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A Study of Green Space Access in the Waikato Region

A thesis
submitted in partial fulfillment
of the requirements for the degree
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Abstract

Access to green space provides a wide range of social, economic, health and environmental benefits. However, there are disparities in the ways that people access these benefits. This research aimed to examine how access to green space was spatially distributed across the Waikato region, whether a relationship existed between access to green space and socioeconomic deprivation, and what the planning and policy implications of this were.

In order to quantify access to green space, a Geographic Information System (GIS) analysis was undertaken using the Access to Natural Greenspace Standard (ANGSt) model, an English distance based accessibility measure. The ANGSt model measures how many people meet each of four standards based on travel distance to different sized green spaces. The results of this analysis were compared with New Zealand Deprivation (NZDep) index scores in order to determine if socioeconomic deprivation had any effect on access to green space. Semi-structured interviews were then undertaken in order to ground the results in current planning theory and practice.

The results of the GIS analysis showed that, generally, urban populations had better access to small green spaces within walking distance, while rural populations had better access to large green spaces. This study was unable to find evidence of a relationship between deprivation and green space access.

While most people in the region have access to a green space, there are still areas where access is lacking. Further study is needed in order to better understand the determinants of accessibility and how equitable access to the benefits of nature can be achieved.

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Introduction

Access to green space provides people with access to the benefits of nature, and as such it is important to ensure that all people have access to green spaces. Despite this, few studies have examined access to green space, particularly in New Zealand. One means of quantifying access is to assess the distances people must travel to reach green spaces. This thesis will examine the physical accessibility of green spaces in the Waikato region and whether accessibility is related to socioeconomic deprivation. Following this it will examine what green space accessibility and its link with socioeconomic deprivation means for planning and policy.

Research Questions

This research aims to answer the following questions:

- How much green space is available in the Waikato region and how accessible are these spaces?
- What effect does socioeconomic deprivation have on access to green spaces and the benefits of nature in the Waikato region?
- What are the planning and policy implications of the findings regarding green space accessibility for the region?

Green Space and Access

Natural green space has been defined by Natural England as “places where human control and activities are not intensive so that a feeling of naturalness is allowed to predominate” (Natural England 2010: 8). Green space accessibility is the ability of the public to access and benefit from green spaces in their day to day lives. Accessibility can be inhibited by several physical, economic and social barriers such as distance, cost and disability. Harrison, Burgess, Millward and Dawe (1995: 2) defined access as “certain rights of approach, entry or use that are legally or conventionally defined”, and they defined accessibility as “the extent to which these rights can be exercised in particular places, at particular times and by particular people”.

Access to green spaces has been linked with numerous benefits including improved physical and mental health, community wellbeing, environmental improvement and potential economic benefits, with greater benefits coming from greater access to green space. There is evidence that people who live in socioeconomically deprived communities have less access to green space, and as such have less access to the benefits of green spaces. However, further study

is needed in order to fully understand the nature of the relationship between deprivation and green space access.

In New Zealand publicly accessible natural green spaces consist primarily of conservation zones, such as reserve land, conservation areas and coastal-marine areas, and bodies of water such as rivers, lakes and wetlands.

The accessibility of the region's green space has never been measured using a travel distance based measure.

Research Rationale

This research is important for several reasons. The analysis provided in this research could directly inform New Zealand's future green space planning efforts. This research will also help to fill several existing gaps in research surrounding green space and accessibility. If successful, the methods of this study could be used in other regions of New Zealand in order to provide a national view of green space accessibility in relation to deprivation.

While some work has been done towards providing an inventory of existing green space for the Waikato, more work is needed in order to provide a complete picture of accessibility for the region. The Department of Conservation (DoC) has mapped public conservation areas and other public green spaces across the country and the Waikato regional council's infrastructure inventory (Waikato Mayoral Forum Technical Working Group 2013) identified the significant infrastructure (including public open spaces) for the region, but to date, there has not been a complete survey of green space access for the region.

Increasing evidence of the numerous benefits of green space access suggest that it will play an important part in future planning efforts. The Waikato Infrastructure Inventory identified parks and public open spaces as being a major contributor to all four wellbeings (economic, social, environmental and cultural wellbeing) for Waikato residents. This research would provide a picture of green space for the region that accounted for distribution and potential equity issues.

Assessing the distribution of green space in the Waikato region will allow the regional and territorial authorities to see what areas require intervention in order to provide adequate access to green space for all residents of the region. It will also allow them to assess the effectiveness of the current approach to green space planning.

Lastly, this research will test the applicability of the Access to Natural Greenspace Standard (ANGSt) for New Zealand use. ANGSt is an English standard for assessing green space access using a range of distance and size-based criteria. It will also test whether the ANGSt model is effective at analysing the link between green space accessibility and socioeconomic deprivation. To date it is not evident that these tools have been used in New Zealand.

Regional Challenges

This research is especially important in the face of future challenges arising both globally and locally. The population of the Waikato region grew from 325,220 to 416,200 between 1986 and 2012, an increase of 28%. The region's population is expected to continue growing at a rate similar to the rest of the country, with the population expected to reach 469,910 by 2031, a growth of 13%. This growth puts increasing pressure on all natural resources and infrastructure. This growth however is not consistent across all districts, with the majority of the growth taking place in a few urban centres, leading to the Waikato region's population becoming increasingly urbanised, which has consequences for access to green space (Jackson, 2013). Hamilton city's continual outward growth presents another challenge for the future of the region. Much like the rest of the country, the Waikato region has an ageing population. Ageing populations, particularly in the Waikato region's rural areas, can lead to underfunding of local government in those districts, which leads to increasing pressure on infrastructure. The Waikato Mayoral Forum considers that the global and national trends that create these impacts on the region are likely to continue (Waikato Mayoral Forum 2014). These regional challenges are fuelled by national and global trends including climate change, urbanisation and changing population structures.

The New Zealand Deprivation index (NZDep) is a measure of socioeconomic deprivation that assigns a decimal score to New Zealand meshblocks based on ten measures of deprivation (Atkinson, Salmond, & Crampton 2014). The Waikato region has an NZDep weighted average score of 6, meaning the region scores slightly below the national median NZDep score of 5, indicating that it is more socioeconomically deprived than average (Waikato Regional Council n.d.). The higher than average levels of deprivation indicate that if a link exists between deprivation and accessibility, then Waikato residents are more likely to suffer from inadequate green space accessibility.

Thesis Structure

This chapter serves as an introduction to green space and accessibility, the next chapter, Chapter Two, provides a review of recent literature around the topic of green space accessibility. It aims to define access to green space, while also looking at the planning

concepts and theory behind the research and examining the benefits that access to green space can provide. The review covers international academic research and established planning theory, as well as grey literature that provides a local context to this research.

Chapter Three sets out the methodology and methods that were used in order to collect the necessary data to answer the research questions. The chapter details the three-part method of quantification of green space, analysis of accessibility using ANGSt and interviews with key informants regarding the planning and policy implications of green space access in the region. The chapter also explains how the data was collected and why these particular methods were used.

The findings from the research are presented in Chapter Four. The results of the quantification of green spaces and the ANGSt analysis are presented as tables and maps to show clearly and concisely the findings of the research.

Chapter Five, discusses the results in terms of the project's research questions and looks at what further research could be undertaken in order to build on the findings of the study. This chapter also critically evaluates the method in order to determine if the limitations of the study may have impacted the accuracy of the results.

The concluding chapter, Chapter Six, provides a summary of the research project as a whole.

Literature Review

This chapter provides a review of recent literature relating to green space access, and the benefits it can provide, from both international and New Zealand sources. It examines the broad trends of research around this topic, in addition to this it also examines the relevant planning theories that inform this research. Literature examined in this review includes academic sources such as journal articles as well as 'grey literature' such as government plans, policies and reports.

The literature review will first seek to define green space and green space accessibility. It will then examine the relevant elements of planning theory and how they relate to green space accessibility. Next, it will look at the benefits that green space provides and how access to these benefits depends upon the accessibility of these spaces. Finally, it will examine the local context for green space accessibility, and how the international literature surrounding green space applies to New Zealand and the Waikato region in particular.

There has been a great increase in the amount of international research into green space accessibility and the benefits it can provide over the past few decades, with most of this research being undertaken in developed countries. This has been fuelled by increased awareness of the ways that ecological processes impact our lives and how human impacts influence and interrupt these processes.

Green Space Accessibility

What is Green Space?

There are many different definitions of what qualifies as green space, these definitions differ according to what types of spaces are included, the scale of spaces, and what makes spaces 'green'.

Some definitions of green space differ according to how 'green' green spaces must be. While some include recreational spaces that do not necessarily contain vegetation, others include only those spaces that are well vegetated. The US Environmental Protection Agency (2016) defines green space simply as "land that is partly or completely covered with grass, trees, shrubs, or other vegetation. Green space includes parks, community gardens, and cemeteries". Some literature refers to open space rather than green space, the term open space often does not necessitate a natural characteristic to the kinds of spaces included, and as such open space may include spaces without a natural characteristic such as town squares

or artificial sports turfs. Harrison, *et al.* (1995) found that a common link between most definitions of green space is the recognition of green spaces as areas where the surface is predominantly natural such as earth, water and living things. In this way, Natural England's ANGSt Plus guidelines feature a hierarchy of naturalness for green spaces in the United Kingdom (see Table 1) (Land Use Consultants, 2008).

Naturalness in green spaces is often defined as a perceived closeness to a state of natural vegetation growth (Ode, Tveit, & Fry, 2008; Sang, Knez, Gunnarsson, & Hedblom, 2016). Natural England defines natural green spaces as areas not dominated by human activity, which leads to a feeling of 'naturalness' being experienced in these areas (Land Use Consultants, 2008). Some research has suggested that areas which are perceived to be 'more natural' are more likely to be used for physical activity and lead to better well-being for nearby residents (Sang, Knez, Gunnarsson, & Hedblom, 2016). Green spaces can be made more natural through habitat improvement and creation (Land Use Consultants, 2008) and by facilitating and maintaining ecological networks.

Table 1: Levels of Naturalness

Level 1	<ul style="list-style-type: none"> • Nature conservation areas • Woodland • Remnant countryside
Level 2	<ul style="list-style-type: none"> • Formal and informal open space • Unimproved farmland • Rivers and canals • Unimproved grassland • Disused/derelict land • Country parks • Open access land
Level 3	<ul style="list-style-type: none"> • Allotments • Church yards and cemeteries • Formal recreation space
Level 4	<ul style="list-style-type: none"> • Improved farmland

Source: (Land Use Consultants 2008)

In urban areas, green space includes larger spaces such as parks and urban forests, and smaller scale spaces such as street trees, vacant lots and green roofs. Green Space Scotland (2011) defines green space as “the ‘green lungs’ of our towns and cities” spaces that bring

greenery into urban areas. Myers (1975: 149) states that the purpose of urban green space is to “serve conservation and urban shaping functions in addition to providing recreational opportunities”.

Box and Harrison (1993) identified four major forms of urban green space:

1. Remnants of Natural Systems
2. Agricultural Land (arable land, pastures, hedges)
3. Private Gardens and Public Parks
4. Habitats that develop on disused urban sites.

Remnants of Natural Systems

These include urban forests, lakes, rivers and gullies. These may take the form of conservation parks or nature reserves. Although often subject to some degree of maintenance these spaces are generally perceived as being more natural than parks and streetscapes (Jorgensen, Wilson, & van der Berg 2010).

Agricultural Land (arable land, pastures, hedges)

Urban agriculture is the raising of animals and growing of food crops in urban areas (RUAF Foundation n.d.). Besides the obvious benefit of providing food, urban agricultural spaces also provide other benefits including natural disaster relief and opportunities for recreation (Moreno-Peñaranda 2011).

Private Gardens and Public Parks

Though some research has pointed to the benefits of private gardens, more research is needed in this field (Dunnett & Qasim 1998). However, private gardens are very rarely publicly accessible, so many of these benefits tend to accrue only to their owners.

Public parks serve multiple purposes including fostering spaces for recreation, conserving nature and providing numerous environmental benefits (The Parks Forum 2008), as they are publicly owned they are usually publicly accessible.

Habitats that develop on disused urban sites

Recent research has shown that vacant lots often provide important social and ecological benefits to the community (Kremer, Hamstead, & McPhearson 2013), often being used as community gardens, sports fields or parking areas. However, vacant lots differ from the other forms of urban green space in that they are less permanent and could be developed at any time (Box & Harrison 1993).

Urban green spaces are of considerable importance as they help to preserve ecological networks that would otherwise be lost to human development, they also offer some of the only opportunities for access to nature for city dwelling people (Ignatieva, Stewart, & Meurk 2010).

The major similarities between popular definitions of green spaces are that green spaces require a sense of naturalness and some degree of public access or ownership. These definitions may differ on the degree of access or naturalness required and whether or not bodies of water (sometimes called blue spaces) are included as green spaces.

What is Access to Green Space?

While some of the most fundamental benefits of green space can be gained through its mere existence (for example, oxygen production, climate control, preservation of biodiversity), greater benefits are achieved with greater levels of access (Weldon, Bailey, & O'Brien 2007). Improving access to natural green space is important because it allows more people to reap greater benefits from green spaces. While green spaces do provide ecological benefits on a global level, accessing many of the benefits of green spaces requires more direct forms of access. Easily accessible green spaces are more likely to be actively used by a wide variety of people (Willis & Osman 2005), which leads to more people enjoying the numerous benefits they provide.

Access to green space falls in to two broad categories: physical access, which is access that is measured objectively using methods such as walking distance, and perceived access, which is based on subjective measures of access such as surveys of how easy people feel it is to access green spaces. Some studies suggest that perceived access to green space may be equally if not more important than physical access when it comes to gaining the benefits of green space accessibility (Dewulf, Neutens, Van Dyck, de Bourdeaudhuij, & Van de Weghe 2012).

Physical accessibility is accessibility that is measured using objective means, it is often measured by the distance or travel time from home to a green space. Physical accessibility can also be measured by the area of green space available per person. Decreasing the distance people have to travel to green space is important because people will only be willing to travel so far to use a green space.

Another aspect of physical accessibility is public access: whether the green space is open to the public, and if so how open it is to the public. Public access is not the same as public ownership, as not all publicly owned land is publicly accessible and some privately owned land is open to the public. There are also different levels of public access (as shown in Table 2).

Some green space may be only open to the public during certain hours or times of the year, or sections of the space may be off limits to the public.

Overcrowding is another factor that can limit the physical accessibility of a green space (Ioja, et al., 2008). Green space area per capita measures can be used to measure how crowded an area's green spaces are. Standards for green space area per population include 5.5ha of parkland and sports fields per 1000 people used as a target by Auckland Council (Auckland Council, 2010) and 1ha of Local Nature Reserve per 1000 people as used in the ANGSt standards. A Romanian study assessed the usefulness of green space per capita standards using the country's legal requirement that urban areas have 26m² of urban green space per person standard, however the study found that such standards when used alone were not sufficient for cities to achieve their sustainability goals (Badiu, et al., 2016).

Weldon (Weldon, Bailey, & O'Brien 2007) identified five levels of green space and woodlands access:

Table 2: Levels of Green Space Access

Level 0: Virtual Access	The user is not able to see or visit the greenspace, and is only able to access virtual reproductions of it, for example a picture, memory or video of it.
Level 1: A View	The user is able to see the greenspace, but is not necessarily able to enter it. Research has shown that views of green space still provide positive benefits to users (Kuo & Sullivan, Environment and Crime in the Inner City: does vegetation reduce crime?, 2001).
Level 2: Being In	The user is able to enter or pass through the green space. Being in the natural environment affords greater access to the 'sensory amenity' of nature.
Level 3: Active Engagement	The user is actively engaged in the green space and can affect changes on it. This can create a two way physical mental interaction between the user and nature.

