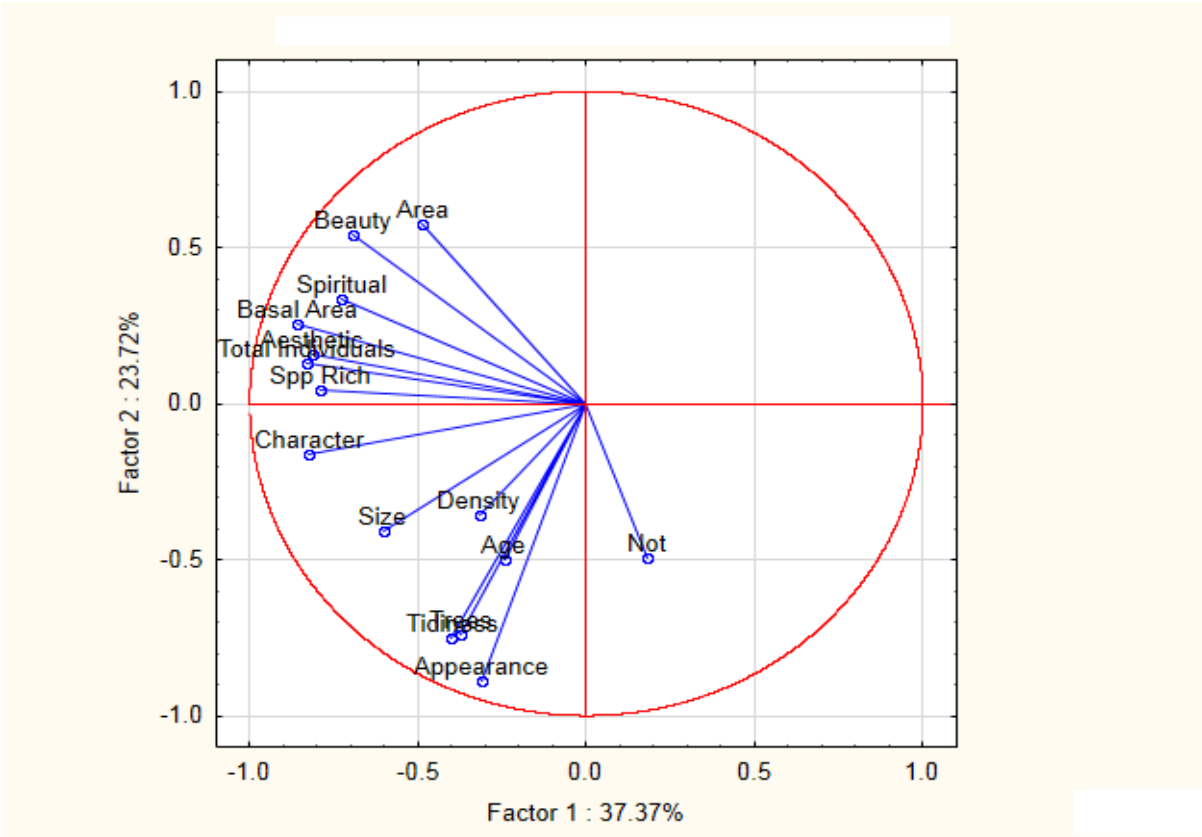

Figure 3.2: The relationships between stated spiritual and aesthetic experiences and garden attributes (12 sites) ("Not" indicating that a church garden is not necessary at all)

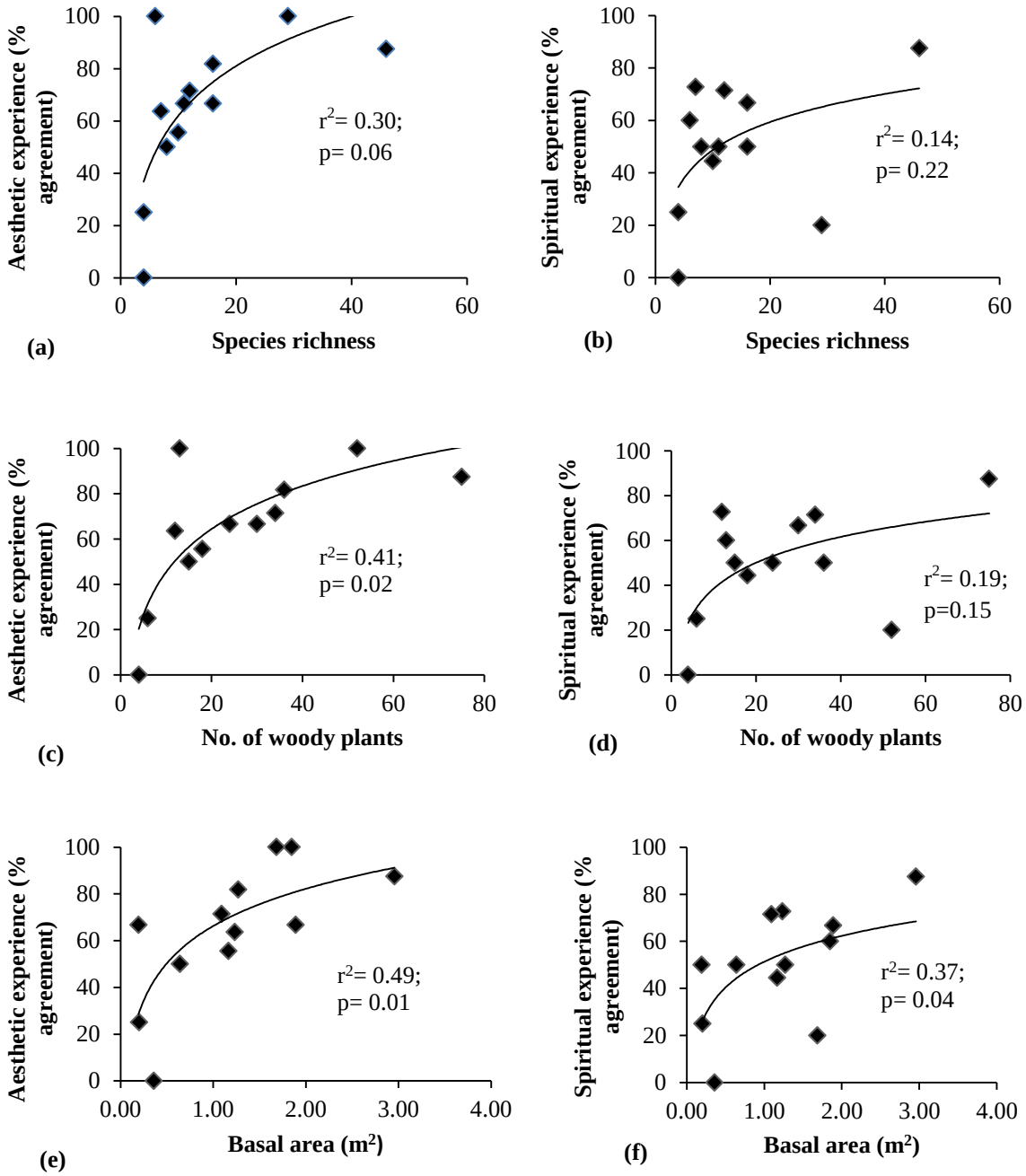

Figure 3.3: Relationship between species richness (a, b), number of woody plants (c, d) and basal area (m^2) (e, f), and stated aesthetic and spiritual experience

3.4 DISCUSSION

There was a variety of responses in terms of the spiritual, aesthetic and cultural benefits that respondents felt they received from their sacred areas. It has been hypothesized that for a

natural area to be sacred, one has to see the area as separate from humanity (Milton, 1999). However, the level of satisfaction with and well-being received from nature will only be significant if the individual is well attuned to nature's beauty (emotionally connected to their natural surroundings), and feels a heightened sense of connectedness with that piece of nature (Zhang et al., 2014). The results presented here show this to be the case.

3.4.1 Perceived, felt and possible benefits to respondents

Of the respondents that had a garden surrounding their church/temple/mosque, 14 % stated that they never spent any time in the garden. Even though this is the case, these respondents could possibly still have received benefits through viewing the garden walking past, or smelling the fresh flowers and dew on the grass (Brown & Grant 2005; Kaplan, 2001). Reasons for the majority of the respondents stating that they believed a garden was necessary ranged from it providing them with peace and tranquility to it allowing them to step away from everything else and ready themselves for prayer. Relaxation (Bennett & Swasey, 1996) and the ability to "step away" (Chiesura, 2004) from the outside world have been associated with natural areas in different settings. This being said, 27 % of the respondents stated that if their church did not have a garden, their religious experience would not be influenced in any way. Half of the respondents (50 %) stated that they held social as well as religious functions in the garden. The availability of green space surrounding houses as well as within a particular area have been found to increase social interaction, which has in turn been shown to improve health (Kemperman & Timmermans, 2014; Sullivan et al., 2004). This corresponds with 68 % of the respondents from the churches without gardens agreeing that a church garden would provide an area for spiritual and social functions.

There was a majority agreement amongst the respondents with regards to the stated reasons for why they believed a church garden was necessary. Although the majority of the respondents felt that their garden improved their religious experience, this was not the case when it came to the responses of those who did not have a garden (only 43 % of the respondents agreeing with the statement that a garden would improve their religious/spiritual experience). This may, however, be seen as a large percentage due to the fact that people are usually content with the status quo, and only really appreciate certain things once they have experienced it (Nordh et al., 2009).

One result that stood out was that the majority of the respondents did not believe that the sacred area surrounding their place of worship promoted the remembrance of departed ones. This was also the case with respondents from churches without gardens, with only 28 % of the respondents agreeing with the statement. When the responses to this statement were investigated for churches that actually had a garden of remembrance, all respondents felt it did. This shows that to receive certain benefits from a particular garden, specific features and amenities are needed (Qiu et al., 2013; Nordh et al., 2009).