Level 4: Ownership and or Management	The user has some level of responsibility over the management of the green space. This can include community management schemes and commercial activities.
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Source: Weldon et al. (2007)

Perceived access cannot be objectively measured, it is based on how accessible people feel a green space is, while people's perceptions may not necessarily reflect the reality of physical access, perceived access is important because people often make decisions based on their perceptions rather than objective measures (Cooper 2003). Perceived access is often measured using qualitative data gathered from interviews and questionnaires, as such it is more subjective than physical access. In order to gain the maximum benefit that green space can provide, it is important that green spaces are not only physically accessible, but are also perceived to be accessible by potential users. The physical distance to green spaces is only one factor of many influencing the way that people perceive green space accessibility. Perceived access is influenced by both public-based factors such as neighbourhood safety, green space quality and design, as well as individual user based factors such as ethnicity, gender, income and age (Wang, Brown, & Liu 2015). Some research has found that there is little correlation between actual and perceived walking distances to green space (Dewulf, Neutens, Van Dyck, de Bourdeaudhuij, & Van de Weghe 2012). A British study found that deprived areas tended to have better physical access to green spaces, but had worse reported perceived access, lower perceived safety and less frequent use (Jones, Hillsdon, & Coombes 2009).

Another important aspect of perceived access is the perceived safety of a green space. Much like access, safety can be measured both objectively, using statistics and models, and subjectively by measuring people's perceptions. Perceptions of safety tend to affect people's behaviours more than actual objective measures such as crime statistics (Cooper 2003). Research indicates that people are less likely to use green spaces that they feel are unsafe (Owen, Humpel, Leslie, Bauman, & Sallis 2004), and that living in close proximity to these spaces can have several negative effects on residents (Jones, Hillsdon, & Coombes 2009). One study found no association between concerns about park safety and park use (Cohen, et al. 2007), however, this study was limited to eight parks in mostly low-income neighbourhoods of Los Angeles which may have affected the results. Green spaces that are perceived to be unsafe are less likely to be used for physical activity and travel (Jones, Hillsdon, & Coombes 2009), and have a negative effect on property values (Petras, Tita, & Greenbaum 2006).

Factors influencing the perceived safety of green space include lighting, visibility, maintenance of the space and security measures (Machielse 2015). One study found that the visibility of greenery in a neighbourhood was positively correlated with perceived safety (Li, Zhang, & Li 2015). Crime Prevention Through Environmental Design (CPTED) is a widely accepted series of measures for creating actual and perceived safety in public spaces (Brisbane City Council 2000), these include implementing improved lighting, clear lines of sight, predictable routes and casual surveillance. Applying the principles and methods of CPTED has the potential to improve the perceived safety of public green spaces by reducing opportunities for crime. An American study found that neighbourhoods where green spaces were better maintained had 20% less calls to police (Braga & Bond 2008).

The Effect of Socioeconomic Deprivation on Access to Green Space

Socioeconomic deprivation is a state of observable social and economic disadvantage relative to the rest of society, measuring socioeconomic deprivation helps to measure socioeconomic position: the social and economic factors that influence the positions people hold in society (White, Gunston, Salmond, Atkinson, & Crampton 2008). Socioeconomic deprivation is linked with numerous negative outcomes including higher mortality rate, higher risk of mental illness (Ministry of Health 2013) and increased environmental hazard risk (EHINZ 2014)

Evidence varies about the link between deprivation and open space access, some studies have found that more deprived communities have poorer open space access (CABE 2010; Estabrooks, Lee, & Gyurcsik 2003), while others have found that more deprived communities have better physical green space access, but may have worse perceived access and poorer quality spaces (Giles-Corti & Donovan 2002). Many of these studies have focused on recreational facilities rather than simply green spaces, which often includes non-natural facilities such as indoor sports facilities and golf courses, which likely reduces their effectiveness at evaluating green space access. Though the evidence of a link between deprivation and open space access is mixed, it is clear that people in more deprived communities visit green spaces less frequently than people from less deprived communities. This disparity in green space use leads to inequitable access to the benefits supplied by green spaces, which in turn leads to inequalities in wellbeing.

More deprived areas are more likely to bear the costs of environmental degradation than less deprived areas (Walker, Fairburn, Smith, & Mitchell 2003), and people living in these areas are less likely to be able to relocate to greener areas or possess private green spaces such as gardens. This is an important environmental justice issue as a lack of access to nature results in a lack of access to the benefits provided by nature.

The Accessible Natural Green Space Standard (ANGSt)

ANGSt was developed out of English Nature Research Report 153 in 1996 following the recommendations of a 1993 report by the United Kingdom Man and the Biosphere Committee's Urban Forum (Harrison, Burgess, Millward, & Dawe 1995). It features a series of distance-based standards for access to green spaces that measure how accessible green space is and how it is distributed equitably across a given area. ANGSt allows governing bodies to examine the levels of natural green space provision in their jurisdiction and see where intervention is required in order to provide adequate green space for all people (Natural England 2010). ANGSt is based on three core principles: improving green space access, improving green space naturalness and improving green space connectivity. Improving the connectivity of green spaces helps to foster ecological networks which offer many advantages over disconnected green spaces. The ANGSt standards are as follows (Handley, et al. 2003, p. 15):

Every person should have access to:

- One accessible green space 2ha or larger within 300m
- One accessible green space of at least 20 hectares within 2km
- One accessible green space of at least 100 hectares within 5km
- One accessible green space of at least 500 hectares within 10km
- At least 1 hectare of local nature reserve per 1000 population.

Report 153 acknowledged that a lot of areas, especially heavily urbanised areas, will not be able to meet these standards completely, however, they considered the standard to be more of a goal to work towards rather than an absolute necessity (Harrison, Burgess, Millward, & Dawe 1995). Box and Harrison (1993), however, considered that it was vital for there to be minimum standards for accessible natural green space, as not having some form of standard would lead to the loss of natural green spaces in urban areas.

The rationale for a minimum distance to greenspace of 300m is based on the average maximum distance parents were comfortable with allowing their children to travel unaccompanied from home. Natural England saw it as important for green spaces to be in close walking distance as their goal was to have green spaces available as a part of everyday life (Land Use Consultants 2008). Using distance based measures rather than green space area per population allows for the distributional aspect of green space accessibility to be examined, this allows for areas that are deprived of green space access to be more easily identified (Harrison, Burgess, Millward, & Dawe 1995).

The range of minimum sizes is based on benefits to biodiversity as larger sites tend to have greater biodiversity and are host to larger organisms. The minimum size of two hectares was based on this being a size at which many people felt a sense of being in nature in green spaces of this size, and it also allows for natural sites that can have more than one type of habitat present (Harrison, Burgess, Millward, & Dawe 1995). Box and Harrison (1993) recommended the inclusion of a standard pertaining to provision of local nature reserves per population as they asserted that local nature reserves would act as benchmarks of quality and naturalness.

After the publication of report 153, the ANGSt standard has been implemented as a guideline rather than as a regulatory measure. Most local authorities chose to focus instead on improving the quality of green spaces, an approach that was supported by Natural England. Those areas where the standards were applied tended to fare quite poorly, with very few households achieving all of the standards and many meeting no standards. A number of local authorities requested guidance on how to implement the ANGSt standards in their area, in response to this Natural England released a guidance document for the rollout of ANGSt known as ANGSt Plus (Natural England 2010). ANGSt Plus includes guidance on assessing the naturalness, accessibility and quality of green spaces (Land Use Consultants 2008).

ANGSt is not without its limitations. The major limitations of ANGSt are a lack of focus on green space quality, not accounting for the equity issues other than distance that may prevent access, and being designed with English use in mind. ANGSt focuses on the size and distribution of green spaces, but does not account for differences in the quality level or level of naturalness of these spaces. Poor quality spaces are less likely to attract visitors and tend to provide less benefit to biodiversity. Natural England also stresses the importance of equitable access, as not all people are equally capable of accessing green spaces, for example a person who does not have access to a car is not as capable of accessing further green spaces (Harrison, Burgess, Millward, & Dawe 1995).

The ANGSt Plus guidance addressed some of the limitations of ANGSt. The guidance included some information on improving the accessibility and naturalness of green spaces and recommended the use of the pre-existing Green Flag award as a measure of green space quality. The ANGSt Plus guidelines recommend several means of improving the accessibility of existing green spaces, these include: providing amenities for youth, improving paths and signage, removal of barriers such as locked gates and using outreach programs to promote use of the space (Land Use Consultants 2008).

The primary alternative to the ANGSt model is measuring green space accessibility by the area of green space available per capita. One standard for measuring green space area per

capita is the Six Acre Standard, this is an older British Standard that requires six acres (2.43 hectares) of recreational space per 1000 people (Planning Service 2004). ANGSt does contain a similar green space per capita standard, however the standard applies only to conservation land. Green space area per capita standards fail to account for the distribution of green space, which means they are not able to identify any equity issues in the distribution of green space.

Planning Concepts and Theory

The matters discussed in this thesis relate directly to several concepts in contemporary planning theory. The major concepts that are discussed in this section are: green infrastructure, ecological connectivity, resilience and environmental justice.

Green Infrastructure

Green infrastructure is a planning concept that examines how networks of green spaces can be used to provide the services traditionally provided by built infrastructure (Foster, Lowe, & Winkelman 2011). As with green space, several different definitions of green infrastructure exist, ranging from a means of stormwater management (Environmental Protection Agency 2015) to an overarching term for all green assets that can provide environmental benefits and ecosystem services (Benedict & McMahon 2001). Green infrastructure differs from other planning approaches to conservation in that the concept implies methods of conserving natural values as a way of improving development, while other conservation approaches tend to see conservation of natural values as being opposed to development (Benedict & McMahon 2001). Gill, Handley, Ennos and Pauleit (2007) define green infrastructure as an interconnected network of green spaces that provide ecological benefits.

In practice, the green infrastructure approach is used to provide a more sustainable option for infrastructure. Green infrastructure can provide some of the functions traditionally associated with built infrastructure such as stormwater management, while also providing natural benefits such as climate regulation and soil conservation (European Commission 2013). Implementing green infrastructure can provide economic and environmental advantages over traditional built infrastructure, these include adapting to climate change (Foster, Lowe, & Winkelman 2011), reduced costs of infrastructure projects (Environmental Protection Agency 2014) and improved stormwater treatment (Environmental Protection Agency 2015). In addition to providing these benefits, several types of green infrastructure can also function as public green space and provide many of its benefits (Lovell & Taylor 2013). In recent years, green infrastructure has increasingly been used to provide stormwater management in a more cost-effective manner than through traditional grey infrastructure (Environmental Protection Agency 2015).

Until recently, green spaces were generally thought of as serving a single function, such as parks for recreation or reserves for protecting indigenous species, however, the green infrastructure approach allows planners to create multifunctional green spaces that can provide numerous benefits over single function spaces (Landscape Institute 2009). Green spaces that serve multiple purposes are a more efficient use of land, examples of multifunctional green spaces include recreational areas that also feature green stormwater management infrastructure (Water Environment Research Foundation 2009).

Ecological Integrity

Ecological integrity refers to the ability of an ecosystem to support and maintain biodiversity and ecological processes (Yonover 2015). Amongst other things, the ecological integrity of an ecosystem depends upon its ecological connectivity (Ness 2004) and resilience (Thrush, Hewitt, Lundquist, Townsend, & Lohrer 2011).

Resilience

Resilience is a relatively new concept applied to planning theory. Resilience is a concept borrowed from ecology where ecological resilience is defined as “the magnitude of the disturbance that can be absorbed before the system changes its structure.” (Holling & Gunderson 2001: 28). The resilience approach to planning stresses the inherent unpredictability and inevitability of crises, and advocates building resilience and adaptability to these crises rather than attempting to prevent them. Rather than attempting to ‘bounce back’ to a previous state after a crisis, resilience encourages adapting to the new state (Davoudi 2012). Resilience has begun to be used by many planners and policy makers possibly as a response to economic recession and pressure to reduce public spending (Shaw 2012). The resilience approach is used by planners to plan for anticipated future crises such as energy scarcity, climate change and natural disasters (Khodabkhsh, Mashayekhi, & Malekpour Asl 2015). Some academics have drawn a distinction between the more widespread and traditional engineering resilience and newer, more adaptive ecological resilience. Engineering resilience assumes that systems ‘bounce back’ to an equilibrium following a disturbance to the system, as such engineering resilience attempts to withstand a crisis for as long as it takes for the system to return to equilibrium (Fünfgeld & McEvoy 2012). An example of an engineering resilience approach is using physical structures such as levees and sea walls to prevent flooding, a socio-ecological resilience approach could be designing buildings to not be permanently damaged and to quickly return to functionality when they are inevitably flooded (Department of Communities and Local Government 2014). The resilience approach can have many benefits, reducing costs of environmental disasters, preventing loss of life and protecting cultural and historical sites (FEMA 2013).

Improving access to green spaces helps to build resilient communities in several ways, increased green space area in cities can help to reduce runoff and manage flooding (Kim, Lee, & Sung 2016), improve climate change adaptability (Gill, Handley, Ennos, & Pauleit 2007) and improve ecological understanding (Colding & Barthel 2013), all of which are forms of resilience building. Urban green spaces have also been traditionally used for food production in times of crisis, however Barthel, Parker and Ernstson (2013) argue that this resilience has been reduced in recent years due to the loss of urban green spaces and collective memory of food production techniques.

Ecological Connectivity

An ecological network, sometimes known as a green space network, is an interconnected series of (usually legally protected) natural areas that preserves the functions and systems of natural ecosystems (Lausche, et al. 2013). Ecological connectivity is the degree to which organisms and ecological processes can move through a network (Taylor, Fahrig, Henein, & Merriam 1993). Preserving ecological networks provides for much better preservation of biodiversity compared to fragmented green spaces. Biodiversity is important as it preserves the functions of ecosystems that maintain human life (Daily 1997), biodiversity creates functional redundancy, where in the event that one species is lost another species can fill a similar role (Colding & Barthel 2013). The benefits that ecological networks provide are known as ecosystem goods and ecosystem services, these include, among many others: clean air, fresh water and pollination of crops (Lausche, et al. 2013). Ecological networks allow the movement of wildlife and biological systems through a landscape, these wildlife movements keep ecosystems functioning and provide us with ecosystem services.

Lausche et al. (2013) identified three primary components of ecological networks: Patches, Corridors and Matrices.

Patch:

These are usually protected natural areas that serve as the main hubs of ecological networks. Patches are relatively homogenous areas that differ from the characteristics of the surrounding area, examples include urban forests or lakes. Cores are patches that serve the primary purpose of protecting biodiversity (Bennett 2004). Stepping stones are smaller separate patches that link cores patches by allowing wildlife to move between core patches, examples of stepping stones include patches of plants, series of small reserves and patches of woodland in farming areas.

Corridor:

Corridors are physical connections that link the individual patches together, to form a network. Examples of corridors on different scales include roadside green spaces, rivers and coastlines.

Matrix:

Matrices are the background landscapes in which patches and corridors are located. Matrices that are dominated by human activity tend to inhibit the connections between natural patches. Studies have found that the matrix plays an important part in facilitating connections in the ecological network (Baum, Haynes, Dilleuth, & Cronin 2004). Examples of matrices include the urban area with pockets of green space and agricultural land with protected areas of forest.

Mosaic:

In addition, landscape ecology also uses a fourth term 'mosaic' to describe the overall pattern of the other components that forms a landscape.

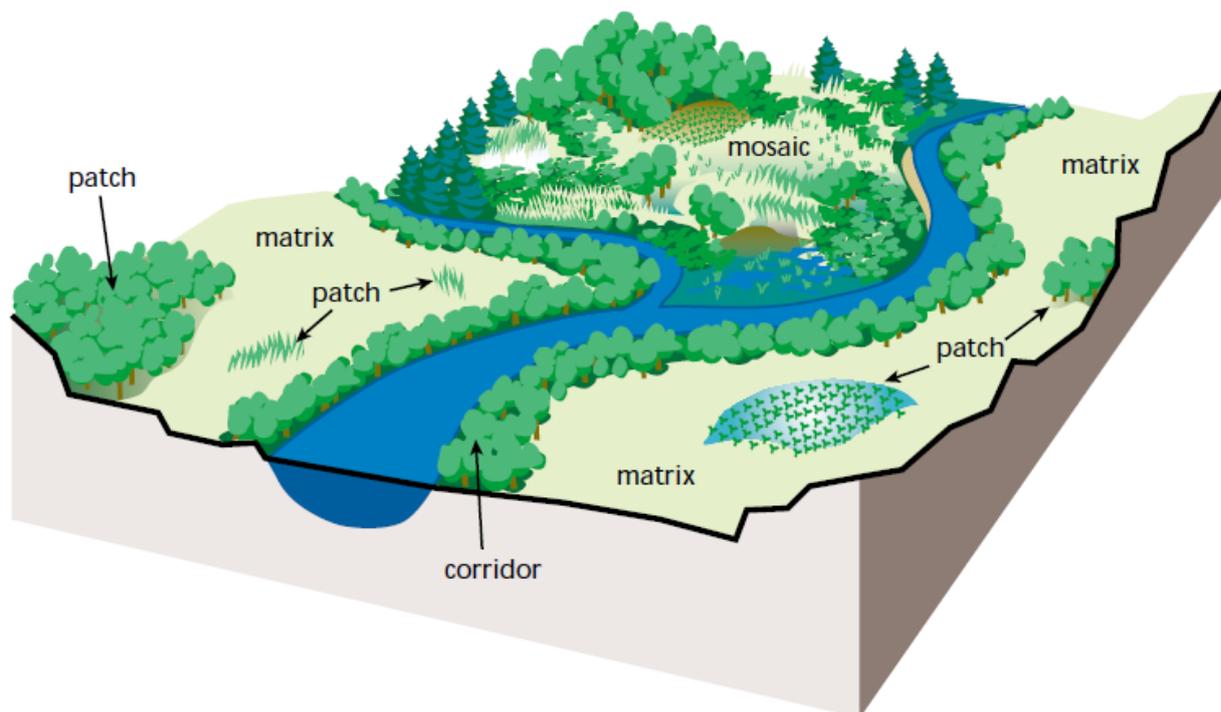


Figure 1: The Patch-Corridor-Matrix-Mosaic Model

Source: Gökyer (2013)

Human development has led to many ecological networks becoming fragmented or at risk of fragmentation. Road development, agricultural activity and urban sprawl all contribute to the fragmentation of ecological networks (Environmental Protection Agency 2012). Fragmentation

interrupts many of the ecological processes and wildlife movements that take place in these systems, this interrupts the functions of the ecosystem and reduces the benefits we receive from ecosystem goods and services (Bennett & Saunders 2010). Urban ecological networks are especially important to biodiversity, as they provide one of the only opportunities for wildlife movement and connectivity in the urban environment (Ignatieva, Stewart, & Meurk 2010).

Connectivity conservation is the preservation and restoration of ecological networks from the fragmentation that can occur due to the impacts of human development. Connectivity conservation seeks to provide matrices that allow ecological networks to flourish. Protecting ecological networks from fragmentation allows us to gain the full benefits of these networks rather than disconnected green spaces. Landscape connectivity is the movement of organisms and ecological processes through an ecological network (Taylor, Fahrig, Henein, & Merriam 1993) and higher quality connections have more movement. Actions that improve the connectivity of a landscape include preserving the existing elements of the ecological network, filling gaps in the network and restoring lost connections (Bennett & Saunders 2010). Improving the connectivity that exists in a network can improve the landscape's resilience ecological integrity of the landscape (Olds, Connolly, Pitt, & Maxwell 2011).

Environmental Justice

Environmental justice is the response to the disproportionate allocation of the impacts of environmental hazards that exists in our society (Energy Justice Network 2015). Environmental justice recognises that ethnic minorities and poorer people tend to bear the costs of environmental hazards more than others, and that all people should share equally in the benefits of the environment (Department of Environmental and Occupational Health Services 2016). Historically, certain underprivileged groups have been adversely affected by both the allocation of both negative environmental impacts, such as being closer to waste disposal sites (Cole & Foster 2001), and positive environmental benefits such as access to nature (Rigolon & Flohr 2014). There is some evidence to suggest that socioeconomically deprived communities may have less access to natural green spaces, and particularly poor access to quality spaces (Giles-Corti & Donovan 2002). This hinders the ability of the people living in these communities to gain access to the benefits provided by natural green spaces.

What Benefits Does Improved Green Space Accessibility Provide?

Increased public access to green space can provide many benefits. These benefits are social, economic, environmental and cultural. Many of the benefits of green space can be related back to the concept of ecosystem services, while there are many ecosystem services provided by nature, this review focuses primarily on those benefits that are provided directly by access to nature.

Health Benefits

There has been a great deal of research over the past two decades into the health benefits associated with green space access and physical activity in green spaces. Recent research has increasingly shown that increased access to green space can lead to major improvements in public health (Forest Research 2010). Improvements in public health also lead to a decrease in costs to the public health system.

Research has shown that there is a strong correlation between access (both measured and perceived access) to green space and increased levels of regular physical activity (Forest Research 2010; Toftager, et al. 2011), while some studies have shown that other efforts to promote physical activity such as public awareness campaigns and health education have limited effect on physical activity levels (Pate & Buchner 2014). Many studies have found a positive association between green space accessibility and 'utilitarian' physical activities (non-leisure physical activities such as cycling or walking to work) (Owen, Humpel, Leslie, Bauman, & Sallis 2004). Some studies have found that utilitarian physical activity has a greater impact on combating obesity than leisure activity (Csizmadj, Lo Siou, Friedenreich, Owen, & Robson 2011).

Regular physical activity has been shown to have numerous health benefits including: significantly decreased risk of cardiovascular disease (Lee, Sesso, & Paffenbarger 2000), some forms of cancer (Slattery, et al. 2003), obesity (Fox & Hillsdon 2007), stroke (Lee, Folsom, & Blair 2003) and type 2 diabetes (Kriska 2003) as well as improved mental health (Penedo & Dahn 2005). Church and Blair (2009) identified an increase in physical activity as one of the most effective actions for improving health, second only to quitting smoking. An American study found that overall getting the recommended minimum amount of physical activity, 75-150 minutes per week, can reduce overall mortality by 31% compared to those who reported no leisure time physical activity (Arem, et al. 2015).

A Natural England study (Rolls, Fordham, & Sunderland 2016) found that the decrease in exercise from a loss of access to natural green space in England would lead to an increase in

annual premature deaths by 374 and 2300 additional life-limiting diseases per year. This is estimated to have a cost to the public health system of £457.6 million per year (\$826.8 million NZD).

Access to green space has also been shown to have a positive impact on mental health. Access to green spaces is linked with reduced stress (Nielsen & Hansen 2007), improved cognitive ability (Berman, Jonides, & Kaplan 2008), reduced anxiety (Thompson, et al. 2012) reducing depression (Bedimo-Rung, Mowen, & Cohen 2005) and recovery from mental fatigue (Townsend & Weerasuriya 2010). Ecotherapy (also known as green therapy) is a term that refers to the therapeutic benefits that access to nature can provide for alleviating both physical and psychological health problems (Bushak 2013). As evidence of its benefits has mounted, ecotherapy has been increasingly prescribed as a means of treating various conditions (Sorgen 2013). Access to green space is associated with increased levels of physical activity, physical activity is associated with improved psychological health (Rimmele, et al. 2009), including reducing anxiety, depression aggression and improving sleep (Burdette & Whittaker 2005 in Townsend and Weerasuriya 2010).

Higher levels of green space accessibility have been shown to reduce the likelihood of many of these conditions and improving equality in green space access could reduce many of these health inequities (Forest Research 2010). Research has shown that populations with greater exposure to the natural environment have reduced health inequalities resulting from income deprivation (Mitchell & Popham 2008). Access to green spaces has also been shown to have a positive effect on early childhood physical and cognitive development, which is linked with higher educational achievement (Dadvand, et al. 2015).

Environmental Benefits of Green Space Access

Green space provides many environmental benefits, including improved aesthetic values, sustainable stormwater management and mitigating air and heat pollution in urban areas. The environmental benefits of green space do not always require the higher levels of green space access described by Weldon et. al. (2007), many of them can be gained simply from living and working near to green spaces.

Neighbourhoods with a greater proliferation of natural features, such as green spaces, are often considered more aesthetically pleasing than neighbourhoods dominated by the built environment, this is often reflected in higher property values in these neighbourhoods (Cho, Bowker, & Park 2006). Neighbourhoods that are considered more aesthetically pleasing can

inspire a sense of pride or community ownership of the neighbourhood, which can lead to reduced crime, and improved quality of life (American Planning Association 2016).

Green spaces play a role in alleviating flood risk as green spaces are generally permeable surfaces which allow stormwater to infiltrate through the soil (Forest Research 2015). Increasing amounts of impermeable surface is considered one of the major contributors to flooding in urban areas (New Hampshire Estuaries Project 2007). The increase in impermeable surfaces in urban areas has been driven by several factors, urban sprawl, intensification of urban areas (Herald 2003) and increasing car use which has led to more roads and paved driveways (Frazer 2005). The traditional approach to flood protection has been to use grey infrastructure such as flood barriers and drainage systems to contain flood waters, however increased flooding frequency and severity, due to urban expansion into floodplains (Konrad 2003), climate change (Milly, Wetherald, Dunne, & Delworth 2002), and increasing impermeable surface area, has strained traditional engineered stormwater infrastructure and forced planners to explore new flood management strategies (US Geological Survey 2016). As a result, urban planners have increasingly explored using green infrastructure and green space to manage flooding (Gedge 2015). Provision of public green space is one of the best ways to increase permeable surfaces in urban areas. Increased impermeable surface area also causes an increase in stormwater runoff into waterways, which has a major negative impact on water quality (Environmental Protection Agency 2014).

Natural green spaces can also have a major positive impact on urban air quality. Studies have shown that vegetation can remove significant amounts of dust, soil and other particulate matter from the air (Sæbø, et al. 2012). Particulate matter below 10 microns in diameter (PM₁₀) is associated with several major health problems including asthma and cardiovascular disease (Brooks 2008). The vegetation in green spaces also absorbs various pollutants such as nitrogen oxide, ozone (Grundström & Pleijel 2014), heavy metals (Kocić, Spasić, & Urošević 2014) and greenhouse gases such as Carbon Dioxide (Sinnott, Smith, & Burgess 2015). A systematic review of the effects of green space on urban air quality found that all types of green spaces had a positive impact on air quality (Zupancic, Westmacott, & Bulthuis 2015). These improvements in air quality can have run-on positive effects on public health as poor air quality is linked with higher likelihood of developing respiratory illness, premature mortality, and several other health problems (Shah & Balkhair 2011). The health risks of poor air quality are especially high amongst infants (Landrigan, et al. 1998) and people in socioeconomically deprived communities (Zupancic, Westmacott, & Bulthuis 2015).

Urban areas are usually one to three degrees warmer than rural areas, this is due to what is known as the urban heat island effect (Environmental Protection Agency 2016). The urban

heat island effect is primarily caused by modified land (such as concrete and asphalt) in heavily urbanised areas absorbing more heat than the more vegetated rural areas (Lo & Quattroch 2003) and also by the heat energy produced by urban activities such as vehicle movements and industrial activity (Rizwan, Dennis, & Liu 2008). The rises in temperature from the urban heat island effect can lead to increased energy consumption and can adversely affect human health and water quality (Environmental Protection Agency 2016). Urban parks also help to mitigate the urban heat island effect on the surrounding area, studies have found that parks could help to cool the area up to 224m away from the park, although the magnitude of the cooling effect depended on park size, density of vegetation cover and park shape (Cao, Onishi, Chen, & Imura 2010; Feyisa, Dons, & Meliby 2014).

The environmental benefits of green spaces tend to rely on access to green spaces, but not necessarily direct access. Green spaces can provide benefits such as climate control and improved air quality to nearby areas. This indicates that measuring the distance of these spaces to the places where people live could measure the access that people have to these benefits.

Social Benefits of Green Space Access

From a social perspective, improved access to quality green spaces can have positive effects on the development of communities, improving social cohesion and helping to create safer communities.

Research has suggested that there is a positive correlation between provision of neighbourhood amenities such as parks and positive interactions between community residents (Cohen, Inagami, & Brian 2008). This research found that access to high quality green spaces had a positive effect on collective efficacy. Collective efficacy is a measure of social capital, it is the social cohesion between members of a community that allows them to create a safer, more desirable environment together (Sampson, Raudenbush, & Earls 1997). Greater collective efficacy has numerous benefits for a community, it is associated with reduced crime, and improved health outcomes such as lower rates of asthma and premature mortality (Cohen, Inagami, & Brian 2008). However, proximity to low quality green spaces such as parks that are perceived to be associated with gang activity and crime can have a negative impact on collective efficacy.

Social exclusion is the process of denial of access to resources, rights and the ability to participate in the activities and relationships available to the majority of people (Mack 2016). Certain groups are more likely to be socially excluded, these include ethnic minorities, people with disabilities, the elderly and people on low incomes, social exclusion is linked with higher incidence of mental illness and higher unemployment (Shaw, Dorling, & Davey Smith 2006).

Green spaces have been shown to be effective at reducing this social exclusion (Forest Research 2010). Community gardens have been shown to be useful in fostering relationships between community residents, especially amongst people from different cultural backgrounds (Colding & Barthel 2013).

Greener neighbourhoods can also help to build a sense of community ownership and engagement with the environment (American Planning Association 2016). This increase in social capital has numerous benefits for a community including reduced crime, and improved educational attainment (Claridge 2004).

Some studies have linked neighbourhoods with higher levels of vegetation with lower crime rates and higher perceived safety (Kuo & Sullivan 2001). However Michael, Hull, & Zahm (1999) found that dense vegetation plays a role in facilitating crime, although its presence is not necessary for crime to occur, but merely reduces criminal effort. Kuo and Sullivan (2001) argued that vegetation could potentially reduce crime in two ways, firstly the increase in passive surveillance from additional visitors that vegetated areas provide leads to a decrease in crime and second by reducing the mental fatigue of residents which has been linked to violence and criminal behaviour. A systematic review of evidence of a link between green space proliferation and crime by Bogar and Beyer (2015) concluded that further research was needed in order to better understand these links.

Economic Benefits of Green Space Access

Access to green space can also provide economic benefits, these include increased property values, worker productivity, and attracting visitors to local businesses. However, compared to other aspects of green space research, researchers have only recently begun to investigate the economic benefits of green space accessibility. Dravigne et. al. (2008) identified a substantial research gap that exists due to the lack of research into the economic benefits provided by green spaces.

Provision of green space can improve property values as land adjacent to green space is usually considered more desirable due to its aesthetic qualities, opportunities for recreation and environmental benefits (Catrakilis 2015). Several non-market pricing evaluations have found evidence of this relationship. An analysis of the effect that proximity to green space has on property values found that proximity to green space had a positive impact on property values and that values were further increased by proximity to water bodies (Cho, Bowker, & Park 2006). A meta-analysis of hedonic pricing and contingent valuation studies showed that most of the studies examined found a link between green space proximity and increased

property values (Dravigne, Waliczek, Lineberger, & Zajicek 2008). However, one study found that the overall effect on house values was ambiguous, though proximity of green space was more likely to have a positive impact on the property values of mid and high value properties (Liu & Hite 2013). Increased property values can encourage further property development in an area (Saraev 2012). Increased property values represent one form of people's willingness to pay for the benefits of green space (Crompton 2001).

The effects of green space on overall economic vitality are more ambiguous, and further study is needed in this area. Saraev (2012) found evidence that provision of green space lead to increases in business occupancy, private investments and business start-ups. Some literature, particularly grey literature, suggests that green space has the ability to attract inwards investment (Project EverGreen 2013), however, this does not appear to be based on empirical research and further investigation is required in order to determine the actual impact, if any, green space has on these values (Bell, et al. 2008). Saraev (2012) found limited evidence of an association between the provision of green space and the creation of new jobs.

Several studies have examined the benefits of green space for businesses. One study found that workers who had views and access to green spaces exhibited higher productivity (Barton & Pineo 2009) and greater self-reported job satisfaction (Dravigne, Waliczek, Lineberger, & Zajicek 2008). Green spaces can also generate tourism, which has benefits for the surrounding area (Saraev 2012), but their ability to attract tourism is dependent on their quality and accessibility (Cianga & Popescu 2013). Benefits of increased tourism include increased spending at nearby businesses and improved neighbourhood safety.