The majority of respondents believed that a garden surrounding their place of worship improved both their stated spiritual and aesthetic experience. This may be because the respondents viewed these areas as beautiful, which often leads to the connection between an individual and their spiritual values (Wild et al., 2008; Williams & Harvey, 2001). This was, however, not the case when it came to the stated cultural experience of the respondents. When this is compared to the response from congregants of churches without gardens, it is found that the majority felt that a garden would improve their spiritual or religious experience. When the potential to increase benefits through a garden that was: larger, had a greater variety of plants, or had specific tree species or amenities was explored, in all three cases the majority of the respondents did not agree. This was found for congregants of churches both with and without gardens. Fuller et al. (2007) found that a number of benefits provided by a green space increased with area (as area had a positive correlation with number of habitat types), something which the respondents did not perceive in this study. It was also shown that the level of being able to reflect and have distinct identity was improved by an increase in species richness (Fuller et al., 2007) whereas my results did not show a significant relationship between stated spiritual or aesthetic experience and species richness. Congregants in this study did not feel that an increased area would improve their spiritual, cultural, or aesthetic experience. The fact that the respondents did not feel amenities or certain species would improve their experience could be because those amenities were not present, and for them to appreciate them they would need to experience them (Nordh et al., 2009).

A recurring response from respondents was that they believed that an array of colours and the presence of a bench in the garden would improve their stated spiritual experience. Half of the

respondents (50 %) from churches without gardens felt that sitting in a garden would make it easier for them to connect with God. Qin et al. (2013) found that colours were one of the most important factors in influencing overall level of people's satisfaction with the vegetative environment of parks. Lafortezza et al. (2009) stated that one could receive different psychological benefits during different seasons of the year. This was echoed by respondents who said that the presence of deciduous trees would remind the faithful that, like the leaves that wither away in winter, their life will also come to an end. When referring specifically to spirituality, only 40 % of the respondents stated that it would be easier to connect with God when in their sacred area. This may be compared to a study that asked 232 environmental educators what had influenced their commitment to environmental concerns, and only six percent of the respondents made specific reference to God or religion (Palmer, 1998; in Milton, 1999).

In terms of the aesthetically pleasing space provided by a garden, the majority of the respondents believed that these areas reduced their stress and made them feel healthy. These, along with many other restorative benefits provided by green areas, have been found on many occasions throughout the world (Flouri et al., 2014; Chiesura, 2004; Sullivan et al., 2004; Macintyre et al., 2003; Takano et al., 2002; Bennett & Swasey, 1996; Ulrich, 1984). One respondent said that "the tidiness of the garden showed respect for their deity, as well as for God, as He gave us nature to look after it". Milton (1999) argued that for an area to be sacred it should be pristine. However, these gardens were far from a pristine natural environment. This may be the case in the Shinto religion of Japan, where sacred urban forests are the object of nature worship, being left as natural as possible (Ishii et al., 2010). This may however be linked to the particular religion of the respondent. Those respondents who stated that the tidiness of the garden showed respect for their deity were all from the Christian faith, a faith that teaches human 'dominion' over nature (Pretty et al., 2009). Other faiths (Hinduism and Buddhism) stress the inter-relationships between humans and the rest of nature, perhaps making for better connectedness between their religious practices and the sacred natural areas (Ormsby, 2013).

Many of the respondents did not link their religious practices to their culture. Ward Thompson (1998; in Ward Thompson, 2002) said that parks serve as a refuge or a form of

paradise, something that has been embedded in cultural histories. However, respondents in this study emphasized that they did not believe these spaces influenced their culture in any way. Although many of the benefits provided by the natural environment to the psychological well-being of humans are classified under the broad heading of cultural ecosystem services (MEA, 2005), when it came to sacred areas in this study, people saw these benefits as separate from their cultural heritage. Milton (1999) argued that when an individual refers to having a religious or spiritual attitude towards nature (or in this case the garden surrounding their place of worship), they see that area as sacred. Although it would be impossible to have a different category for each of the benefits under cultural services, I argue that many people stressed that they see them as separate, especially when one refers to religious sacred areas and so should be seen in a different light. This could be due to the vast multitude of meanings and interpretations of culture and cultural experiences. This could have influenced the results of this study and should be looked at in greater detail in future research.

It was interesting to note that although the majority of the respondents felt that amenities would not improve their experiences, they were also not satisfied with the amenities present within their gardens. This again highlights the point that for an individual to receive certain benefits, or even to be able to perceive these benefits, the presence of amenities can help (Qiu et al., 2013; Nordh et al., 2009). The majority of the respondents were satisfied with the appearance of the garden. The respondents, however, felt that their gardens were underutilized. This would be due to the fact that these areas are locked most of the time due to fear of crime and vandalism.

Responses pertaining to perceived benefits provided by sacred areas differed very little between respondents that had a garden and those that did not. One difference was that respondents that had a sacred area stated that they believed their garden reduced noise levels, while their counterparts did not. This could have been because these respondents actually noticed the reduced noise when stepping into their garden. Gidlöf-Gunnarsson and Öhrström (2007) found that it is essential to provide access to a green area, to provide lower sound levels from road traffic, therefore offering opportunities for reduced stress and increased relaxation. Interestingly, those that had a garden did not perceive these areas as having the

potential to mitigate climate change, while the majority of their counterparts did. The majority of the respondents from churches without gardens felt that a garden would make the church more of a tourist attraction, while the majority of respondents from religious areas that did have a garden did not agree. This could be due to those without gardens romanticizing the idea of having a garden, believing that they would attract people such as in other parts of the world (Connell, 2004). The reality was however that these gardens were often locked, were quite small and that they had noticed that not many tourists had visited.

3.4.2 The effect of garden attributes on user perceived and felt benefits

There was no significant relationship between stated spiritual experience and species richness or number of woody plants within a garden. This may be compared to Fuller et al. (2007), where increasing plant species richness was associated with the respondents' ability to reflect and have the feeling of distinct identity. However, the majority of the respondents did not agree that an increase in the variety of plants within their church garden would improve their spiritual experience. This may be related to the findings of Fuller et al. (2007) who showed that park users were able to perceive plant species richness. Assuming that respondents would have been able to compare their garden with an area of higher plant diversity, or their garden with increased plant species richness, they still did not believe that it would improve their experience. There was a significantly positive relationship between stated spiritual experience and basal area of woody plants, highlighting that respondents' spiritual experience was subconsciously improved when there was more greenery surrounding their place of worship. Qiu et al. (2013) found that more open parks were preferred to those that had more complex vegetation. This may be related to these findings, with respondents enjoying less complex greenery. Thus, overall respondents responded positively to the presence of vegetation and its increasing abundance, but not to the variety of species.

The size of the sacred area had no influence on stated spiritual or aesthetic experience. This is contradictory to what was found by Fuller et al. (2007). van den Berg et al. (2010) found that the moderating effects of green spaces were felt to a greater extent by those who had greater amounts of green space within a three kilometre radius when compared to those who had green spaces within a one kilometre radius. This suggests that as the area increased, so too did the moderating benefits (van den Berg et al., 2010). The restorative function of a park

does not, however, depend solely on the size of that park, as some of the smallest parks (pocket parks) in Scandinavian cities having the highest scores relating to user satisfaction (Nordh et al. 2009). The results of the PCA were supported by the stated experiences of the respondents, with the majority of the respondents stating that a larger garden would not improve any of their experiences.

When the outlier of St. Mary's was omitted, there was a significant relationship between stated aesthetic experience and species richness, while significant relationships were seen between stated aesthetic experience and basal area and number of individuals. This suggests that it was the overall view of the garden that improved people's experiences, and that people were not in tune with the finer details of their gardens. This was supported by the fact that in the majority of the sampled churches in which experiences were influenced positively by their gardens, these gardens lacked large individual trees making up the majority of the total basal area. Kowarik (2011) stated that one may argue that ecosystem services in urban areas depend on abundance of biomass rather than the level of species richness or the occurrence of a particular species. This may be the case in this study as total biomass was positively related to both stated spiritual and aesthetic experience. This may be compared to Matsuoka (2010) who reported a positive relationship between nature exposure in schools and student performance. Views of greater quantities of trees and shrubs were positively associated with standardized test scores, graduation rate, the percentage of the students planning on going to college and fewer occurrences of criminal behaviour (Matsuoka, 2010).

Sacred areas that occur within the urban environment therefore have the potential to provide an array of benefits if sufficient vegetation is provided. For particular benefits to be optimized and felt by congregants, vegetation surrounding these places of worship should be increased. Amenities should also be provided, as once congregants have been exposed to certain amenities, more benefits could be felt (Nordh et al., 2009).

If a larger sample size could have been obtained for members of different religious faiths such as Muslim, Buddhism and Hinduism, it may have made for an interesting comparison. Christian and Muslim faiths both teach dominion over nature, while Buddhist and Hinduism encourage being one with nature (Ormsby, 2013). These differences could influence the perceived and felt benefits of the respondents.

3.5 CONCLUSION

The factor that most greatly influenced the experience of the respondents was that of basal area within the garden. Basal area had a significantly positive relationship with both the stated spiritual and aesthetic experiences of the respondents. However, number of woody plants also had a significantly positive relationship with aesthetic experience. Although it is extremely difficult to link perceived and felt benefits, this study found that respondents subconsciously received benefits from their sacred areas surrounding their places of worship. Greater abundances of trees and shrubs should be used by those who determine which trees and amenities are brought into a sacred urban area, ensuring that the benefits will be optimized by all who use the area.

The results show that the respondents felt that the sacred area surrounding their place of worship provided them with many perceived and felt benefits. Those that attended churches without gardens did in some cases believe that having a garden would improve their experience. However, respondents often mentioned that they felt most spiritual within their church, and that not having a garden did not influence their experience negatively. The potential social, ecological and economic benefits provided by sacred areas were recognized by both groups of respondents, with the majority of the respondents feeling that humans did not have the right to modify the environment to suit their needs, as well as agreeing that humans are having an impact on, and need to protect, the environment.