There are few estimates of the economic benefits of green infrastructure systems such as flood management and stormwater management, and those that there are tend to offer little definitive evidence for these benefits (Saraev 2012). This is something that requires further study to prove conclusively.

Benefits Summary

There is a significant amount of evidence of the benefits that access to green spaces can provide present in both grey literature and academic research. Specifically, there is evidence of considerable health, economic, environmental and social benefits from green space access. Accessing some of the benefits of green spaces does not necessarily require the use of green spaces, however evidence seems to suggest that more benefits are accrued with higher levels of access. The evidence also seems to point to the interconnected nature of these benefits, environmental benefits can also provide social economic benefits and vice versa. The various

benefits of access to green space can lead to improvements in quality of life both directly and indirectly (Mensah, Andres, Perera, & Roji 2016). One study found that self-reported life satisfaction was, on average, higher among people who lived in green areas (White, Alcock, Wheeler, & Depledge 2013). Overcrowding is an issue that can reduce the benefits provided by green spaces (Iloja, et al. 2008). It is also clear that the benefits of green space tend to accrue to those with more access to green space and higher quality of green space. This presents a potential equity issue for communities and groups that have less access to green spaces. If planners can improve access to green space, they will be able to provide greater access to the benefits that green spaces provide.

While there is a growing body of evidence for the benefits of green space access, there are still many gaps in the existing research. Although it is clear that green space access does provide a range of benefits, the ecological systems that allow spaces to provide these benefits are not always well understood. Further study is also needed in order to better understand the potential economic benefits provided by green space access. While there is a great deal of reference to the economic benefits of green spaces in grey literature, systematic reviews of academic literature have proved inconclusive. As further research is carried out into the benefits of green space access, it is likely many more benefits of green space access will be discovered that are not yet understood.

Green Space Access in New Zealand

In New Zealand, there has been relatively little research on green space access. As such, the accessibility of New Zealand green space is not well understood and more research is needed. One study found that the average New Zealand census area unit consisted of 19% useable green space by area, useable green space was defined as green space within 10m of a road (Richardson, Pearce, Mitchell, Day, & Kingham 2010).

Local level plans and policies around green space are relatively scarce, one of the few specific green space plans in the Waikato region is the Hamilton Open Space Plan. The Hamilton Open Space Plan governs vegetated spaces such as parks, gullies and reserves as well as built spaces such as streets and civic spaces (Hamilton City Council 2013). The Hamilton Plan is the city council's vision for the future of Hamilton city covering 2015-2025. The Hamilton Plan identifies increasing the proportion of green spaces in the city as a necessary step of achieving the council's vision of a green city. Other relevant plans include the reserve management plans produced by territorial authorities under the Reserves Act 1977, these provide guidance on the day to day management of individual reserves. Reserve management plans contain objectives and policies for reserves, which often include plans for future

developments to improve the quality of the reserves. The New Zealand Recreational Association (NZRA) set out guidelines for parks and open spaces, these include how to categorise parks and open spaces and levels of service for each category (New Zealand Recreation Association n.d.). Outside of the NZRA guidelines there is little national-level policy guidance, while at the local level, green space related policy is typically restricted to reserve management plans and some sections of district plans. District plans often contain policies and guidelines for acquisition of new land for reserves.

Green Space Accessibility

Publicly Accessible Land in New Zealand

Public accessibility is an important part of green space accessibility. Ensuring that the public can legally access green spaces is important as having green spaces within close proximity is meaningless if the public cannot legally access them. Publicly accessible land is usually protected by some form of legislation. Nearly a third of all New Zealand land is publicly owned and under protection in some way (Molloy 2012). New Zealand's protected areas are governed under six key statutes (Molloy, 2016):

- Reserves Act 1977
- Conservation Act 1987
- National Parks Act 1980
- Wildlife Act 1953
- Marine Reserves Act 1971
- Marine Mammals Protection Act 1979

In New Zealand publicly accessible land takes several forms, Walking Access New Zealand (WANZ) has identified the following categories:

- **Foreshore**

Most of New Zealand's foreshore is publicly owned and accessible under the Marine and Coastal Area Act 2011, although some is privately owned.

- **Marginal Strips**

These are strips of land adjoining the coast, rivers over 3m in width or lakes over 8ha in area, they are created when land alongside these water bodies is sold by the crown. Marginal strips are administered by the DoC.

- **Esplanade Reserves, Esplanade Strips and Access Strips**

These are forms of esplanade areas provided for under the Resource Management Act 1991 (RMA). These differ based on how they are created under law, the nature of their boundaries and the systems of ownership. Esplanade reserves are parcels of land 20m or less in width adjoining water bodies that are usually created by the subdivision of land under RMA s 232. They are administered by territorial authorities.

Esplanade strips serve the same purpose as esplanade reserves, but have boundaries that move with the movement of water margins. Esplanade strips remain in the ownership of the landowner. Esplanade strips are created under s233 of the RMA.

Access Strips are created through agreement between the territorial authority and the landowner under s 237B of the RMA, they remain in the ownership of the landowner.

- **Public Reserves and Other Crown Land**

Public reserves are publicly owned areas that have been made for recreational, historical, scenic, scientific and natural purposes, commonly created under the Reserves Act 1977

In New Zealand, there are nine categories of reserves created under the Reserves Act 1977 national reserves, recreational reserves, historic reserves, scenic reserves, nature reserves, scientific reserves, government purpose reserves, local purpose reserves, and wilderness areas. These areas exist in order to protect water quality, soil quality, biodiversity, historic resources and to provide recreational opportunities (Conservation Act 1987; Molloy 2012). The different categories of reserves all serve different purposes, have different rights of access, differ in scale and are managed by different government bodies. The extent of public access to these reserves depends upon the reason for which the reserve was created and any management plan created for the reserve.

Public access to crown owned land is dependent on the use of the land, for example prisons are not generally accessible by the public. In order to be publicly accessible, crown land must be explicitly designated as such. This category of publicly accessible land includes forms of crown land other than marginal strips and conservation land that can be reasonably expected to be publicly accessible.

- **Walkways**

Statutory walkways are governed by the Walking Access Act 2008, they may cross over public or private land and are created by government agreement with the landowner.

- **Conservation Land**

This includes national parks, forest parks and several other land types. These are commonly accessible to the public. Section 17 of Conservation Act 1987 states that access to conservation areas by the public shall be free. The Conservation Act 1987 was created to promote the conservation of New Zealand's natural and historic resources. The act created the DoC and governs the various categories of conservation land in New Zealand. Conservation land is administered by the DoC and comprises national parks, conservation parks, regional parks and forest parks. Conservation areas can typically be expected to be open to the public.

Other forms of publicly accessible land include roads and unformed legal roads (paper roads) (New Zealand Walking Access Commission, 2010), however, these do not generally meet the criteria for naturalness to be considered green space.

Deprivation and Green Space in New Zealand

The New Zealand Deprivation Index (NZDep) is an index of socioeconomic deprivation that uses census data to provide a decile score for each meshblock (the smallest unit of census area, representing around 100 people). NZDep is based on 10 indicators: income, communication, employment, qualification, home ownership, support, living space and transport access. In 2006, the Waikato region scored a weighted average of 6 on the NZDep index, indicating that the region is, on average, slightly below the national median (5) for deprivation (Waikato Regional Council n.d.). Basing the measure on these indicators gives a more accurate view of deprivation than solely using household income as these indicators can define a person's opportunities both socially and economically.

Few New Zealand studies have examined the relationship between deprivation and access to community resources, and only one could be found that examined it in relationship to green spaces specifically. A national study found that rural areas of New Zealand generally had poorer access to parks and beaches than urban areas (Pearce, Witten, Hiscock, & Blakely 2008). A New Zealand based study of access to open space (in this study open space was limited to parks and beaches) found that more deprived communities tended to have better physical access to open space than less deprived communities, although it was noted that this relationship was not consistent in rural areas, this study also failed to account for green space size and quality (Witten, Hiscock, Pearce, & Blakely 2008). A similar study of access to community resources in two New Zealand cities, found that more deprived communities tended to have better physical access to these resources (Field, Witten, Robinson, & Pledger, 2004).

The Benefits of Green Space Access

Improving access to green spaces would provide New Zealanders with improved access to the benefits provided by green spaces. Even benefits that do not require direct access to a green space such as improved air quality and climate control depend on other levels of access such as living near to a green space.

Despite the evidence for the benefits of exercise, only 51.4% of New Zealand adults are physically active and 29.9% of adults and 10.1% of children are obese (Ministry of Health 2014). This is higher than the worldwide average adult obesity rate of 13% (World Health Organization 2015) or the OECD average of 18% (OECD 2014). In 2006, low physical activity accounted for 4% of all illness, injury, disability and mortality in the country (Ministry of Health 2013).

Improved access to green space also has the potential to reduce New Zealand's existing health inequalities. The New Zealand Medical Association (2011) identified a range of health inequities that exist for various underprivileged groups, these include inequities based on ethnicity, income and education level. According to the report, large gaps exist in mortality rates between Māori and non-Māori and between low income and high income groups. Deprived, lower income, Māori and Pacific people are also more likely to suffer from a range of chronic conditions including diabetes, obesity and several mental health conditions (Ministry of Health 2014). Adults living in socioeconomically deprived areas also have higher levels of all major health risks.

Around two thirds of New Zealand's population live in areas that are naturally flood-prone (McSaveney 2012) meaning that access to the potential reduction in flooding provided by green spaces is especially important.

It is important to note that there is a distinct lack of New Zealand based research on the benefits of green spaces, however, given that most studies of green space have been undertaken in developed countries similar to New Zealand, and the findings tend to be consistent across multiple countries, the findings of these studies should still be applicable to a New Zealand context.

Conclusion

Overall the majority of literature supports the value of green space access. There has been a great deal of research done into green space access and the benefits that can be derived from it, however, it is clear that there are still major gaps in the research. Many of the benefits of green spaces are not well understood, and there are likely many more important life-

supporting functions of green spaces that we do not yet understand. There is also a lack of research into rural green spaces, despite many studies finding that people living in rural areas generally have worse access to public green spaces. There have also been few studies that examined access to green space and accounted for green space size and quality.

The benefits of green spaces derive from ecological processes that take place in nature, these benefits are also known as ecosystem services. The ability of natural systems to deliver these benefits depends on the ability of the ecosystem to sustain itself, ecosystems depend upon biodiversity and connectivity in order to sustain themselves. The benefits of green spaces are dependent upon their accessibility, and it is clear that access to the benefits of nature is not equitable. Environmental justice requires that all people have equitable access to the benefits of nature and that the costs of environmental degradation are distributed equally. Accessibility is the ability of green spaces and the benefits they provide to be accessed by the public. Accessibility depends upon many factors including, physical distance, perceived safety, socioeconomic standing and legal barriers to access such as opening hours. Addressing the inequalities that exist in access to green space is a matter of environmental justice. Further research is needed into how factors other than physical distance impact the accessibility of green spaces.

In summary, access to green spaces provides people with access to the ecosystem services that sustain and improve life. Removing barriers and inequalities in green space accessibility is an important priority of environmental justice. The majority of studies of accessibility have found that most areas do not meet recommended standards for access to green spaces. It is clear that improving access to green space would have many benefits for many people. This study will help to fill in some of the existing gaps in the literature surrounding green space accessibility and its link to socioeconomic deprivation. Understanding the causes of access inequalities could help planners and policymakers to provide equitable access to the benefits of nature for all.

Methodology

This chapter describes the methodology used to analyse features of green space in the Waikato region and the planning and policy implications of green space accessibility. The methodology primarily consisted of three methods: examining the overall quantity of green space available in the region, assessing accessibility using a modified ANGSt model and GIS, and finally examining the planning and policy implications of green space accessibility. A combination of qualitative and quantitative data was gathered. Specifically the research aimed to answer the following questions:

- How much green space is available in the Waikato region and how accessible are these spaces?

In order to answer this the region's green space was quantified using GIS software and the ANGSt model was applied to the region show the physical accessibility of green spaces for Waikato residents.

- What effect does socioeconomic deprivation have on access to green spaces and the benefits of nature in the Waikato region?

In order to account for the effect of socioeconomic deprivation on accessibility, the results of the green space quantification and the ANGSt analysis were compared with New Zealand Deprivation Index (NZDep) data.

- What are the planning and policy implications of this research?

Exploring the planning and policy implications of the research findings involved discussion of the findings with key informants such as planners and other council staff.

Study Area

The study area chosen for this research was the Waikato region. This area was chosen as it has a diverse range of settlements and landscapes, a mixture of urban and rural populations, and a mixture of more and less socioeconomically deprived areas. The region contains of eight constituent territorial authorities: Hamilton, Hauraki, Matamata-Piako, Otorohanga, South Waikato, Thames-Coromandel, Waikato and Waipa and parts of three other territories: Rotorua, Taupo and Waitomo. The results for the Rotorua, Taupo and Waitomo districts cover only the areas of these districts that fall within the Waikato region, as such they do not reflect a fully accurate picture of green space accessibility in those districts.

Quantifying Green Space

The first step of the method was to quantify the region's green space using geographic information system (GIS) software. GIS allows for the visualization and analysis of geographic data on a map (GIS Geography, 2016). GIS software can be used to analyse spatial data in order to find spatial patterns and relationships. The quantification approach described above required undertaking a stocktake of the total amount of green space available in the region. Understanding the available green space not only gave a basic overview of how much green space Waikato residents have access to, but also showed the spaces that may not be accessible or may currently fail to meet the requirements of the ANGSt standards for size or naturalness. Having this data also showed the spaces which could potentially be brought into the region's green space network in the future. Examining the total amount of green space area available in the region and the amount being spent on green space was a relatively simple method that gave an overall picture of green space proliferation within the region. This was then be compared with the results of other ANGSt analysis undertaken in England in order to give a simple indicator that showed how green space in the Waikato compares to these regions.

Collecting this information gave a broad overview of green space accessibility, showing the total amount of green space for the region, and how many people share these spaces. This information was also used in place of the ANGSt standard for local nature reserves per 1000 population, as this standard is not applicable to New Zealand. While green space per capita measures do not account for the distributional aspect of green space accessibility, they do show the amount of green space that is shared between people. This is especially important as increasing urbanisation and population growth put increasing strain on existing green spaces as they serve more and more people while increasing densification of cities causes a loss of privately owned green spaces. Using a combination of a green space per capita measurement and a distance to green space measurement gave a more complete picture of green space accessibility than the ANGSt analysis alone. Comparing green space per capita with NZDep scores also gave a basic overview of the relationship between green space accessibility and socioeconomic deprivation. Overcrowded green spaces are not able to provide the same level of benefits as having adequate green space per capita.

This analysis used green space data provided by the Walking Access Commission New Zealand and meshblock level data collected in the 2013 Census.

First, the total area of green space in the Waikato region was calculated. In order to do this the green space data from WANZ was limited to only those spaces that met the definition for accessible green space. The WANZ data included four categories of publicly accessible land:

conservation areas, public reserves, roads and marginal strips; of these, only conservation areas and public reserves meet the criteria of size, naturalness and accessibility to be considered accessible green spaces. Once the total area of accessible green space had been calculated, it could be compared against census population data in order to give the average amount of green space available per capita. Individual green space per capita calculations were also performed for each district within the Waikato region so that comparisons could be made between districts.

Method

The method for calculating green space per capita was as follows:

In order to focus the analysis on the Waikato region, the green space and meshblock datasets had to be limited to the regional boundaries using the clip function of ArcGIS 10.5 (ESRI, 2016). This was completed using regional boundary data acquired from Statistics New Zealand. Clips were also created for the boundaries of the individual districts that make up the region so that comparisons could be made between them.

The total amounts of conservation land and public reserve land within the clipped area were calculated and the sum of these figures gave the total green space area for the region. Green space per capita was calculated by dividing the total green space area by the Waikato region's usually resident population (URP). Usually resident population is the census count of all the people who usually live in a given area and were present in New Zealand on census night (Statistics New Zealand n.d.). The percentage of the area that is green space was calculated by dividing the total land area of a region by the total green space area of that region.

Further analyses were then run on each of the individual districts that make up the Waikato region by clipping to the boundaries of each district and repeating the same method. The results of these analyses allowed comparisons to be made between different districts. The average NZDep score of the meshblocks in a district was compared with the amount of green space available per person using regression analysis in order to give an approximate view of the relationship between the quantity of green space available and socioeconomic deprivation. A bivariate linear regression was performed using the regression function of Microsoft Excel. This regression used the green space area per capita for each district as the dependent variable and the mean district NZDep score as the independent variable. The R^2 value of this regression indicates the strength and direction of the correlation between the two variables, a higher value indicates a stronger correlation.

The number of green spaces with areas of less than two hectares was also calculated in order to determine the amount of green space that was not being assessed by the ANGSt analysis.

Limitations

This quantification of green space is designed to give a simplified overview and, as such it has several limitations. However, the effect of these limitations is reduced when used alongside the ANGSt analysis. While the green space area per population method does not show the distribution of green space across the region, when used in conjunction with the distance based methods used in the ANGSt model, a more complete picture of green space is shown. Comparing NZDep scores against green space per population is unlikely to give a direct correlation between socioeconomic deprivation and green space accessibility, however, this is only intended to supplement the ANGSt analysis and socioeconomic deprivation.

Access to Green Space

In order to measure the accessibility of green space, a GIS based method was used, using a version of the British ANGSt model that was slightly modified to work with New Zealand data. The GIS analysis primarily used existing data from several sources. This accessibility data was then compared with the NZDep index of socioeconomic deprivation in order to examine the relationship between socioeconomic deprivation and green space accessibility.

The ANGSt standard is a British green space accessibility standard based on distance between green spaces and homes for a range of different sized green spaces.

Applying the ANGSt Model

Applying the ANGSt model to the Waikato region involved analysing the distances between different sized green spaces and the places where people live. This analysis shows how many of the region's households meet the different ANGSt standards.

Due to the differences between England and New Zealand, the method recommended by the ANGSt Plus guidelines needed to be modified before it could be applied in a New Zealand context. In England, the ANGSt Plus guidelines recommend using GIS software to create catchment areas around each green space and count the postcodes within each catchment area. Postcode data contains a residential address count which can be used to get the number of households with access to that green space. The guidelines then recommend multiplying the number of households by the average number of residents per household (from census data). This would give the population which meets that standard. Due to differences in the nature of the data available, some modifications were made to this method. This analysis used census meshblock data and WANZ green space data to identify which meshblocks had access to green spaces. For a given ANGSt standard, any meshblock that fell within the criteria distance of a green space of the criteria size was considered to meet that standard. For

example if a meshblock was within 300 metres of a green space with an area of two hectares or more it meets that standard.

As with the quantification of green space, the ANGSt analysis used conservation land and public reserve land as green spaces. Some spaces such as esplanade reserves and marginal strips, although publicly accessible by law, are often out of the way and are usually too small to meet the minimum 2ha standard. Privately owned green spaces and public spaces lacking a natural characteristic (such as town squares) were excluded as they did not meet the criteria for accessibility and naturalness. Due to the difficulty of determining the accessibility and naturalness of individual parcels of other crown land these were excluded from the analysis. The areas included were all accessible by foot and predominated by a natural characteristic.

The data for this GIS analysis was gathered from several sources, this study used only existing data sources. The green space data was provided by the New Zealand Walking Access Commission (Walking Access New Zealand, 2016), this data is continuously updated based on the latest Topo50 maps from Land Information New Zealand (LINZ). Topo50 maps have a stated margin of error of +/- 22m, although in some areas this is +/- 6m due to advances in technology. The meshblock data including population and deprivation data came from the 2013 census, this data is publicly available. All of the data used in this study is available at a national scale, making it possible to use these methods for further study in other regions or for the entire country.

These data sources were chosen for the modified ANGSt analysis as they were readily available and would give the most accurate possible results. The walking access data was used as it showed clearly the public accessibility status of each piece of land with polygon data. Using polygon data rather than point data accounted for the area of green spaces, which gave a more accurate view of accessibility than using point based data would have. Using the NZDep data gave a more accurate measure of socioeconomic deprivation than using other single indicator data such as household income alone would have. The data sources used for this analysis were easy to access and use and gave more accurate results than using other data would have.

ANGSt is a distance based standard for measuring green space accessibility, the major alternative method to distance based standards for green space accessibility is to measure green space area per population. However, this method does not account for the distribution of green space and can lead to green spaces that are not easily accessible by many people (Natural England, 2010, p. 23).

As local nature reserve is a specific form of legally designated protected area specific to the United Kingdom, the final standard requiring one hectare of local nature reserve per 1000

population was left out of this analysis. The analysis of green space area per population in the previous section took its place in this study.

The process of applying the ANGSt model to the Waikato region first required that green spaces be identified. The New Zealand Walking Access Commission had already undertaken work to map New Zealand's publicly accessible land and this data was used to identify green spaces.

Method

In order to find which meshblocks meet each ANGSt criteria the following method was followed:

Green space and meshblock shapefiles were clipped to the boundaries of the Waikato region and to the territorial boundaries within the region. A spatial query was then run on the clipped green space shapefile to identify spaces greater than or equal to two hectares in area. The shapefiles for conservation land and public reserve land were merged to create an overall 'green spaces over two hectares' shape file.

Applying the distance criteria involved running a second spatial query to find all meshblocks in the region that are located within 300 metres of a green space with an area of two hectares or more.

The meshblock data contains the census data for the usually resident population (URP) of each meshblock, the URP of all of the meshblocks with access gave the total population in the area who meet that standard. Dividing the region's population by the number of people who meet the standard gave the percentage of the population that meet the standard. Data was also gathered on the average NZDep scores of the meshblocks which meet, or do not meet, the standard.

This process was repeated for each of the different ANGSt area/distance standards (20ha space within 2km, 100ha space within 5km, and 500ha space within 10km) and to show the percentage of meshblocks that meet none of the standards or all of the standards. The full process was then repeated for each territorial authority to allow comparisons to be made between districts. The method was also repeated using public reserve data only in order to assess access to public reserve land.

This method was as close as possible to the ANGSt Plus recommended method as could be achieved with the data available, the results it produced should be as accurate as the results achieved using the British method.

Having run the ANGSt analysis on accessibility, the next step was to introduce the socioeconomic deprivation data in order to establish the nature of the relationship between socioeconomic deprivation and green space accessibility. This was achieved by comparing the results of the ANGSt analysis with NZDep deprivation scores.

The NZDep measures socioeconomic deprivation based on 10 factors, this data is based on 2013 census information. It classifies meshblocks into decile scores 1-10 (a score of 1 means that a meshblock is in the most deprived 10% of all meshblocks, a score of 10 means it is in the least deprived 10%). Comparing the green space accessibility data with the NZDep index shows how socioeconomic deprivation affects the distribution of green spaces. Determining what relationship exists between a meshblock's NZDep score and whether it meets the ANGSt standards could show if a relationship exists between deprivation and accessibility.

In order to compare the NZDep data with the ANGSt results, the average NZDep score of meshblocks which met or do not meet each ANGSt standard was calculated, in addition to the average scores of those meshblocks which meet all standards or meet no standards. This data can be compared to see if any significant pattern emerges.

A spatial query was run to identify which meshblocks met or did not meet each standard and had an NZDep score of 7 or greater (high socioeconomic deprivation) or of 3 or less (low socioeconomic deprivation). This meant that the ANGSt results of meshblocks with high (or low) socioeconomic deprivation could be examined. Analysing this data shows whether meshblocks with high deprivation are more or less likely to meet the ANGSt standards.

The key results of the ANGSt analysis were also compared against the results of the ANGSt analyses carried out in four English counties (Essex, Herefordshire, Norfolk and Suffolk), while counties are more analogous to districts, comparing these results helps to give an international context to the findings.

Limitations

This method was limited by several factors. Using a straight line based measure of distance failed to account for the actual routes people take to reach green spaces, which are likely to be further than the straight line distance. This could have been remedied by running a network analysis of the road network, however, the ANGSt guidelines recommend using straight line distance and all previous studies have used this method. One reason given for using this approach is that it is considered the simplest means of measuring access. The distances used in the ANGSt model were chosen to reflect the fact that actual travel distances are likely to be longer than straight line distances (Handley, et al., 2003). Additionally, using meshblock data was necessary in order to compare access with NZDep data which is meshblock based. The

method failed to account for the differences in individual ability to travel to green spaces. Factors such as disability and access to a car can greatly affect people's ability to travel long distances to access green space. There may be some inaccuracy in the green spaces identified, as identifying the accessibility and naturalness of these spaces would have required that site visits be undertaken, which was not possible due to time limitations. The ANGSt method also fails to account for the potential benefits of access to green spaces under 2 hectares in area, however the literature surrounding ANGSt suggests that sites over 2 hectares generally provide greater benefits than smaller areas, the previous quantification of green spaces per capita, however, did include these smaller spaces.

The modifications made to the ANGSt model were minor, and as such, are unlikely to have decreased its accuracy. Overall, the limitations of this method were able to be sufficiently mitigated in order to produce a negligible effect on the accuracy of the results.

The ANGSt analysis also failed to account for the population pressure exerted on green spaces, as a small number of spaces could make a densely populated area meet the ANGSt standards for accessibility, but the spaces may become overcrowded. Combining the ANGSt analysis with the quantification of green space per capita helped to avoid this issue.

An alternate method for applying the ANGSt model would have been to carry out a network analysis on the actual travel distance from individual addresses to green spaces, while this would have given a more accurate measure of travel distance, it would not have been possible to compare this data with NZDep data as NZDep data is meshblock based. The ANGSt guidelines recommend using straight line distances, and changing this method would have required examining the effects that changing the method would have on the results and would have made comparisons with previous ANGSt studies difficult. This also would have included non-residential addresses, which would have diluted the accuracy of the analysis.

Directly comparing ANGSt results with English figures fails to account for geographic, cultural and historical differences between the two countries, and as such cannot be used to objectively state that one location has achieved better access than another. However, recognising similarities or differences in the results can provide a general idea of how accessible the region's green space is and can help to determine whether the ANGSt method is suitable for New Zealand use. As England is the only country to have previously carried out any ANGSt analysis, this data is the only international data available.

Planning and Policy

With many challenges on the horizon for the Waikato region, it is important to understand how planning and policymaking can address green space accessibility issues. The Waikato region's population is expected to increase from 416,200 in 2012 to 469,910 by 2031, an increase of 13.8% (Jackson 2013). This increase in population will put further strain on all infrastructure including the region's green spaces. The Waikato region has an older population than the New Zealand average and the population is ageing faster than the average. Other challenges include an increasingly urbanised population and the expansion of urban areas into greenfield land. The findings of the GIS work were used as the basis for an analysis of the planning and policy implications of the work. In order to understand these implications, semi-structured interviews were undertaken with key informants. These interviews introduced a qualitative element to the data collected.

Semi-structured interviews follow a set of predetermined topics, but use open-ended questions and allow participants to discuss topics that are not included in the interview schedule. This method was chosen as it allowed participants to deviate from the specified questions while still maintaining some degree of structure in order to keep the interview on topic. This was ideal for these interviews as the participants were already knowledgeable in the topic and it was important to allow them to discuss topics they felt were relevant to the research. Discussing set topics also gave a degree of uniformity to the results.

Four semi-structured interviews were carried out, asking participants about green space planning, accessibility and what they thought the results of the GIS study meant for planning in the region. The interview participants included key informants selected from territorial authorities in the Waikato, with a preference for staff of the three most populous districts (Hamilton City, Waikato District, and Waipa District). The participants were selected using the snowball sampling method (Goodman, 1961), in this method existing contacts are used in order to gather further contacts, with this process repeated until enough participants had been gathered to give a range of opinions from different organisations and specialties. These interviews were intended to ground the findings of the GIS analysis in current planning practice.

The interviews were conducted in order to provide context and direction to the research question regarding the planning and policy implications of the results of the GIS research. The questions in the interviews covered the current practices for green space planning in the region, the applicability of the ANGSt standard for Waikato and New Zealand use and what the results might mean for future planning efforts. Questions were carefully designed in order to avoid leading participants towards any particular answer or viewpoint and to allow them to

give their views about the topics. These interviews were audio recorded in order to ensure accuracy. The interview schedules are attached as appendix 1.

Once the data was collected it was analysed in order to produce a synthesised result that can inform the discussion of the implications for planning and policy of the results of the ANGSt analysis. The recorded interviews were transcribed in order to make this analysis easier, the data analysis involved examining the transcripts of the interviews to look for emerging patterns and themes in the answers and comments given by the participants. Further research was undertaken to supplement the information provided by interviewees.

Collecting qualitative data from these interviews gave valuable insight into the planning and policy implications of this research. Examining the planning and policy implications of the GIS analysis is important as it gives an impression of the ways that green space accessibility could be improved. The interviews also provided an opportunity for practicing planners and other council staff to comment on the usefulness of the ANGSt model for New Zealand use and potential limitations of the methods used.

Limitations

Semi-structured interviews are limited by the skill of the interviewer, the quality of their questions and the clarity of the answers provided by the subject. Interviewers can unintentionally lead the subject towards certain answers, or ask questions that fail to produce useful information. In order to avoid these problems, questions had to be designed in order to minimise leading and allow participants to discuss topics they felt were important to the discussion. Interview subjects may limit the effectiveness of the interview if they do not give accurate information, in order to prevent this, interview participants had to be carefully selected and the interviewer had to attempt not to lead the participants (Bryman, 2015). The spontaneous nature of semi-structured interviews can make it difficult to synthesise the results as they are often not standardised. Analysing themes common across multiple interviews and trying to find the most relevant information helped to mitigate this limitation. Semi-structured interviews are often limited by small sample sizes, however in the case of this study, the aim of the interviews was to provide expert analysis from key informants, and therefore the small sample size was not a limiting factor.

Methodology Summary

This chapter provided an overview of the methods used to measure green space accessibility, its relationship with socioeconomic deprivation and the planning and policy implications of accessibility and of this relationship for the Waikato region. Quantifying the region's green space showed how accessible green space is in terms of the quantity of green space available

to Waikato residents. Gathering this data showed the population pressure exerted on green space in each district and made up for a limitation of the ANGSt analysis: that it does not account for overcrowding. Using the ANGSt model showed how accessible green space is in terms of travel distance for the people of the Waikato region. Comparing this data with NZDep index scores demonstrated what relationship (if any) exists between socioeconomic deprivation and the ability to access green space. Using a combination of distance and per capita based measures showed both how green space is distributed across the region and the total amount of green space that is available for the population. The green spaces included in this analysis were public reserves and conservation land, which were selected based on the ANGSt criteria of accessibility and naturalness. Undertaking interviews with planners and council staff allowed the planning and policy implications of the results of the GIS analysis to be examined. Together these techniques formed an effective methodology to collect the necessary data to answer the research questions set out at the beginning of this project. There has been relatively little research of this kind undertaken in New Zealand before, although since the start of this study some councils have begun to look into similar GIS analysis of accessibility to open space.

Limitations

The methodology developed for this study was subject to several limiting factors, the accuracy of the data used, the reliability of the methodology and how the methodology was applied.

The major limitation of this methodology was its failure to account for green space quality and perceived accessibility. However, given the time and resource limitations of this study, measuring these was beyond the scope of the study. While measuring these factors would have allowed for comparison of how socioeconomic deprivation can affect multiple different aspects of green space accessibility, this study focused only on physical accessibility. The relationships between these different factors are not well understood, and further study could help shed light on the nature of these relationships.

A wealth of data was available for this research and the data sources that were used are considered to be reliable enough not to present any obstacle towards finding the relationship between socioeconomic deprivation and green space accessibility. The population and deprivation data both came from census data, while census data can suffer from some inaccuracy due to human errors in the data collection process (Hansen, Hurwitz, & Pritzker 1953), it is generally considered one of the more reliable data sources available. The green space data provided by WANZ has a margin of error of +/- 22m which is unlikely to have a

significant effect on the results of the GIS analysis due to the large scale of the green spaces being examined.