CHAPTER 4

Concluding discussion

4.1 INTRODUCTION

Urbanization has increased rapidly, bringing along with it many social and economic benefits, but unfortunately also attendant environmental problems (Cities & Biodiversity Outlook, 2012; Elmqvist et al., 2008; Newman, 2006; Pauchard et al., 2006; McKinney, 2002). Urbanization is one of the many human activities that have greatly reduced the amount of ecosystem benefits humans receive from the natural environment. Throughout this study the importance of natural areas in providing ecosystem services, with particular reference to cultural ecosystem services, has been highlighted, and the protection of these areas is one way in ensuring that services to both human populations and other organisms are continuously provided. For this to occur it is essential that urban areas are planted appropriately and green or natural areas be conserved or maintained in a way so as to maximize the benefits and services (Sushinsky et al., 2013). In trying to understand the benefits provided by urban green spaces, many studies have been done on institutional green areas such as school or university grounds, parks and more recently private gardens (Pothier & Millward, 2013; Davies et al., 2009; Fuller et al., 2007; Li et al., 2005; Tajima, 2003). There has however been a lack of information on sacred areas, such as church gardens, that occur within the urban matrix.

Sacred natural sites have been well documented throughout history in a variety of locations, religions and cultures (Jackle et al., 2013; Frosch, 2010; Ishii et al., 2010; Deil et al., 2005). Such areas have been shown to host a variety of biological diversity. The protection of this biodiversity has occurred through taboos and social protection through cultural practices. These practices have restricted individuals from removing or damaging trees or animals that occur in these areas, allowing many sacred sites to store some of the oldest trees and rare species within a landscape or region (Salick et al., 2007).

The cultural and religious practices and ceremonies that take place in sacred sites have also been extensively documented (Mallarach & Papayannis, 2010; Deil et al., 2005; Khaneghah,

1998; in Khan et al., 2008; King et al., 1997). These practices occur throughout the world, enriching the cultural and spiritual lives of those that believe in and are apart of the activities. It is these benefits from the natural environment (cultural ecosystem services) that are least understood out of all of the four ecosystem services categorised by the Millennium Ecosystem Assessment (2005).

Research on the benefits provided by sacred areas in terms of storing biodiversity as well as the social benefits is extremely scarce with respect to the urban landscape (Keniger et al., 2013). Areas such as church, temple or mosque gardens and cemeteries are relatively poorly studied and therefore little is known about the diversity that they harbour. This is to an even greater extent when it comes to social benefits. This study has therefore sought to examine the potential benefits that these areas provide, both in terms of the storing of woody plants, as well as providing the urban population with spiritual and cultural services.

4.2 THE INFLUENCE OF SITE ATTRIBUTES ON PLANT COMMUNITIES OF URBAN SACRED AREAS

The densification of urban areas is decreasing the vegetation and tree cover found in these areas (Sushinsky et al., 2013; Nowak & Greenfield, 2012). To maintain vegetation in the urban environment it is important to conserve institutional and private natural areas within towns and cities. The natural areas that remain have the potential to provide a wide variety of ecosystem services (Elmqvist et al., 2008). Urban greening has been advocated as a means to deliver the aforementioned ecosystem services, and therefore provide social, ecological and economic benefits (Young, 2010).

Studies on urban green spaces and their components have been widely documented (Nowak & Greenfield, 2012; Nagendra & Gopal, 2011; Gill et al., 2008; Colding et al., 2006; Kuhn et al., 2004; Stewart et al., 2004; Jim & Liu, 2001; Nowak et al., 1996; Kunick, 1987). Many recent studies have focused on the extent and diversity of green space by private gardens (Davies et al., 2009; González-Gracía & Sal, 2008; Loram et al., 2007; Mathieu et al., 2007; Colding et al., 2006). Sacred sites are another refuge of natural biodiversity, being well documented in many cultures and rural areas throughout the world (Malhotra et al., 2007; Sheridan & Nyamweru, 2007; Gadgil & Vartak, 1976; in Khan et al., 2008). However, sacred

areas that occur in the urban environment are often overlooked in literature on both urban green space as well as sacred natural areas. While there has been research done on the church forests of Ethiopia (Wassie et al., 2009; Aerts, 2007; Wassie et al., 2005) there is limited information pertaining to the vegetation of sacred sites within the urban environment and none from sub-Saharan Africa. This study sought to (i) characterize the woody plant structure and composition for all sacred areas within Grahamstown, South Africa, and (ii) assess the factors that might influence the abundance and composition.

Grahamstown sacred areas covered a total of 38.7 (±2.9) ha. Although McConnachie et al. (2008) did not include private gardens or cemeteries in their calculation of determining extent of public green space in Grahamstown, this study shows that sacred urban areas make up 2.2 % of the total area of Grahamstown. This increases the total area of Grahamstown attributed to public green space to 16.1 %.

A wide range of woody plant species were found throughout the sample sites of this study. A total of 139 different species were encountered. Of these, 56 % were exotic, 32 % indigenous and the remainder unidentified. This figure is lower than that of other studies that have been carried out in Birmingham (67 %) (Thompson et al., 2003) and Sheffield (70 %) (Smith et al., 2006), while it was similar to that of a garden in Leicestershire (60 %) (Owen 1991; in Smith et al., 2006). The percentage of exotics found in this study is expected to be higher, presuming that most (if not all) unidentified species were exotic. The three most common species (all of the genus *Cupressus*) made up almost half of the total plants sampled (44.6 %) and were almost all found in large cemeteries. This is similar to the parks studied by Nagendra and Gopal (2011) in Bangalore, where the top five species made up close to half the population. The high percentage of exotics that occur in urban areas could be attributed to manager preference, with more than 40 % of all exotics comprising of ornamentals (Weber, 2003; in Smith et al., 2006).

The majority (69 %) of the stems recorded in this study fell into the smallest diameter at breast height size class (0-15 cm), while only 0.8 % of the stems contributed to the largest category (90 cm and above). This is contrary to the guidelines suggested by Millward and Sabir (2010) who state that 40 % of the urban tree population should occur between a diameter at breast height of 0-15 cm, 30 % from 15-60 cm, 25 % from 60-90 cm and the

remainder from 90 cm and above. This is likely to be a result of the large amount of shrubs found in the sample sites. The 10/20/30 rule of Santamour (1990) states that urban forests should not comprise of more than ten percent of any one species, 20 % of any one genus or 30 % of any particular family (Kendal et al., 2014). In all three cases the suggested percentages were surpassed. This may be attributed to the large amount of *Cupressus* trees found in the largest of the sample sites. It indicates a need for greater diversity of plantings in the future at this scale.

There were low levels of similarity between the woody plant communities of sacred sites in Grahamstown church gardens and cemeteries. This was demonstrated by the fact that not one species occurred at all of the study sites, similar to a study done on the cemeteries of Campbelltown, where only one species occurred at every site (McBarron et al., 1988). Soil characteristics had no significant association with specific plant assemblages indicating that human management and planting were the overwhelming determinants of garden diversity. This is different to what was found on the vegetation of cemeteries in Illinois and Indiana where different soil type influenced species composition and relative abundance (Betz & Lamp, 1992). Species compositions of sacred groves in the Pondicherry region of India were also attributed to soil characteristics, with groves occurring in swampy, clayey and sandy loam areas (Ramanujam & Cyril, 2003). The small size of Grahamstown may also be a factor because the spatial scale reduces landscape heterogeneity and distances between sites.

Site age did not significantly influence any of the garden attributes (such as woody plant density, basal area, species richness or total number of woody plants). Age has been seen to influence vegetation composition within the semi-natural forests of Nova Scotia (LaPaix & Freedman, 2010). However, when the effect of neighbourhood age in species richness in Halifax, Nova Scotia, was investigated, age was found to have no significant influence (Turner et al., 2005). Nagendra and Gopal (2011) found that age had no influence on species richness, however, size class diversity was significantly greater in older perks, something that was not seen in the relationship between age and woody plant basal area in this study.

Size of the site had a significantly positive relationship with basal area as well as the total number of woody plants. However, there were no relationships between size and any of the other aforementioned garden attributes. This is different to the findings of Smith et al. (2006)

who found that garden area significantly influenced species richness. They also noted that species density decreased with decreasing garden size (Smith et al., 2006). The sacred shrine/temple forests of Japan show a decrease in species richness with decreasing area (Ishii et al., 2010). This finding is mirrored by Angold et al. (2006) who found a positive relationship between site species richness and site area. The lack of those relationships in this study could be because many of the smaller gardens were well looked after, while the larger gardens often contained largely lawned areas, or areas cemented for parking.

Denomination did not have a significant influence on garden attributes. Religious beliefs have been found to affect the ecology of sacred sites, differing in useful and endemic species composition when compared to non-sacred sites (Anderson et al., 2005). Religions, Shintoism and Buddhism, have forests of differing characteristics in Japan (Ishii et al., 2010). Shinto shrines receive little management, while Buddhist temples are intensely managed (Ishii et al., 2010). This may be due to the fact that these areas were more like home gardens than that of a sacred forest (Ishii et al., 2010) or groves found on the outskirts of a village which are typically dominated by natural vegetation communities. Garden owner (or in this case those in charge of maintenance) preference would probably have a much bigger influence than site size, age or denomination on the vegetation found at a particular sample site.

A clear distinction throughout the study was that of the lack of woody plants found in the church gardens and cemeteries in Grahamstown East. Grahamstown East is a township area created by the Apartheid regime, which formed a unique racial divide in cities across South Africa (Donaldson-Selby et al., 2007). This part of Grahamstown is characterized by generally less educated and poorer people, living in high density housing with little public green space (McConnachie & Shackleton, 2010). Although the church gardens studied are private, the local municipality has an opportunity to support congregations and greatly improve the livability of local areas. Vandalism and herbivory have a large impact on plants in these impoverished areas of Grahamstown (Richardson & Shackleton, 2014). If fencing were provided for the churches it may reduce the impacts of livestock, and potential taboos surrounding cemeteries would reduce the amount of vandalism. This once again highlights the influence of maintenance on sacred area vegetation. Three different maintenance regimes

on tree species composition and vegetation structure of sacred groves of India were investigated (Chandrarhekara & Sankar, 1998). They found that each regime yielded different results, with those being managed by individual families being most disturbed compared to groups of families or statutory agencies (Chandrahekara & Sankar, 1998).

Sacred areas therefore do have the potential to store a variety of woody vegetation. Promotion of the greening of the sacred areas that lack vegetation is therefore something that would not only increase the biodiversity in the urban environment, but also improve the lives of the urban population (Zhang et al., 2014; Kaplan, 2001). Sacred areas that are well vegetated could serve as nodes of connectivity for small mammals and birds (Angold et al., 2006), as well as provide habitats for a variety of organism (Davies et al., 2009).

4.3 CONGREGANT USE AND APPRECIATION OF SACRED SITES

People have an inherent connection with nature, a phenomenon known as biophilia (Wilson, 1984). However, as each generation becomes less exposed to the natural environment this connection to species and ecosystem services potentially becomes reduced (Kahn & Kellert, 2002). Natural areas provide a host of social benefits (Keniger et al., 2013) such as restorative function (Kaplan, 2001), improved self-esteem, physical health and well-being (Aldridge & Sempik, 2002) and reduced depression and anxiety (Macintyre et al., 2003).

Sacred natural sites have often been looked at separately from other natural areas, providing many benefits, as well as different ones, to a variety of people (Jackle et al., 2013; Ishii et al., 2010; Chandrakanth et al., 1990). Once the literature had been reviewed it was clear that the majority of the studies on sacred environments focused on eastern countries and religions with an emphasis on rural settings. Whereas studies on urban greening generally are dominated by literature from North America and Europe (Keniger et al., 2013; Shackleton, 2012). This part of the study sought to bring together the three dimensions, namely the urban environment, cultural and spiritual services and sacred sites.

4.3.1 Perceived and felt benefits to congregants

Natural environments host certain elements that provide restorative benefits to humans (Kaplan, 1995). This response goes beyond purely aesthetic preferences (Miller, 2005), with

people often feeling a deep connection with natural environments. The psychological benefits associated with natural sites have been documented in a number of different settings, indicating that green spaces offer a number of positive benefits to those that use them (van den Berg et al., 2010; Fuller et al., 2007; Takano et al., 2002). Additionally, school grounds that have a large amount of greenery improve the scores and behaviour of students (Matsuoka, 2010). Sacred natural areas play a large role in the religious practices and cultural heritage of those living in rural areas and those that come to visit these areas on pilgrimages (Jackle et al., 2013). There is, however, a large gap in the knowledge of the benefits provided by these sacred sites in urban environments.

The majority of the respondents from churches with and without gardens felt that sacred areas surrounding their church (or potentially surrounding their church) reminded them of the beauty created by God, signified tranquility and peace, enhanced their religious experience and provided them with a place to reflect. Natural areas have the ability to relax people (van den Berg et al., 2010; Bennett & Swasey, 1996), aiding them in the process of 'stepping away' before a church service (Chiesura, 2004). Respondents without a garden did not feel that a garden would improve their religious or spiritual experience, stating that they felt most connected to God within the church. This was, however, contradicted by the majority of the respondents stating that sitting in a garden made it easier for them to connect with God.

Respondents did not feel that if a garden were larger, had a greater variety of plants, or contained certain tree species or amenities that it would improve their cultural, spiritual or aesthetic experience. This is different to Fuller et al. (2007) who found that the ability to reflect and have distinct identity increased with area (and habitat type) as well as species richness. The fact that respondents did not feel that amenities would improve their experience could be because they do not have these features present, and for one to appreciate them they have to have experience with them (Nordh et al., 2009). Respondents did feel that a garden surrounding their church improved their spiritual and aesthetic experience. This could be because of the links that people make with beauty and spiritual values (Wild et al., 2008). They did not, however, feel that church gardens provided cultural services in the narrow sense of the word. Ward Thompson (1998; in Ward Thompson, 2002) said that parks form

part of our cultural histories. However, respondents in this study emphasized that they did not feel that church gardens influenced their culture in any way.

Assessing perceived social, ecological and economic benefits found little differences between those with and without gardens. One noticeable difference was that those who had a garden perceived reduced noise levels, while those without did not. This is supported by Gidlöf-Gunnarsson and Öhrström (2007) who showed how green areas reduced noise levels from road traffic. Those that did not have a garden felt that one would increase the potential for tourism. Although this has been found to be the case in other countries or for other gardens (Connell, 2004), the reality was that very few people visited the gardens that already existed.

These findings highlight the importance of church gardens in urban environments. While it has been shown in many cases that urban parks and areas with more street trees improve the lives of those in the surrounding areas (Kemperman & Timmermans, 2014; Takano et al, 2002) this shows that there is another element that could enhance the lives of urban populations. These gardens are therefore bringing in a spiritual component to the urban environment, something that many people need to travel long distances to achieve when going on pilgrimages or religious retreats (Jackle et al., 2013). It could be proposed that benefits would not only be provided to those that come into direct contact with church gardens, but also those that may view them in passing (Kaplan, 2001), termed as incidental interactions by Keniger et al. (2013).

A limitation to these analyses of responses would be that not all of the questionnaires were returned for each of the sample sites. This meant that questionnaires were only received back from churches that had vegetation in the gardens surrounding their buildings, and none in the more impoverished areas of Grahamstown where they contained gardens, however, these gardens were bare.

4.3.2 The links between woody vegetation and social benefits

The impact that certain vegetation has on the psychological benefits received from natural areas is of extreme importance to humans. This information is invaluable when it comes to the planning, development and upkeep of natural and green areas in urban environments.

Fuller et al. (2007) found that as plant species richness of parks increased, so too did the ability of park users to have the feeling of distinct identity and the ability to reflect. The positive effects of greenery surrounding schools (Matsuoka, 2010) also highlights that green areas should be molded to maximize benefits for not only those that use them on a daily basis, but for all that may be influenced positively from any form of contact.

There was a significant relationship between respondent satisfaction of site tidiness, number of trees and appearance. This is intuitive as each characteristic refers to the appearance of the garden. A PCA revealed potential relationships between spiritual and aesthetic experiences and woody plant basal area, number, and species richness. Upon closer investigation spiritual experience was significantly positively related to basal area of woody plants. Site age, size, species richness and woody plant number did not influence stated spiritual experience significantly. The respondent's scoring of aesthetic experience had a significantly positive relationship with basal area and total number of woody plants. Although site size did not influence the stated experiences of the individuals, in other studies benefits received from green areas within the urban environment have been found to increase with increasing area (van den Berg et al., 2010; Fuller et al., 2007). However, the restorative benefits received from parks are not solely dependent on park size (Nordh et al., 2009). This was reinforced by the fact that people stated that they did not feel that a garden with an increased variety of plants would improve any of their stated experiences. The high prevalence of alien plant species in found in the sites did not seem to influence the respondents' experience in any way. The same may be observed when it comes to the low levels of similarity found between the different sites. Although there was high variability this had very little effect on the spiritual, aesthetic and cultural experience of the respondents. The fact that experiences were influenced by basal area and woody plant numbers suggests that people enjoy vegetation as a whole, and are not too concerned with the variety of plants found within a garden. This is reinforced by the fact that there was a high variability of plant communities between gardens as well as large proportions being alien; however, neither of these factors influenced respondent experience. Kowarik (2011) argued that ecosystem services in urban areas depend on biomass rather than species richness or occurrence of particular species. Matsuoka (2010) similarly reported that student performance significantly improved with greater quantities of trees and shrubs in school grounds.

Thus, in summary, this study has shown that sacred urban areas are therefore of vital importance to those that use them (Figure 4.1). These areas add to the matrix of urban green spaces, providing benefits to other organisms as well as the urban population.