Green space per capita measures tend to ignore the distributional aspect of green space accessibility, however, as this method is being used in conjunction with a distance-based accessibility measure this was not a problem.

The ANGSt model faced the limitations of being designed for English use, and failing to account for certain barriers to access that may exist. The modifications made to the ANGSt method were relatively minor and the basic structure of the method was the same, meaning that these modifications are unlikely to have had any impact on the accuracy of the results. The inability to take the actual travel routes of green space users into account may have reduced the accuracy of the results of the analysis, however given the data available, using straight line measures of travel distance was the only feasible method. This method also failed to account for equity issues such as disability and access to transport that may inhibit people's ability to access green spaces.

Semi-structured interviews have limitations relating to the subjectivity of the data received, the skill of the interviewer and the qualitative nature of the results (Bryman, 2015). The data gathered in these interviews was qualitative in nature, as such it can be highly subjective and it can be difficult to determine its accuracy. This is an unavoidable issue with qualitative data, however the subjectivity of the data was precisely what was being sought, opinions and perspectives rather than quantitative data to assist in interrogation and application of the data

The combination of methods used was consistent as they use the same data sources and all three methods complemented each other to produce a more complete view of green space accessibility for the Waikato region.

Given more time, other comparisons could have been made, and site visits could have been undertaken to carry out quality assessments similar to the Public Open Space Tool (POST) evaluation. The POST evaluation is used to assess the quality of green spaces by scoring them against a set of criteria covering presence of amenities and facilities, safety and aesthetic qualities (Taylor, et al., 2011). Taylor et al. (2011) developed a modified version of the POST assessment that could be undertaken via satellite imagery to save time and travel costs while still maintaining 90% accuracy. However, the POST tool was designed with urban green spaces in mind, developing a quality assessment method that would be capable of assessing all types of green spaces would have been far beyond the scope of this study. Some studies have found that deprived communities have worse access to quality green space, and it would have been beneficial to examine the relationship in the Waikato. Undertaking this type of analysis would have allowed for a comparison to be made between accessibility, quality of

spaces and deprivation. Site visits would also have allowed the naturalness and accessibility of sites to be fully assessed, making for a more accurate view of the region's green spaces. With additional resources, a methodology could have been devised to measure the perceptions of green space accessibility, which could have been compared with NZDep data to determine what relationship, if any, exists between socioeconomic deprivation and the perceived accessibility of green spaces in the Waikato. The limitations on resources did place some limitation on the scope of this study, however, they did not affect the accuracy of the results.

Overall the effect of these limitations on the results of this research was not considered to be significant, those limitations that did exist were able to be successfully mitigated so as not to negatively impact the accuracy of the methods. Using alternative methods was not feasible due to the nature of the data available and issues with other methods. The method chosen is considered to be the most accurate method available within the scope of this study.

Results

This chapter presents the research. Results from the quantification of green space, the ANGST analysis and the semi-structured interviews are described here and the implications of these results are discussed in the next chapter. The results are divided into three sections, based upon the three methods discussed in the previous chapter. The tables and maps in this chapter help to illustrate the findings of the study.

Quantifying Green Space

Quantifying the region's green space shows how much green space is available across the different districts. The following maps and tables show how the quantities of green spaces are distributed across the region, the quantity of green space available per person and how green space quantity relates to socioeconomic deprivation.

Figure 2 shows how green space is distributed across the Waikato region. The largest concentrations of green spaces appear to be located on the Coromandel peninsula, the Taupo district and the Waitomo district. The central districts (Hamilton, Waipa, Otorohanga and Waitomo) tend to have fewer large green spaces and less green space overall. Conservation areas tend to be larger and clustered together, while public reserves are smaller and located close to the region's larger settlements. Hamilton, the region's largest settlement has a great deal of small public reserves, but is isolated from any larger conservation areas. Green space tends to be most concentrated in areas with hilly or mountainous terrain, while areas with flatter terrain have less green space and smaller green spaces.

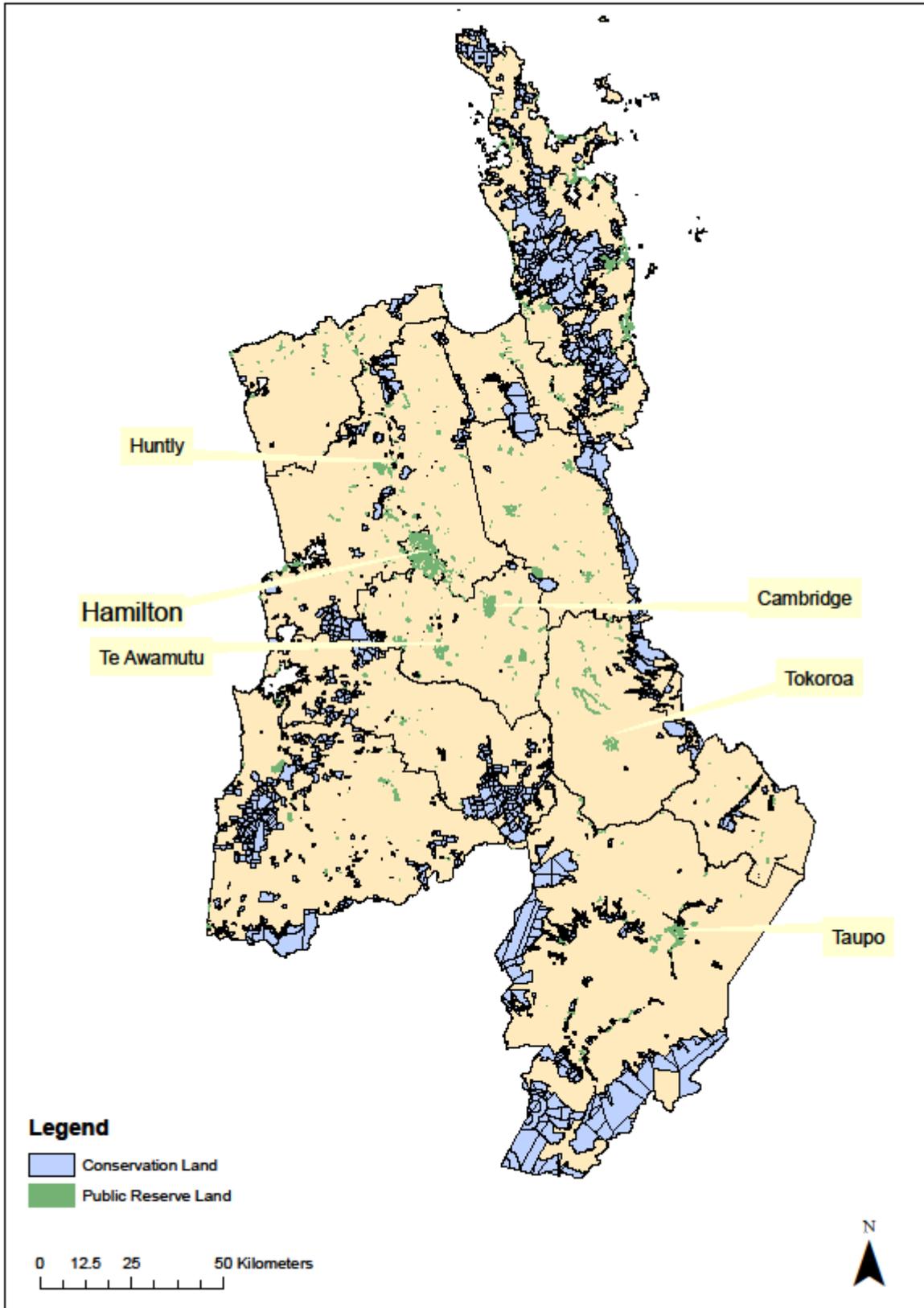


Figure 2 Map Showing All Green Spaces in the Region

The total areas of conservation land, public reserve land and total green space for the entire region as well as each district is shown in Table 3.

Table 3: Green Space Area by Territory

Area Name	Conservation Area (ha)	Public Reserve Area (ha)	Total Green Space Area (ha)
Waikato Region	417406.9021	15714.9426	433121.84
Taupo District	145682.1495	5030.63409	150712.78
Waitomo District	56102.38607	1224.574556	57326.96
South Waikato District	18227.65279	351.6270362	18579.28
Otorohanga District	34151.34902	277.0724905	34428.42
Waipa District	3004.466461	1737.51135	4741.98
Hamilton City	0.356689768	868.1678652	868.52
Matamata-Piako District	25731.98561	1260.493633	26992.48
Waikato District	26197.85839	1571.212474	27769.07
Thames-Coromandel District	84530.5969	2806.156763	87336.75
Hauraki District	35679.7901	445.3539921	36125.14

In total, the Waikato region has 8,070 green spaces, of which 5,131 are public reserves and 2,939 are conservation areas. The total green space area for the Waikato region is 433,122 hectares, of this 417,406 (96%) hectares is conservation area while 15,715 (4%) hectares are public reserve areas. Conservation areas tend to be much larger than public reserves, which explains the large disparity in the total area of each type of green space. The quantity of conservation area greatly exceeds public reserve area in all districts except Hamilton City, which has the least green space area by a significant margin, and only a small area of conservation land. This is due to the small catchment area and dense population of the city compared with other districts. The partial Taupo District has the largest area of green space, also by a significant margin, and accounts for 35% of all green space in the region.

Table 4: Green Space as a Percentage of Total Land Area

Area Name	Total Green Space Area (ha)	Total Land Area (ha)	Green Space Area as a Percentage of Total Land Area
Waikato Region	433122	2457818	17.6%
Taupo District	150713	513542	29.3%
Waitomo District	57327	335247	17.1%
South Waikato District	18579	181901	10.2%
Otorohanga District	34428	199919	17.2%
Waipa District	4742	147004	3.2%
Hamilton City	869	11094	7.8%
Matamata-Piako District	26992	175543	15.4%
Waikato District	27769	445059	6.2%
Thames-Coromandel District	87337	220701	39.6%
Hauraki District	36125	127005	28.4%

Table 4 shows the percentage of the total land area that is green space for each district. 18% of all land in the Waikato region is green space according to the classification introduced earlier. The percentages vary significantly across the different districts. The Thames Coromandel district has the highest percentage (nearly 40%) of its land area as green space. While the Waipa district has the lowest percentage of green space.

The analysis found that the Waikato Region has 1.092 hectares of green space per person, or 1092 hectares per 1000 people. Of this 1.052 hectares is conservation area and 0.04 hectares is public reserve land.

Table 5: Green Space Area per Capita

Area Name	Green Space Area (ha)	Population (URP2013)	Green Space per Capita (ha/person)	Public Reserve Space per Capita (ha/person)
Waikato Region	433122	396567	1.092	0.039627
Taupo District	150713	32760	4.601	0.15356
Waitomo District	57327	8817	6.502	0.138888
South Waikato District	18579	22119	0.840	0.015897
Otorohanga District	34428	9123	3.774	0.030371
Waipa District	4742	46632	0.102	0.03726
Hamilton City	869	137184	0.006	0.006328
Matamata-Piako District	26992	30597	0.882	0.041197
Waikato District	27769	62127	0.447	0.02529
Thames-Coromandel District	87337	25734	3.394	0.109045
Hauraki District	36125	17787	2.031	0.025038

Table 5 shows green space area per capita. There is significant variation in green space area per capita between districts. Due to its high population density compared with other districts, Hamilton has the smallest green space area per person by a significant margin (0.006ha per capita) while the partial Waitomo District has the most (6.502ha per person).

In terms of public reserve per person, the partial Taupo district has the largest area available per capita (1536m² per person), while Hamilton has the least (63.3m² per person).

The average NZDep scores for the Waikato region is 5.8, indicating slightly higher socioeconomic deprivation than the national average. The Waipa District has the lowest score (4.6) indicating that it is on average the least deprived district, while the Hauraki District has the highest score (7.2) indicating the highest average level of deprivation.

Table 6: Green Space per Capita vs. NZDep Score

Area Name	Mean NZDep2013 score	Green Space per Capita (ha/person)
Waikato Region	5.747	1.092
Taupo District	5.472	4.601
Waitomo District	6.485	6.502
South Waikato District	6.845	0.840
Otorohanga District	5.707	3.774
Waipa District	4.612	0.102
Hamilton City	5.882	0.006
Matamata-Piako District	5.733	0.882
Waikato District	5.347	0.447
Thames-Coromandel District	5.585	3.394
Hauraki District	7.227	2.031

Regression analysis carried out to determine the extent of the correlation between the average NZDep score and the green space per capita of each district returned an R^2 value of 0.05, indicating very little correlation between the average NZDep score of a territory and area of green space available per person. There is a large variation in the amount of green space per capita between districts, but relatively little variation in average NZDep score, this indicates that NZDep score may not have a large explanatory effect on the quantity of green space available per person in a district.

The Waikato region has 5,334 green spaces with areas less than two hectares, these spaces together have a total area of 1,742 hectares, or 0.4% of the region's total green space area. Hamilton City alone has 1051 green spaces smaller than two hectares which make up 272 hectares, 31% of the city's green space area.

Access to Green Space

The ANGSt analysis found that of the Waikato region's 396,567 inhabitants:

- 63.76% (252,840) have access to a 2ha or larger green space within 300m
- 45.19% (179,211) have access to a 20ha or larger green space within 2km
- 28% (111,027) have access to a 100ha or larger green space within 5km
- 31.27% (123,996) have access to a 500ha or larger green space within 10km
- 14.50% (57,510) meet all of the above ANGSt criteria
- 17.13% (67,929) meet none of the above ANGSt criteria

Table 7: Population Meeting ANGSt Criteria by Territory

Percentage of Population meeting ANGSt Criteria						
	2ha Space Within 300m	20ha Space Within 2km	100ha Space Within 5km	500ha Space Within 10km	All Standards	No Standards
Waikato Region	63.76%	45.19%	28.00%	31.27%	14.50%	17.13%
Hamilton City	77.19%	38.84%	0.00%	0.56%	0.00%	15.52%
Hauraki District	55.44%	51.66%	79.39%	92.68%	36.87%	2.90%
Matamata-Piako District	43.05%	27.93%	35.49%	70.58%	18.52%	17.32%
Otorohanga District	37.19%	30.19%	24.86%	27.66%	19.57%	52.22%
South Waikato District	46.59%	11.01%	7.24%	16.23%	5.02%	48.88%
Taupo District (Partial)	61.68%	82.65%	33.00%	19.67%	10.11%	8.75%
Thames-Coromandel District	75.25%	84.59%	96.88%	96.23%	63.30%	0.00%
Waikato District	50.76%	56.70%	40.13%	59.65%	28.25%	21.16%
Waipa District	68.91%	19.32%	20.32%	11.86%	5.16%	18.28%
Waitomo District (Partial)	53.39%	87.65%	30.08%	21.06%	18.20%	7.86%

Table 7 shows the percentage of the population that meet each ANGSt standard in the region and in each district. 15% of Waikato region residents meet all four ANGSt access criteria indicating that they have good access to green spaces. 17% of the region's residents do not meet any of the ANGSt criteria indicating that they have little or no access to green space. More people meet the criteria for access to smaller spaces (2ha and 20ha) than larger spaces (100ha and 500ha). 64% of the region's population have access to a green space greater than two hectares within 300m. This means that 36% of Waikato residents do not have a green space within walking distance of their home. There is a reasonable amount of inconsistency in the percentages of population that meet the individual ANGSt standards between the region's different districts.

The most significant difference in accessibility exists between Hamilton City and the other districts, Hamilton scores much lower for percentage of the population meeting the criteria for access to larger green spaces (100ha and 500ha spaces) and no Hamilton residents meet all

four access standards. Despite this, Hamilton residents have access to smaller green spaces (2ha and 20ha) that is generally consistent with other districts.

The Otorohanga and South Waikato districts have the highest percentage of people who meet none of the ANGSt standards, with both districts having close to 50% of their residents unable to access any green space. Conversely, the Thames Coromandel district has the highest percentage of people who have access to all standards and the entire population of the district meet at least one standard.

The average NZDep score of meshblocks meeting all ANGSt standards is 5.9, while the average NZDep score of meshblocks that meet no ANGSt standards is slightly lower at 5.7. This indicates that on average meshblocks with no access to a green space are less socioeconomically deprived than those that meet all standards. However this difference is very marginal, and may simply be the result of statistical noise.