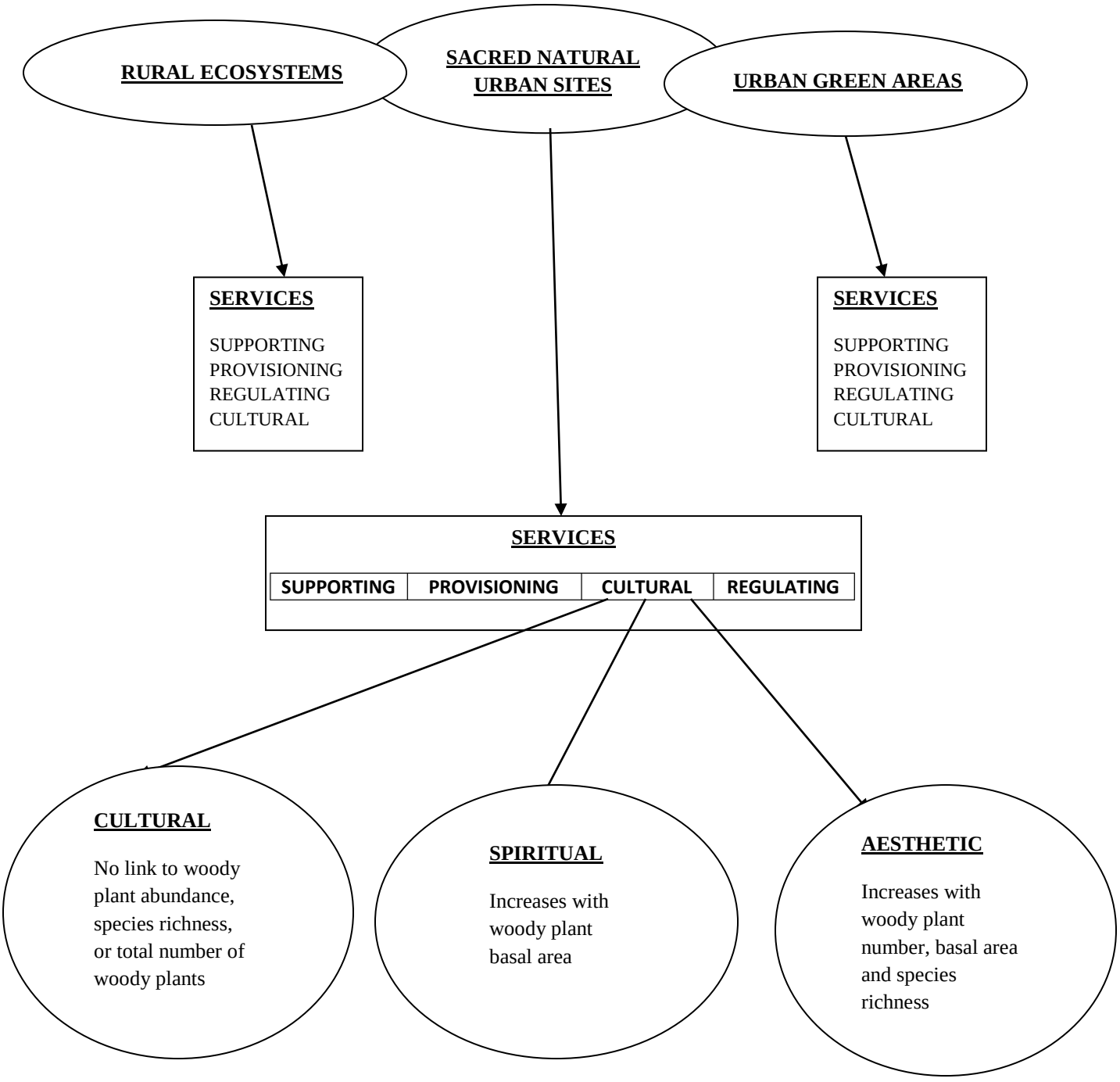

Figure 4.1: The benefits provided by urban sacred sites as found from this study.

4.4 FUTURE RESEARCH

Due to the extensive research on sacred natural sites in eastern countries and rural areas, there is the potential to compare the vegetation communities that occur throughout the world in sacred sites. It would be interesting if a comparison could be made between the sacred sites that occur strictly in urban areas. This could show how these areas are managed like gardens and that management preference has the largest effect, or it could emphasize how the different religions have used certain species when a larger sample size is gathered.

Although this study looked just at the benefits provided to those that directly used these areas, the effect of biodiversity found in sacred urban sites on those in the surrounding houses and work places would further our understanding of these benefits. This could include people whose homes have a view of the garden, those who work nearby as well as those that have to commute past these areas on a daily basis, providing a "naturalised resource for the guided dreams of an urbanised population" (Cooper, 2012).

It would have been interesting to see how congregants of churches with gardens, albeit gardens lacking vegetation, felt about the areas. One could also explore whether or not people felt that in order for them to have a cultural contact with a natural area, it needed to be more removed from the urban environment, more secluded.

Another way in which information could be added to this study is to do a full flora inventory of each of the sample sites. This would then include many of the smaller, flower bearing, ornamentals that could potentially improve the congregants' experience.

To see the true affect that certain tree species and vegetation in general as well as particular amenities have on congregants would be to work with a new church garden. The thoughts and ideas of the congregants could be gathered through questionnaires and participatory group meetings, remodelling the garden once this data had been collected. Once the garden had been completed and had had a chance to grow for a few years, the same congregants could be interviewed, determining whether or not specific vegetation improved their spiritual, cultural and aesthetic experience.

References

Aerts, R. (2007). Church forests in Ethiopia. *Frontiers in Ecology & the Environment* 5: 66.

Alberti, M. 2005. The effects of urban patterns on ecosystem function. *International Regional Science Review* 28: 168-192.

Alberti, M., Marzluff, J., Shulenberger, E., Bradley, G., Ryan, C. & Zumbrunnnen, C. 2003. Integrating humans into ecology: opportunities and challenges for studying urban ecosystems. *Bioscience* 53: 1169-1179.

Aldridge, J. & Sempik, J. 2002. Social and therapeutic horticulture: evidence and messages from research. *Evidence Issue 6*. Loughborough: CCFR Loughborough University.

Alvey, A.A. 2006. Promoting and preserving biodiversity in the urban forest. *Urban Forestry & Urban Greening* 5: 195-201.

Anderson, D.M., Salick, J., Noseley, R.K. & Xiaokun, O. 2005. Conserving the sacred medicine mountains: a vegetation analysis of Tibetan sacred sites in Northwest Yunnan. *Biodiversity & Conservation* 14: 3065-3091.

Andersson, E. 2006. Urban landscapes and sustainable cities. *Ecology & Society* 11: 34.

Angold, P.G., Sadler, J.P., Hill, M.O., Pullin, A., Rushton, S., Austin, K., Small, E., Wood, B., Wadsworth, R., Sanderson, R. & Thompson, K. 2006. Biodiversity in urban habitat patches. *Science of the Total Environment* 360: 196-204.

Anthwal, A., Gupta, N., Sharma, A., Anthwal, S. & Kim, K. 2010. Conserving biodiversity through traditional beliefs in sacred groves in Uttarakhand Himalaya, India. *Resources, Conservation & Recycling* 54: 962-971.

Araujo, M.B. 2003. The coincidence of people and biodiversity in Europe. *Global Ecology & Biogeography* 12: 5-12.

Awoyemi, S. M., Gambrill, A., Ormsby, A., & Vyas, D. 2012. Global Efforts to Bridge Religion and Conservation: Are They Really Working? *Topics in Conservation Biology* 97-110.

Balmford, A., Moore, J., Brooks, T., Burgess, N., Hansen, L.A., Williams, P. & Rahbek, C. 2001. Conservation conflicts across Africa. *Science* 291: 2616-2619.

Barrett, G.W. & Barrett, T.L. 2001. Cemeteries as repositories of natural and cultural diversity. *Conservation Biology* 15: 1820-1824.

Bennett, E.S. & Swasey, J.E. 1996. Perceived stress reduction in urban public gardens. *HortTechnology* 6: 125-128.

Betz, R.F. & Lamp, H.F. 1992. Species composition of old settler savannah and sand prairie cemeteries in northern Illinois and northwestern Indiana. In : Smith, D.A. & Jacobs, C.A. (eds). *Proceedings of the Twelfth North American Prairie Conference.* University of Northern Iowa, Cedar Falls. Pp. 79-87.

Bhagwat, S. A., Ormsby, A. A., & Rutte, C. 2011. The role of religion in linking conservation and development: challenges and opportunities. *Journal for the Study of Religion, Nature and Culture* 5: 39-60.

Brown, C. & Grant, M. 2005. Biodiversity and human health: what role for nature in healthy urban planning? *Built Environment* 31: 326-338.

Byers, B.A., Cunliffe, R.N. & Hudak, A.T. 2001. Linking the conservation of culture and nature: a case study of sacred forests in Zimbabwe. *Human Ecology* 29: 187-218.

Cameron, R.W.F., Blanusa, T., Taylor, J.E., Salisbury, A., Halstead, A.J., Henricot, B. & Thompson, K. 2012. The domestic garden- its contribution to green infrastructure. *Urban Forestry & Urban Greening* 11: 129-137.

Carrier, J-A. & Beebee, T.J.C. 2003. Recent, substantial, and unexplained declines of the common toad *Bufo bufo* in lowland England. *Biological Conservation* 111: 395-399.

Chandrakanth, M.G., Gilless, J.K., Gowramma, V. & Nagaraja, M.G. 1990. Temple forests in India's forest development. *Agroforestry Systems* 11: 199-211.

Chandrashekara, U.M. & Sankar, S. 1998. Ecology and management of sacred groves in Kerala, India. *Forest Ecology & Management* 112:165-177.

Chen, J. 2007. Rapid urbanisation in China: a real challenge to soil protection and food security. *Catena* 69: 1-15.

Chiesura, A. 2004. The role of urban parks for the sustainable city. *Landscape & Urban Planning* 68: 129-138.

Chinyimba, A. 2012. *An assessment of urban residents' knowledge and appreciation of the intangible benefits of trees in two medium sized towns in South Africa*. Unpublished Masters thesis, Rhodes University, Grahamstown, South Africa.

Clayton, S. 2007. Domesticated nature: motivations for gardening and perceptions of environmental impact. *Journal of Environmental Psychology* 27: 215-224.

Cocks, M.L., Bangay, L., Wiersum, K.F. & Dold, A.P. 2006. Seeing the wood for the trees: the role of woody resources for the construction of gender specific household cultural artefacts in non-traditional communities in the Eastern Cape, South Africa. *Environmental Development & Sustainability* 8: 519-533.

Cocks, M.L. & Wiersum, K.P. 2003. The significance of plant diversity to rural households in Eastern Cape province of South Africa. *Forests, Trees & Livelihoods* 13: 39-58.

Colding, J., Lundberg, J. & Folke, C. 2006. Incorporating green-area user groups in urban ecosystem management. *AMBIO: A Journal of the Human Environment* 35: 237-244.

Connell, J. 2004. The purest of human pleasures: the characteristics and motivations of garden visitors in Great Britain. *Tourism Management* 25: 229-247.

Constanza, R., Wilson, M., Troy, A., Voinov, A., Liu, S. & D'Agostino, J. 2006. *The value of New Jersey's ecosystem services and natural capital*. New Jersey Department of Environmental Protection.

COOPER, N.S. 2012. The history of English churchyard landscapes illustrated by Rivenhall, Essex. In: *Sacred Species and Sites: Advances in Biocultural Conservation*. Cambridge University Press. Pp. 97-110.

Cooper, N.S. 1995. Wildlife conservation in churchyards: a case-study in ethical judgements. *Biodiversity & Conservation* 4: 916-928.

Cornelis, J. & Hermy, M. 2004. Biodiversity relationships in urban and suburban parks in Flanders. *Landscape & Urban Planning* 69: 385-401.

Davies, Z.G., Fuller, R.A., Loram, A., Irvine, K.N., Sims, V. & Gaston, K.J. 2009. A national scale inventory of resource provision for biodiversity within domestic gardens. *Biological Conservation* 142: 761-771.

Deil, U., Culmsee, H. & Berriane, M. 2005. Sacred groves in Morocco: a society's conservation of nature for spiritual reasons. *Silva Carelica* 49: 185-201.

De Lacy, P. & Shackleton, C. 2014. The comparative growth rates of indigenous street and garden trees in Grahamstown, South Africa. *South African Journal of Botany* 92: 94-96.

Demirbas, A. 2009. Biofuels securing the planet's future energy needs. *Energy Conversion & Management* 50: 2239-2249.

Dimoudi, A. & Nikolopoulou, M. 2003. Vegetation in the urban environment: microclimatic analysis and benefits. *Energy & Buildings* 35: 69-75.

Diochinova, V., Zhiyanski, M. & Hursthouse, A. 2006. Impact of urbanization on soil characteristics. *Environmental Chemistry Letters* 3: 160-163.

Donaldson-Selby, G., Hill, T. & Korrubel, J. 2007. Photorealistic visualization of urban greening in a low-cost high density housing settlement, Durban, South Africa. *Urban Forestry & Urban Greening* 6: 2-14.

Downs, R.M. & Stea, D. 1977. *Maps in minds: reflections on cognitive mapping*. New York: Harper & Row. Pp. 264-276.

Dudley, N., HIGGINS-ZOGIB, L. I. Z. A., & Mansourian, S. 2009. The links between protected areas, faiths, and sacred natural sites. *Conservation Biology* 23: 568-577.

Dwyer, J.F., Schroeder, H.W. & Gobster, P.H. 1991. The significance of urban trees and forests: towards a deeper understanding of values. *Journal of Aboriculture* 17: 276-284.

Eigenbrod, F., Bell, V.A., Davies, H.N., Heinemeyer, A., Armsworth, P.R. & Gaston, K.J. 2011. The impact of projected increases in urbanization on ecosystem services. *Proceedings of the Royal Society B* 278: 3201-3208.

Elmqvist, T., Alfsen, C. & Colding, J. 2008. Urban systems. In: Jorgensen, S.E. (ed.), *Encyclopedia of Ecology*. Oxford, UK: Elsevier. Pp. 3665-3672.

Escobedo, F.J., Kroeger, T. & Wagner, J.E. 2011. Urban forests and pollution mitigation: analyzing ecosystem services and disservices. *Environmental Pollution* 159: 2078-2087.

Escobedo, F.J. & Nowak, D.J. 2009. Spatial heterogeneity and air pollution removal by an urban forest. *Landscape & Urban Planning* 90: 102-110.

Escobedo, F.J., Wagner, J., Nowak, D.J., de la Maza, C.L., Rodriguez, M. & Crane, D.E. 2008. Analyzing the cost-effectiveness of Santiago Chile's policy of using urban forests to improve air quality. *Journal of Environmental Management* 86: 148-157.

Flouri, E., Midouhas, E. & Joshi, H. 2014. The role of urban neighbourhood green space in children's emotional and behavioural resilience. *Journal of Environmental Psychology* 40: 179-186.

Frosch, B. 2010. Characteristics of the vegetation of tree stands on sacred sites in comparison to well preserved forests in northwestern Morocco. *Ecologia Mediterranea* 36: 83-95.

Fuller, R.A., Irvine, K.N., Devine-Wright, P., Warren, P.H., & Gaston, K.J., 2007. Psycological benefits of green space increase with biodiversity. *Biology Letters* 3: 390-394.

Gadgil, M. & Vartak, V.D. 1976. Sacred groves of Western Ghats in India. *Ecological Botany* 30: 152-160. In: Khan, M.L., Khumbongmayum, A.D. & Tripathi, R.S. 2008. The sacred groves and their significance in conserving biodiversity, an overview. *International Journal of Ecology & Environmental Sciences* 34: 277-291.

Gidlöf-Gunnarsson, A. & Öhrström, E. 2007. Noise and well-being in urban residential environments: the potential availability to nearby green areas. *Landscape & Urban Planning* 83: 115-126.

Gilfedder, L. 1990. Threatened species from Tasmania's remnant grasslands. *Tasmanian Forests* 2: 129-132.

Gill, S.E., Handley, J.F., Ennos, A.R., Pauleit, S., Theuray, N. & Lindley, S.J. 2008. Characterising the urban environment of UK cities and towns: A template for landscape planning. *Landscape & Urban Planning* 87: 210-222.

Goddard, M.A., Dougill, A.J. & Benton, T.G. 2009. Scaling up from gardens: biodiversity conservation in urban environments. *Trends in Ecology & Evolution* 25: 90-98.

González-Gracía, A. & Sal, A.G. 2008. Private urban greenspaces or "patios" as a key element in the urban ecology of tropical central America. *Human Ecology* 36: 291-300.

Guiamet, P.S., Rosato, V., Gomez de Saravia, S., Garcia, A.M. & Moreno, D.A. 2012. Biofouling of crypts of historical and architectural interest at La Plata Cemetery (Argentina). *Journal of Cultural Heritage* 13: 339-344.

Hashimoto, D., Ito, K., Manabe, T., Isono, D. & Umeno, T. 2006. Basic study on distributional patterns and ecological characteristics of shrine/temple forests in Kitakyushu City. *Kyushu Journal of Forest Research* 59: 56-59 (in Japanese). In: Ishii, H.T., Manabe, T., Ito, K., Fujita, N., Imanishi, A., Daisuke, H. & Iwasaki, A. 2010. Integrating ecological and cultural values toward conservation and utilisation of shrine/temple forests as urban green space in Japanese cities. *Landscape & Ecological Engineering* 6: 307-315.

Hogan, D.M. & Walbridge, M.R. 2007. Urbanization and nutrient retention in freshwater riparian wetlands. *Ecological Applications* 17: 1142-1155.

Hope, D., Gries, C., Zhu, W., Fagan, W.F., Redman, C.L., Grimm, N.B., Nelson, A.L., Martin, C. & Kinzig, A. 2003. Socioeconomics drive urban plant diversity. *Proceedings of the National Academy of Sciences* 100: 8788-8792.

Imanishi, A., Murakami, K., Imanishi, J., Hashimoto, H., Morimoto, J. & Satomura, A. 2007. Conservation of isolated urban green spaces for plant species: characteristics of shrine and temple forests and precincts. *Landscape Ecology & Ecosystem Management* 12: 23-34 (in Japanese with English abstract). In: Ishii, H.T., Manabe, T., Ito, K., Fujita, N., Imanishi, A.,

Daisuke, H. & Iwasaki, A. 2010. Integrating ecological and cultural values toward conservation and utilisation of shrine/temple forests as urban green space in Japanese cities. *Landscape & Ecological Engineering* 6: 307-315.

Imanishi, A., Murakami, K., Imanishi, J., Morimoto, J. & Satomura, A. 2005. Herbaceous plant species richness and species distribution pattern at fragmented forests in Kyoto City. *Journal of the Japanese Society of Revegetation Technology* 12:23-34 (in Japanese with English abstract). In: Ishii, H.T., Manabe, T., Ito, K., Fujita, N., Imanishi, A., Daisuke, H. & Iwasaki, A. 2010. Integrating ecological and cultural values toward conservation and utilisation of shrine/temple forests as urban green space in Japanese cities. *Landscape & Ecological Engineering* 6: 307-315.

Integrated Development Plan, 2011. Makana Local Municipality. [Online]. Available: http://goo.gl/dGSkhp [02/09/2014]

Ishii, H.T., Manabe, T., Ito, K., Fujita, N., Imanishi, A., Daisuke, H. & Iwasaki, A. 2010. Integrating ecological and cultural values toward conservation and utilisation of shrine/temple forests as urban green space in Japanese cities. *Landscape & Ecological Engineering* 6: 307-315.

Jackle, H., Rudner, M. & Deil, U. 2013. Density, spatial pattern and relief features of sacred sites in northern Morocco. *Landscape Online* 32: 1-16.

Jacob, R.E., Mltha, V.R. & MacPherson, D. 2004. The kaolinitic clay deposits on Beaconsfield, north of Grahamstown. *South African Journal of Science* 100: 560-564.

Jim, C.Y. 2001. Managing urban trees and their soil envelopes in a contiguously developed city environment. *Environmental Management* 28: 819-832.

Jim, C.Y. & Chen, W.Y. 2008. Assessing the ecosystem service of air pollutant removal by urban trees in Guangzhou (China). *Journal of Environmental Management* 88: 665-676.

Jim, C.Y. & Lui, H.T. 2001. Patterns and dynamics of urban forests in relation to landuse and development history in Guongzhou City, China. *Geography Journal* 167: 358-375.

Jo, H.K. 2002. Impacts of urban green space on offsetting carbon emissions for middle Korea. *Journal of Environmental Management* 64: 115-126.

Kahn, P.H. & Kellert, S.R. (eds.). 2002. *Children and nature: psychological, sociocultural, and evolutionary investigations*. Massachusetts Institute of Technology Press.

Kala, C.P., Dhyani, P.P. & Sajwan, B.S. 2006. Developing the medicinal plants sector in northern India: challenges and opportunities. *Journal of Ethnobiology & Ethnomedicine* 2: 32.

Kaplan, R. 1983. The analysis of perception via preference: a strategy for studying how the environment is experienced. *Landscape & Urban Planning* 12: 161-176.

Kaplan, R. 2001. The nature of the view from home: psychological benefit. *Environment & Behaviour* 33: 507-542.

Kaplan, S. 1995. The restorative benefits of nature: toward an integrative framework. *Journal of Environmental Psychology* 15: 169-182.

Kemperman, A. & Timmermans, H. 2014. Green spaces in the direct living environment and social contacts of the aging population. *Landscape & Urban Planning* 129: 44-54.

Kendal, D., Dobbs, C. & Lohr, V.I. 2014. Global patterns of diversity in the urban forest: is there evidence to support the 10/20/30 rule? *Urban Forestry & Urban Greening* 13: 411-417.

Keniger, L.E., Gaston, K.J., Irvine, K.N. & Fuller, R.A. 2013. What are the benefits of interacting with nature? *International Journal of Environmental Research & Public Health* 10: 213-235.