Access Maps

The following maps show the meshblocks that meet each ANGSt standard.

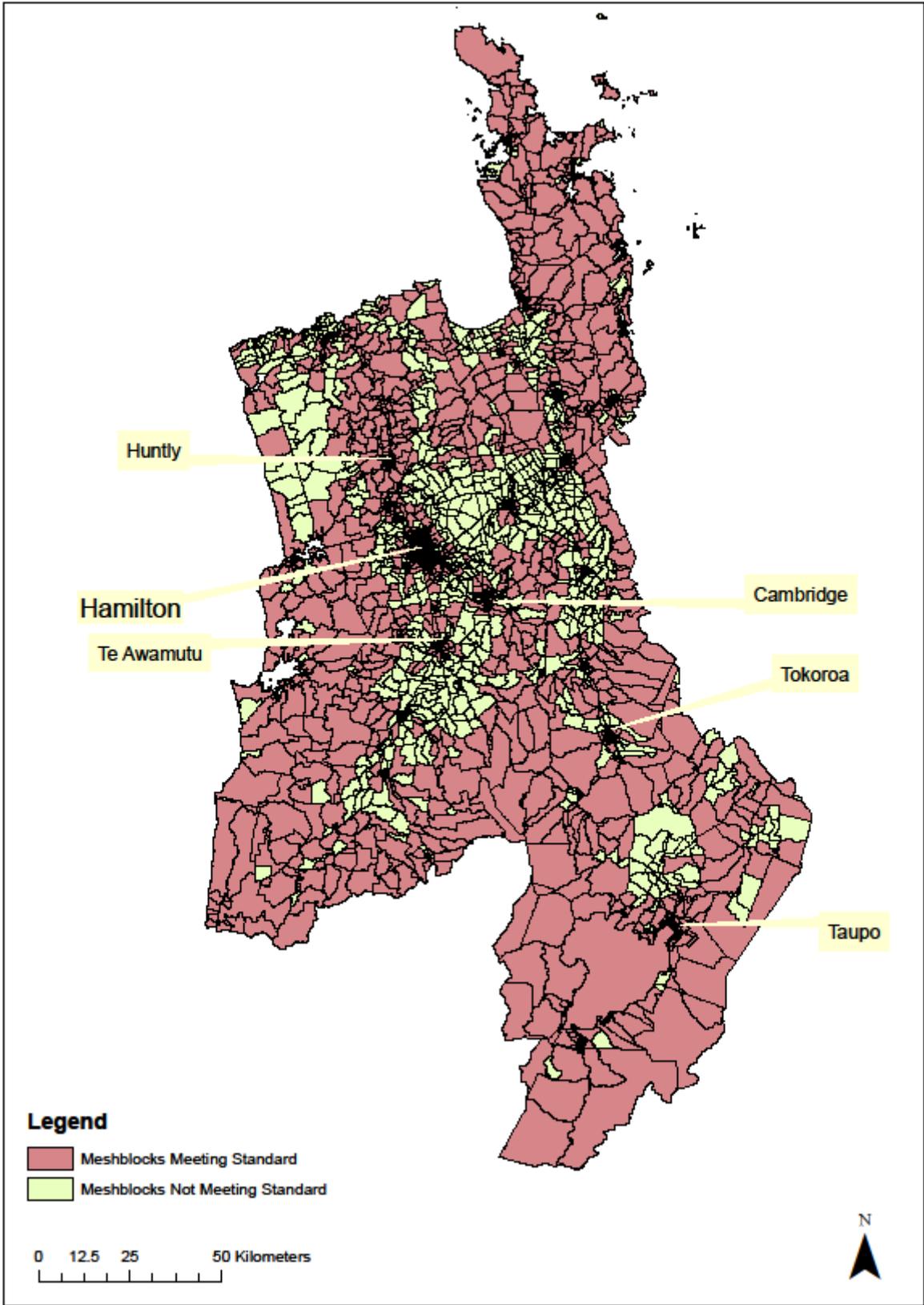


Figure 3: Map showing Waikato Region Meshblocks that meet Two Hectare space within 300 metres Standard

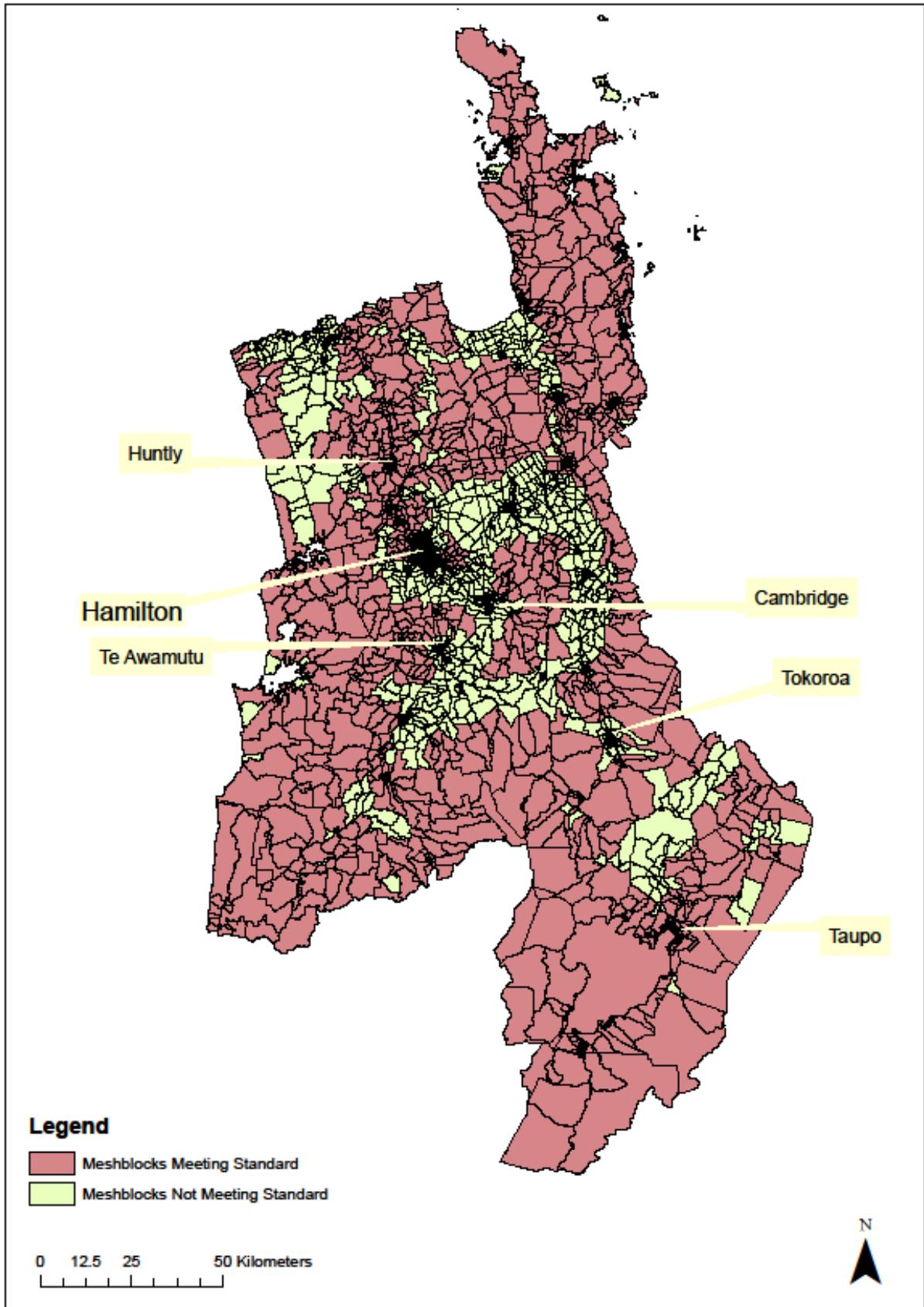


Figure 4 Map Showing Waikato Region Meshblocks that meet 20 hectare space within 2 kilometre Standard

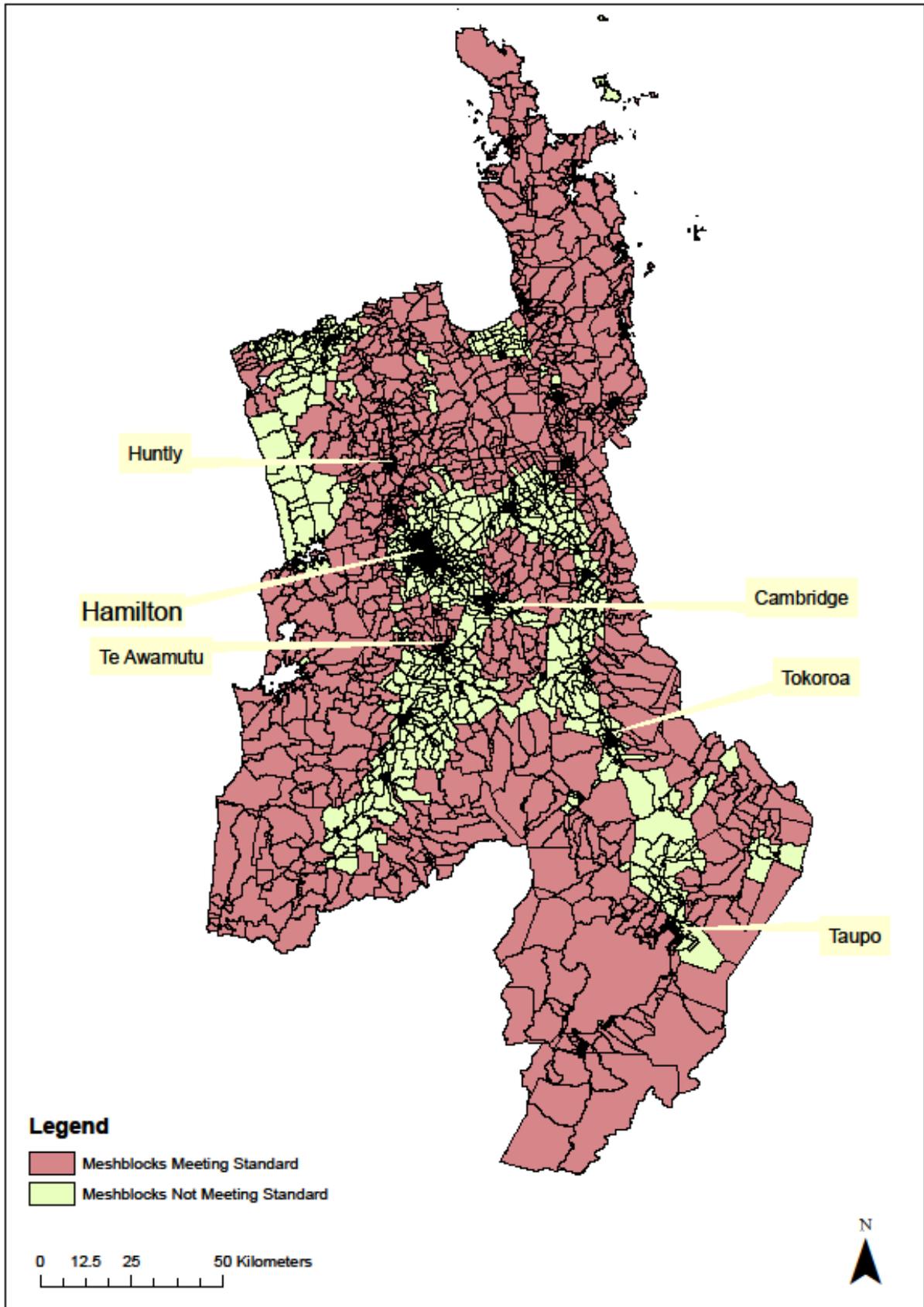


Figure 5 Map Showing Waikato Region Meshblocks that meet 100 hectare space within 5 kilometre Standard

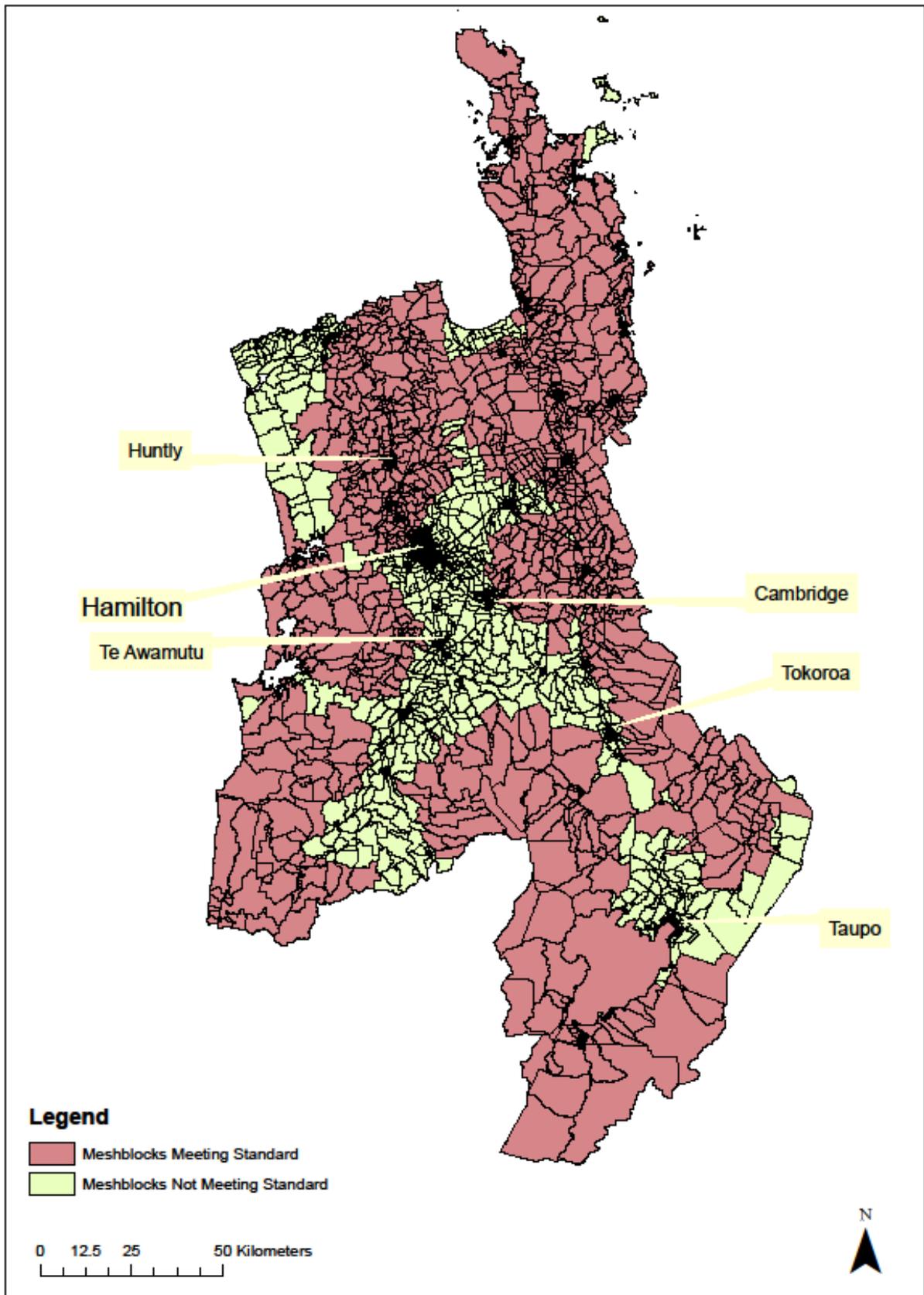


Figure 6 Map Showing Waikato Region Meshblocks Meeting 500 hectare within 10 kilometre Standard

Viewing these maps shows a clear pattern for access to green spaces, the same areas tend to fail to meet each standard. Meshblocks in the central Waikato area (Hamilton, Waipa, Otorohanga and South Waikato districts) tend to meet less ANGSt standards, meshblocks in the north west of the Waikato district also consistently meet less ANGSt standards. Meanwhile meshblocks in the Thames Coromandel, Waitomo and Taupo districts tend to be more likely to meet all ANGSt standards. Ability to meet ANGSt standards is primarily linked with the quantity of green space available in an area. The areas which tend to not meet any standards are correlated with the areas shown to have few green spaces in figure 2. While the areas where meshblocks tend to meet most or all standards are the areas with large clusters of conservation land as shown in figure 2.