Khan, M.L., Khumbongmayum, A.D. & Tripathi, R.S. 2008. The sacred groves and their significance in conserving biodiversity an overview. *International Journal of Ecology & Environmental Sciences* 34: 277-291.

Khan, M.L., Menon, S. & Bawa, K.S. 1997. Effectiveness of the protected area network in biodiversity conservation, a case study of Meghalaya, India. *Biodiversity & Conservation* 6: 853-868.

Khaneghah, A.A. 1998. Social and cultural aspects of sacred trees in Iran. *Conserving the sacred for biodiversity management*. New Delhi: UNESCO and Oxford-IBH Publishing. Pp. 123-127. In: Khan, M.L., Khumbongmayum, A.D. & Tripathi, R.S. 2008. The sacred groves and their significance in conserving biodiversity an overview. *International Journal of Ecology & Environmental Sciences* 34: 277-291.

Khera, N., Mehta, V. & Sabata, B.C. 2009. Interrelationship of birds and habitat features in urban green spaces in Delhi, India. *Urban Forestry & Urban Greening* 8: 187-196.

King, E.D.I.O., Viji, C. & Narasimhan, D. 1997. Sacred groves: traditional ecological heritage. *International Journal of Ecology and Environmental Sciences* 23: 463-470.

Kinzig, A.P., Warren, P., Martin, C., Hope, D. & Katti, M. 2005. The effects of human socioeconomic status and cultural characteristics on urban patterns of biodiversity. *Ecology & Society* 10: 23.

Kowarik, I. 2011. Novel urban ecosystems, biodiversity, and conservation. *Environmental Pollution* 159: 1974-1983.

Kuhn, I., Brandl, R. & Klotz, S. 2004. The flora of German cities is naturally species rich. *Evolutionary Ecology Research* 6: 749-764.

Kunick, W. 1987. Woody vegetation in settlements. *Landscape Planning* 14: 57-78.

Kuruneri-Chitepo, C. & Shackleton, C.M. 2011. The distribution, abundance and composition of street trees in selected towns of the Eastern Cape, South Africa. *Urban Forestry & Urban Greening* 10: 247-264.

Lafortezza, R., Carrus, G., Sanesi, G. & Davies, C. 2009. Benefits and well-being perceived by people visiting green spaces in periods of heat stress. *Urban Forestry & Urban Greening* 8: 97-108.

LaPaix, R. & Freedman, B. 2010. Vegetation structure and composition within urban parks of Halifax Regional Municipality, Nova Scotia, Canada. *Landscape & Urban Planning* 98: 124-135.

Laske, D. 1994. Cemeteries: ecological niches in populated areas. *Naturwissenschaften* 81: 218-223.

Li, F., Wang, R., Paulussen, J. & Liu, X. 2005. Comprehensive concept planning of urban greening based on ecological principles: a case study in Beijing, China. *Landscape & Urban Planning* 72: 325-336.

López-Mosquera, N. & Sánchez, M. 2011. Emotional and satisfaction benefits to visitors as explanatory factors in the monetary valuation of environmental goods. An application to peri-urban green spaces. *Land Use Policy* 28: 151-166.

Loram, A., Tratalos, J., Warren, P.H. & Gaston, K.J. 2007. Urban domestic gardens (X): the extent and structure of the resource in five major cities. *Landscape Ecology* 22: 601-615.

Lussenhop, J. 1977. Urban cemeteries as bird refuges. *The Condor* 79: 456-461.

Macintyre, S., Ellaway, A., Hiscock, R., Kearns, A., Der, G. & McKay, L. 2003. What features of the home and the area might help to explain observed relationships between housing tenure and health? Evidence from the west of Scotland. *Health & Place* 9: 207-218.

Malhotra, K.C., Gokhale, Y., Chatterjee, S. & Srivastava, S. 2007. *Sacred groves in India*. New Delhi: Aryan Books.

Mallarach, J.M. & Papayannis, T. 2010. Sacred natural sites in technologically developed countries: reflections from the experience of the Delos Initiative. In: Verschuuren, B., Wild, R., McNeely, J.A. & Oviedo, G. (eds.). *Sacred natural sites: conserving nature and culture*. London: Earthscan. Pp. 198-208.

Marzluff, J.M. 2001. Worldwide urbanization and its effects on birds. In: Marzluff, J.M., Bowman, R. & Donnelly, R. (eds.). *Avian ecology and conservation in an urbanizing world*. Massachusetts: Kluwer Academic Publishers. Pp. 19-47.

Mathieu, R., Freeman, C. & Aryal, J. 2007. Mapping private gardens in urban areas using object-orientated techniques and very high-resolution satellite imagery. *Landscape & Urban Planning* 81: 179-192.

Matsuoka, R.H. 2010. Student performance and high school landscapes: examining the links. *Landscape & Urban Planning* 97: 273-282.

McBarron, E.J., Benson, D.H. & Doherty, M.D. 1988. The botany of old cemeteries. *Cunninghamia* 2: 97-105.

McConnachie, M.M. & Shackleton, C.M. 2010. Public green space inequality in small towns in South Africa. *Habitat International* 34: 244–248.

McConnachie, M.M., Shackleton, C.M. & McGregor, G.K. 2008. The extent of public green space and alien plant species in 10 small towns of the Sub-Tropical Thicket Biome, South Africa. *Urban Forestry & Urban Greening* 7: 1-13.

McFrederick, Q.S. & LeBuhn, G. 2006. Are urban parks refuges for bumble bees *Bombus* spp. (Hymenoptera: Apidae)? *Biological Conservation* 129: 372-382.

McKinney, M.L. 2002. Urbanization, biodiversity, and conservation. *BioScience* 52: 883-890.

McKinney, M.L. 2006. Urbanization as a major cause of biotic homogenization. *Biological Conservation* 127: 247-260.

McKinney, M.L. 2008. Effects of urbanization on species richness: a review of plants and animals. *Urban Ecosystems* 11: 161-176.

Midilli, A., Dincer, I. & Ay, M. 2006. Green energy strategies for sustainable development. *Energy Policy* 34: 3623-3633.

Millennium Ecosystem Assessment, 2005. *Ecosystems and human well-being: synthesis*. (Vol. 5). Washington, DC: Island Press.

Miller, J.R. 2005. Biodiversity conservation and the extinction of experience. *Trends in Ecology & Evolution* 20: 430-434.

Millward, A.A. & Sabir, S. 2010. Structure of a forested urban park: implications for strategic management. *Journal of Environmental Management* 91: 2215-2224.

Milton, K. 1999. Nature is already sacred. *Environmental Values* 8: 437-449.

Myers, N., Mittermeier, R.A., Mittermeier, C.G., da Fonseca, G.A.B & Kent, J. 2000. Biodiversity hotspots for conservation priorities. *Nature* 403: 853-858.

Nagendra, H. & Gopal, D. 2011. Tree diversity, distribution, history and change in urban parks: studies in Bangalore, India. *Urban Ecosystems* 14: 211-223.

Nagengra, H., Sudhira, H.S., Katti, M. & Schewenius, M. 2013. Sub-regional assessment of India: effects of urbanization on land use, biodiversity and ecosystem services. In: Elmqvist, T., Fragkias, M., Goodness, J., Güneralp, B., Marcotullio, P., McDonald, R., Parnell, S., Sendstad, M., Schewenius, M., Seto, K. & Wilkinson, C. (eds.). *Urbanization, biodiversity and ecosystem services: challenges and opportunities: a global assessment*. Dordrecht: Springer. Pp. 65-74.

Newman, P. 2006. The environmental impact of cities. *Environment & Urbanisation* 18: 275-295.

Nordh, H., Hartig, T., Hagerhall, C.M. & Fry, G. 2009. Components of small urban parks that predict the possibility for restoration. *Urban Forestry & Urban Greening* 8: 225-235.

Nowak, D.J., Crane, D.E. & Stevens, J.C. 2006. Air pollution removal by urban trees and shrubs in the United States. *Urban Forestry & Urban Greening* 4: 115-123.

Nowak, D.J. & Greenfield, E.J. 2012. Tree and impervious cover change in U.S. cities. *Urban Forestry & Urban Greening* 11: 21-30.

Nowak, D.J., Rowntree, R.A., McPherson, E.G., Sisinni, S.M., Kerkmann, E.R. & Stevens, J.C. 1996. Measuring and analyzing urban tree cover. *Landscape & Urban Planning* 36: 49-57.

Oleyar, M.D., Greve, A.I., Whithey, J.C. & Bjorn, A.M. 2008. An integrated approach to evaluating urban forest functionality. *Urban Ecosystems* 11: 289-308.

Ormsby, A.A. 2013. Analysis of local attitudes toward sacred groves of Meghalaya and Karnataka, India. *Conservation & Society* 11: 187-197.

Ormsby, A.A. & Bhagwat, S.A. 2010. Sacred forests of India: a strong tradition of community-based natural resource management. *Environmental Conservation* 37: 320-326.

Orstan, A. & Kosemen, M. 2009. Graves and snails: biodiversity conservation in an old cemetery in Istanbul, Turkey. *Triton* 19: 40-41.

Owen, J. 1991. *The ecology of a garden: the first fifteen years*. Cambridge: Cambridge University Press. In: Smith, R.M., Thompson, K., Hodgson, J.G., Warren, P.H. & Gaston, K.J. 2006. Urban domestic gardens (IX): composition and richness of the vascular plant flora, and implications for native biodiversity. *Biological Conservation* 129: 312-322.

Palmer, J.A. 1998. Spiritual ideas, environmental concerns and educational practice. In: Cooper, D.E. & Palmer, J.A. (eds.). *Spirit of the environment: religion, value and environmental concern.* London & New York: Routledge. Pp. 146-167. In: Milton, K. 1999. Nature is already sacred. *Environmental Values* 8: 437-449.

Palmer, M. & Finlay, V. 2003. *Faith in conservation: new approaches to religions and the environment*. Part 2. Washington, DC: World Bank.

Pauchard, A., Aguayo, M., Pena, E. & Urrutia, R. 2006. Multiple effects of urbanization on the biodiversity of developing countries: the case of a fast-growing metropolitan area (Concepcion, Chile). *Biodiversity Conservation* 127: 272-281.

Pauleit, S., Ennos, R. & Golding, Y. 2005. Modeling the environmental impacts of urban land use and land cover change- a study in Merseyside, UK. *Landscape & Urban Planning* 71: 295-310.

Pothier, A.J. & Millward, A.A. 2013. Valuing trees on city-centre institutional land: an opportunity for urban forest management. *Journal of Environmental Planning & Management* 56: 1380-1402.

Pretty, J., Adams, B., Berkes, F., de Athayde, S.F., Dudley, N., Hunn, E., Maffi, L., Milton, K., Rapport, D., Robbins, P., Sterling, E., Stolton, S., Tsing, A., Vintinner, E. & Pilgrim, S. 2009. The intersections of biological diversity and cultural diversity: towards integration. *Conservation & Society* 7: 100-112.

Prober, S.M. 1996. Conservation of the grassy white box woodlands: rangewide floristic variation and implications for reserve design. *Australian Journal of Botany* 44: 57-77.

Puppán, D. 2002. Environmental evaluation of biofuels. *Social & Management Services* 10: 95-116.

Qin, J., Zhou, X., Sun, C., Leng, H. & Lian, Z. 2013. Influence of green spaces on environmental satisfaction and physiological status of urban residents. *Urban Forestry & Urban Greening* 12: 490-497.

Qiu, L., Lindberg, S. & Nielsen, A.B. 2013. Is biodiversity attractive? On-site perception of recreational and biodiversity values in urban green space. *Landscape & Urban Planning* 119: 136-146.

Ramanujam, M.P. & Cyril, K.P.K. 2003. Woody species diversity of four sacred groves in the Pondicherry Region of South India. *Biodiversity & Conservation* 12: 289-299.

Richardson, E. & Shackleton, C.M. 2014. The extent and perceptions of vandalism as a cause of street damage in small towns in the Eastern Cape, South Africa. *Urban Forestry & Urban Greening* 13: 425-432.

Roy, S., Byrne, J. & Pickering, C. 2012. A systematic quantitative review of urban tree benefits, costs, and assessment methods across cities in different climatic zones. *Urban Forestry & Urban Greening* 11: 351-363.

Saidur, R., Islam, M.R. Rahim, N.A. & Solangi, K.H. 2010. A review on global wind energy policy. *Renewable & Sustainable Energy Reviews* 14: 1744-1762.

Salick, J., Amend, A., Anderson, D., Hoffmeister, K., Gunn, B. & Zhendong, F. 2007. Tibetan sacred sites conserve old growth trees and cover in the eastern Himalayas. *Biodiversity & Conservation* 16: 693-706.

Santamour Jr, F.S. 1990. *Trees for urban planting: diversity, uniformity, and common sense*. Proceedings of the seventh conference of the Metropolitan Tree Improvement Alliance (METRIA) Pp. 57-65.

Secretariat of the Convention on Biological Diversity, 2012. *Cities and biodiversity outlook*. Montreal, 64 pages.

Shackleton, C.M. 2012. Is there no urban forestry in the developing world? *Scientific Research & Essays* 7: 3329-3335.

Sheridan, M.J. & Nyamweru, C. (eds) 2007. *African sacred groves: ecological dynamics and social change*. Athens: Ohio University Press.

Smith, R.M., Thompson, K., Hodgson, J.G., Warren, P.H. & Gaston, K.J. 2006. Urban domestic gardens (IX): composition and richness of the vascular plant flora, and implications for native biodiversity. *Biological Conservation* 129: 312-322.

Statistics South Africa, 2004. Provincial Profile 2004: Eastern Cape. [Online]. Available: http://www.statssa.gov.za/publications/report-00-91-02/report-00-91-022004.pdf [13/05/2013].

Stewart. G.H., Ignatieva, M.E., Meurk, C.D. & Earl, R.D. 2004. The re-emergence of indigenous forest in an urban environment, Christchurch, New Zealand. *Urban Forestry & Urban Greening* 2: 149-158.

Stoffberg, G.H., van Rooyen, M.W., van der Linde, M.J. & Groeneveld, H.T. 2008. Predicting the growth in tree height and crown size of three tree species in the City of Tshwane, South Africa. *Urban Forestry & Urban Greening* 7: 259-264.

Sullivan, W.C., Kuo, F.E. & Depooter, S.F. 2004. The fruit of urban nature: vital neighborhood spaces. *Environment & Behavior* 36: 678-700.

Sushinsky, J.R., Rhodes, JR., Possingham, H.P., Gill, T.P. & Fuller, R.A. 2013. How should we grow cities to minimise their biodiversity impacts? *Global Change Biology* 19: 401-410.

Tait, C.J., Daniels, C.B. & Hill, R.S. 2005. Changes in species assemblages within the Adelaide Metropolitan Area, Australia, 1836-2002. *Ecological Applications* 15: 346-359.

Tajima, K. 2003. New estimates of the demand for urban green space: implications for valuing the environmental benefits of Boston's big dig project. *Journal of Urban Affairs* 25: 641-655.

Takano, T., Nakamura, K. & Watanabe, M. 2002. Urban residential environments and senior citizens' longevity in megacity areas: the importance of walkable green spaces. *Journal of Epidemiology & Community Health* 56: 913-918.

Thompson, K., Austen, K.C., Smith, R.M., Warren, P.H., Angold, P.G. & Gaston, K.J. 2003. Urban domestic gardens (I): putting small-scale plant diversity in context. *Journal of Vegetation Science* 14: 71-78.

Thompson, K., Hodgson, J.G., Smith, R.M., Warren, P.H. & Gaston, K.J. 2004. Urban domestic gardens (III): composition and diversity of lawn floras. *Journal of Vegetation Science* 15: 371-376. In: Smith, R.M., Thompson, K., Hodgson, J.G., Warren, P.H. & Gaston, K.J. 2006. Urban domestic gardens (IX): composition and richness of the vascular plant flora, and implications for native biodiversity. *Biological Conservation* 129: 312-322.

Turner, K., Lefler, L. & Freeman, B. 2005. Plant communities of selected urbanized areas of Halifax, Nova Scotia, Canada. *Landscape & Urban Planning* 71: 191-206.

Turner, W.R., Nakamura, T. & Dinetti, M. 2004. Global urbanization and the separation of humans from nature. *BioScience* 54: 585-590.

Tyrväinen, L. 2001. Economic valuation of urban forest benefits in Finland. *Journal of Environmental Management* 62: 75-92.

Ulrich, R. S. 1984. View through a window may influence recovery from surgery. *Science* 224: 420-421.

United Nations, Department of Economic and Social Affairs, 2010. Population division, population estimates and projections section. [Online]. Available: http://esa.un.org/wpp/unpp/panel_population.htm [12/04/2013].

United Nations Population Division, 2007. Urban Agglomerations 2007. [Online]. Available: http://www.un.org/esa/population/publications/wup2007/2007 urban agglomerations chart.pdf. [10/03/2012].

van den Berg, A.E., Maas, J., Verheij, R.A. & Groenewegen P.P. 2010. Green space as a buffer between stressful life events and health. *Social Science & Medicine* 70: 1203-1210.

Viswanathan, B., Volder, A., Watson, W.T. & Aitkenhead-Peterson, J.A. 2011. Impervious and pervious pavements increase soil carbon dioxide concentrations and reduce root production of American sweetgum (*Liquidambar styraciflua*). *Urban Forestry & Urban Greening* 10: 133-139.

Voegt, C. 2001. Eastern Cape: South African Wild Flower Guide. (No. 11). Cape Town: Botanical Society of South Africa in association with the National Botanical Institute.

Wang, Y., Bakker, F., de Groot, R. & Wörtche, H. 2014. Effect of ecosystem services provided by urban green infrastructure on indoor environment: a literature review. *Building & Environment* 77: 88-100.

Ward Thompson, C. 1998. Historic American parks and contemporary needs. *Landscape Journal* 17:1-25. In: Ward Thompson, C. 2002. Urban open space in the 21st century. *Landscape & Urban Planning* 60: 59-72.

Wassie, A., Sterck, F. J., Teketay, D., & Bongers, F. 2009. Effects of livestock exclusion on tree regeneration in church forests of Ethiopia. *Forest Ecology and Management* 257: 765-772.

Wassie, A., Teketay, D., & Powell, N. (2005). Church forests in North Gonder Administrative Zone, Northern Ethiopia. *Forests, Trees and Livelihoods* 15: 349-373.

Weber, E. 2003. *Invasive plant species of the world: a reference guide to environmental weeds*. Wallingford: CABI Publishing. In: Smith, R.M., Thompson, K., Hodgson, J.G., Warren, P.H. & Gaston, K.J. 2006. Urban domestic gardens (IX): composition and richness of the vascular plant flora, and implications for native biodiversity. *Biological Conservation* 129: 312-322.

Westphal, L.M. 2003. Urban greening and social benefits: a study of empowerment outcomes. *Journal of Arboriculture* 29: 137-147.

Wild, R., McLeod, C. & Valentine, P. (eds.). 2008. *Sacred natural sites: guidelines for protected area managers*. (No. 16). IUCN.

Williams, K. & Harvey, D. 2001. Transcendent experience in forest environments. *Journal of Environmental Psychology* 21: 249-260.

Wilson, E.O. 1984. *Biophilia: the human bond with other species*. Cambridge, Massachusetts: Harvard University Press.

Wüstenhagen, R. & Bilharz, M. 2006. Green energy market development in Germany: effective public policy and emerging customer demand. *Energy Policy* 34: 1681-1696.

Young, R.F. 2010. Managing municipal green space for ecosystem services. *Urban Forestry & Urban Greening* 9: 313-321.

Zhang, .W., Howell, R.T. & Iyer, R. 2014. Engagement with natural beauty moderates the positive relation between connectedness with nature and psychological well-being. *Journal of Environmental Policy* 38: 55-63.