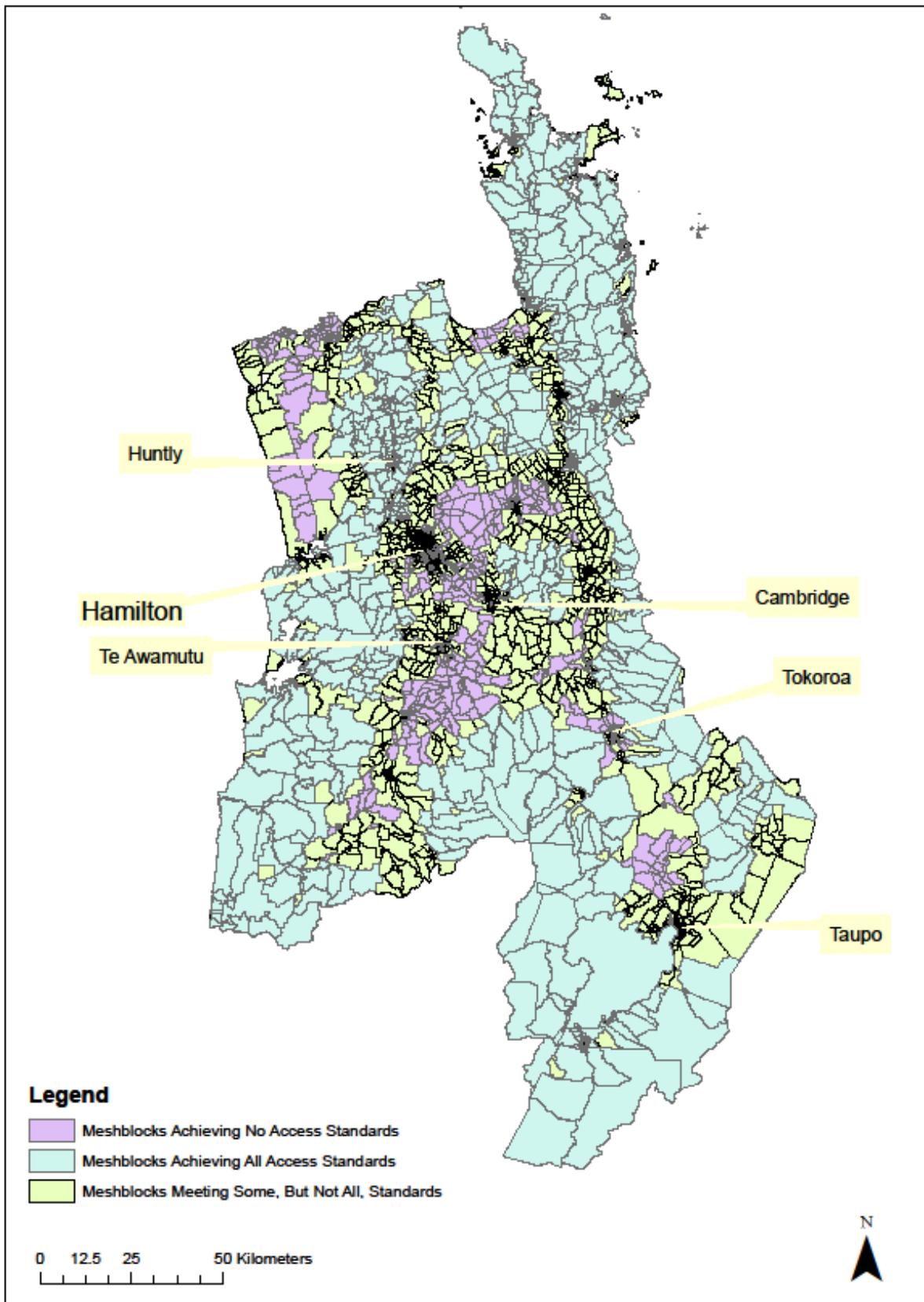


Figure 7: Map Showing Meshblocks Meeting All Standards or No Standards

The following maps show the key results of the region's three most populous districts (Hamilton city, Waikato District and Waipa District) in greater detail.

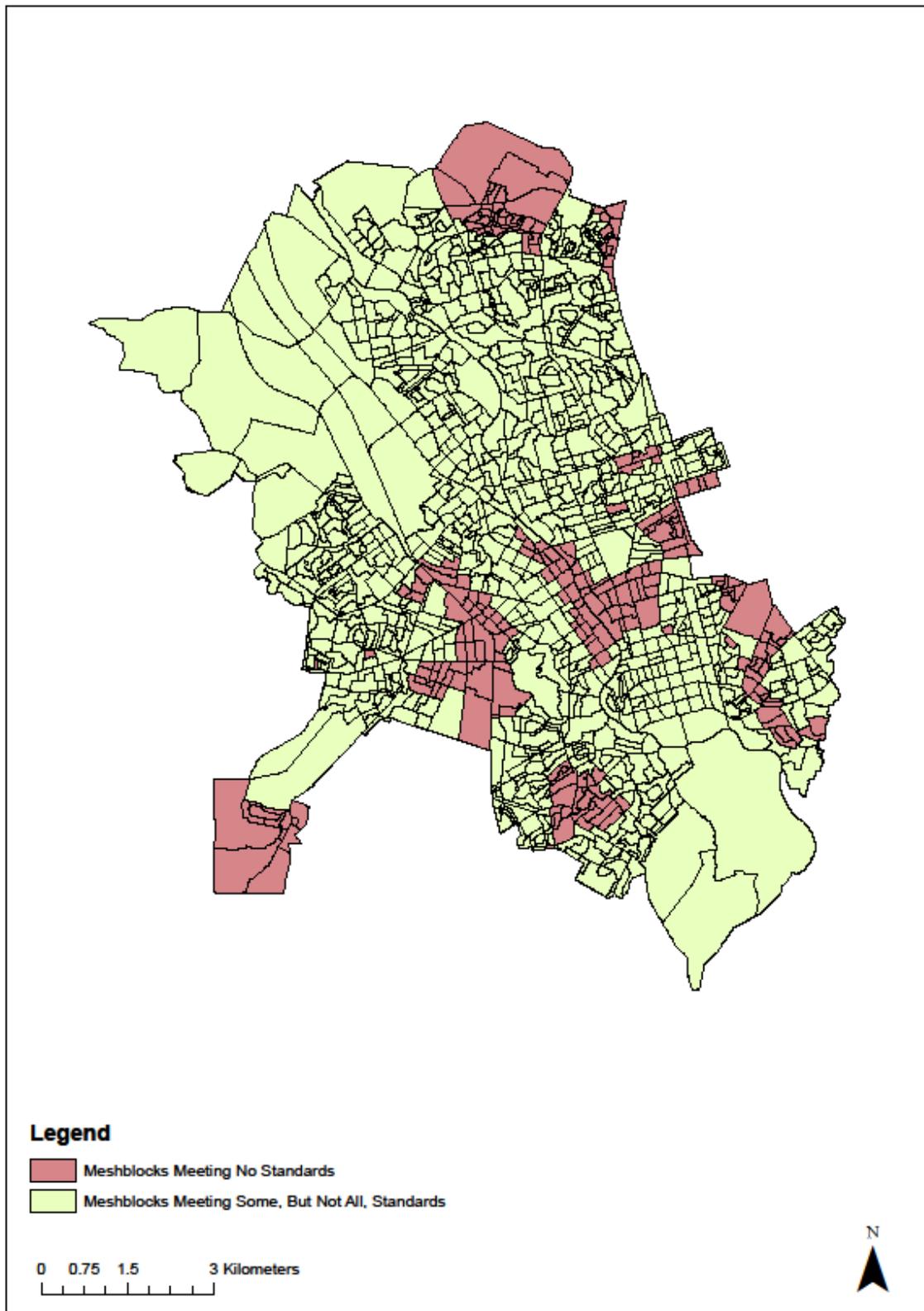


Figure 8: Hamilton City Meshblocks meeting No ANGSt Standards

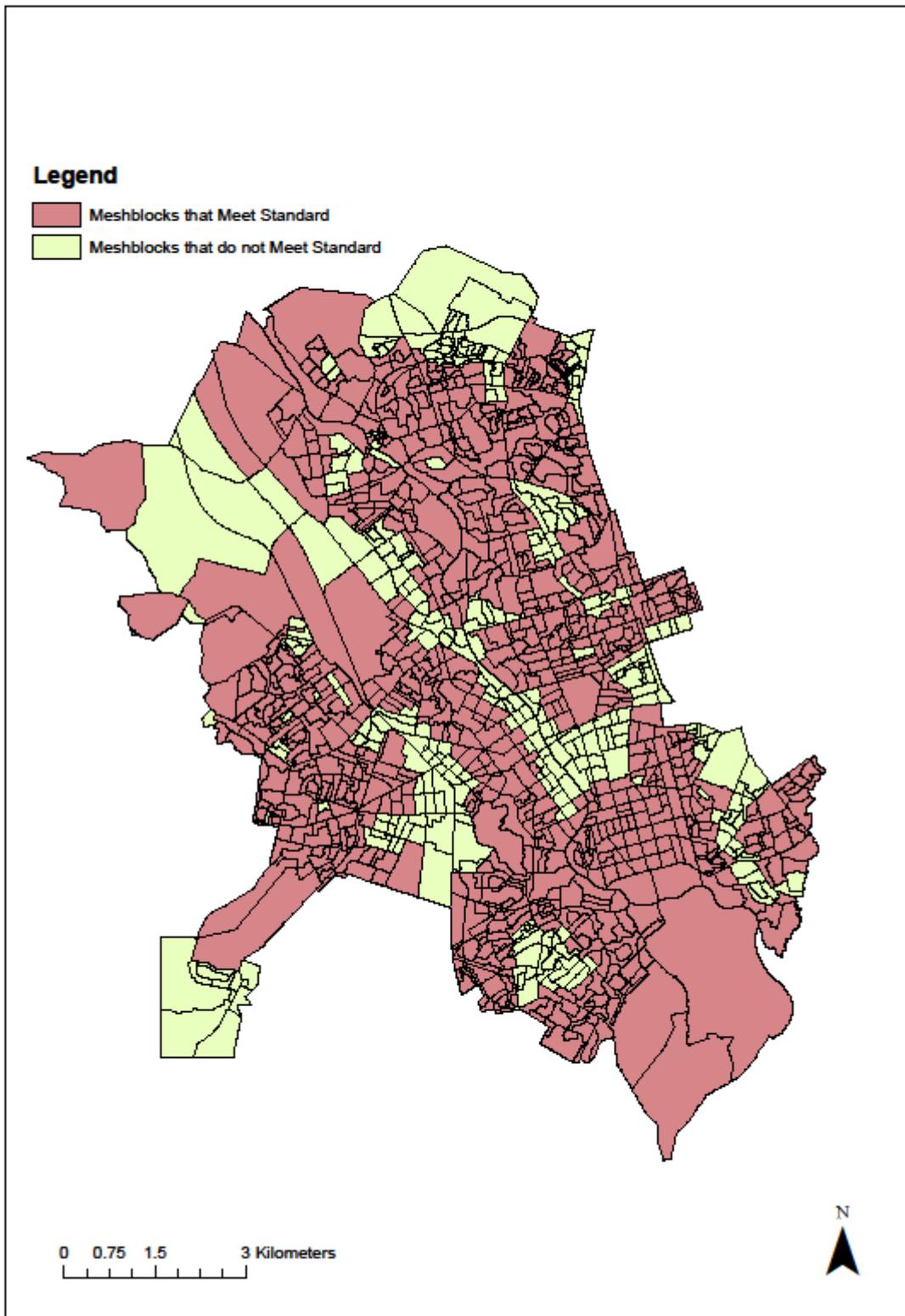


Figure 9: Hamilton City Meshblocks meeting Two Hectare Space within 300 metre Standard

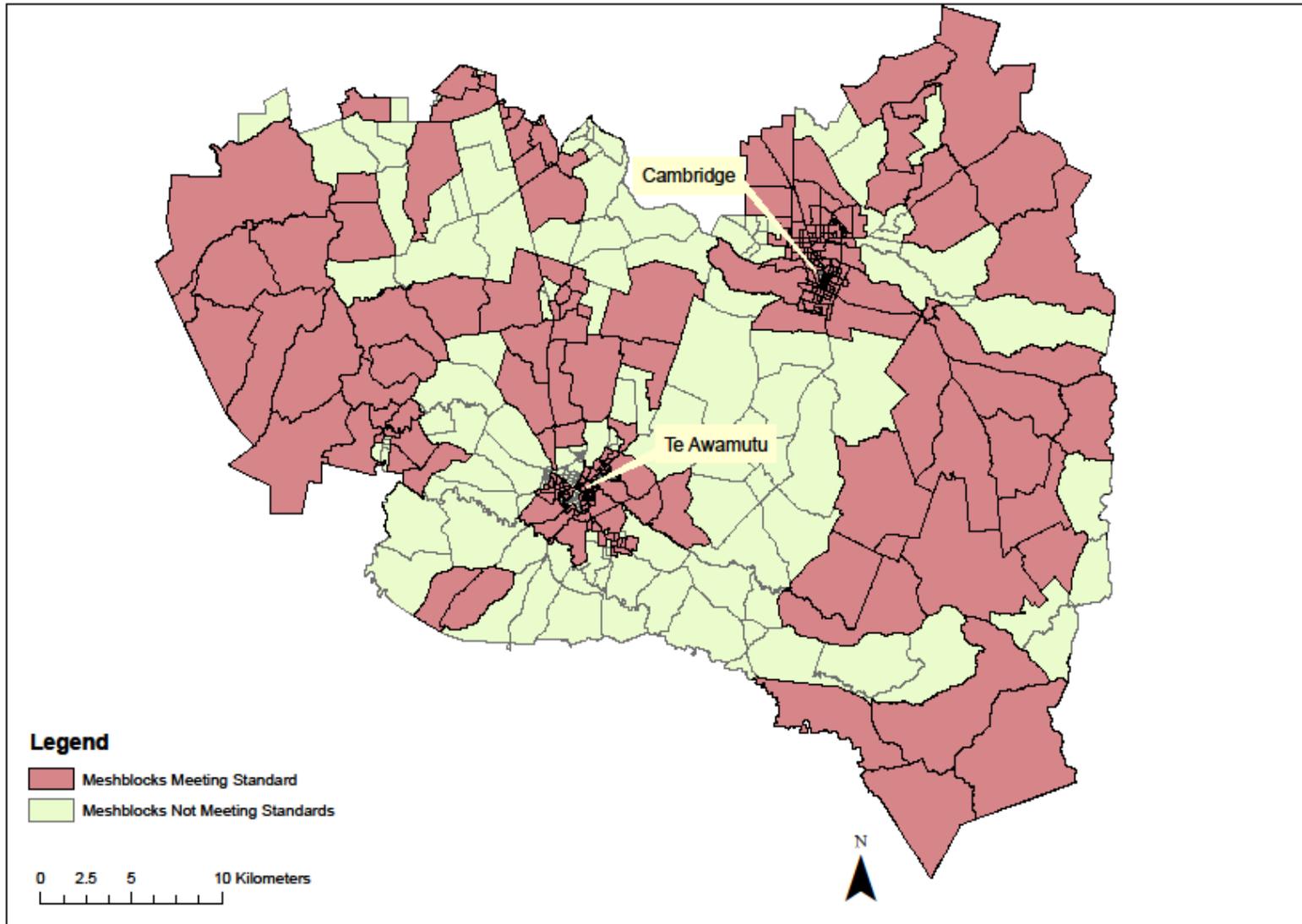


Figure 10: Map Showing Waipa District Meshblocks Meeting Two Hectare Space within 300 metre Standard

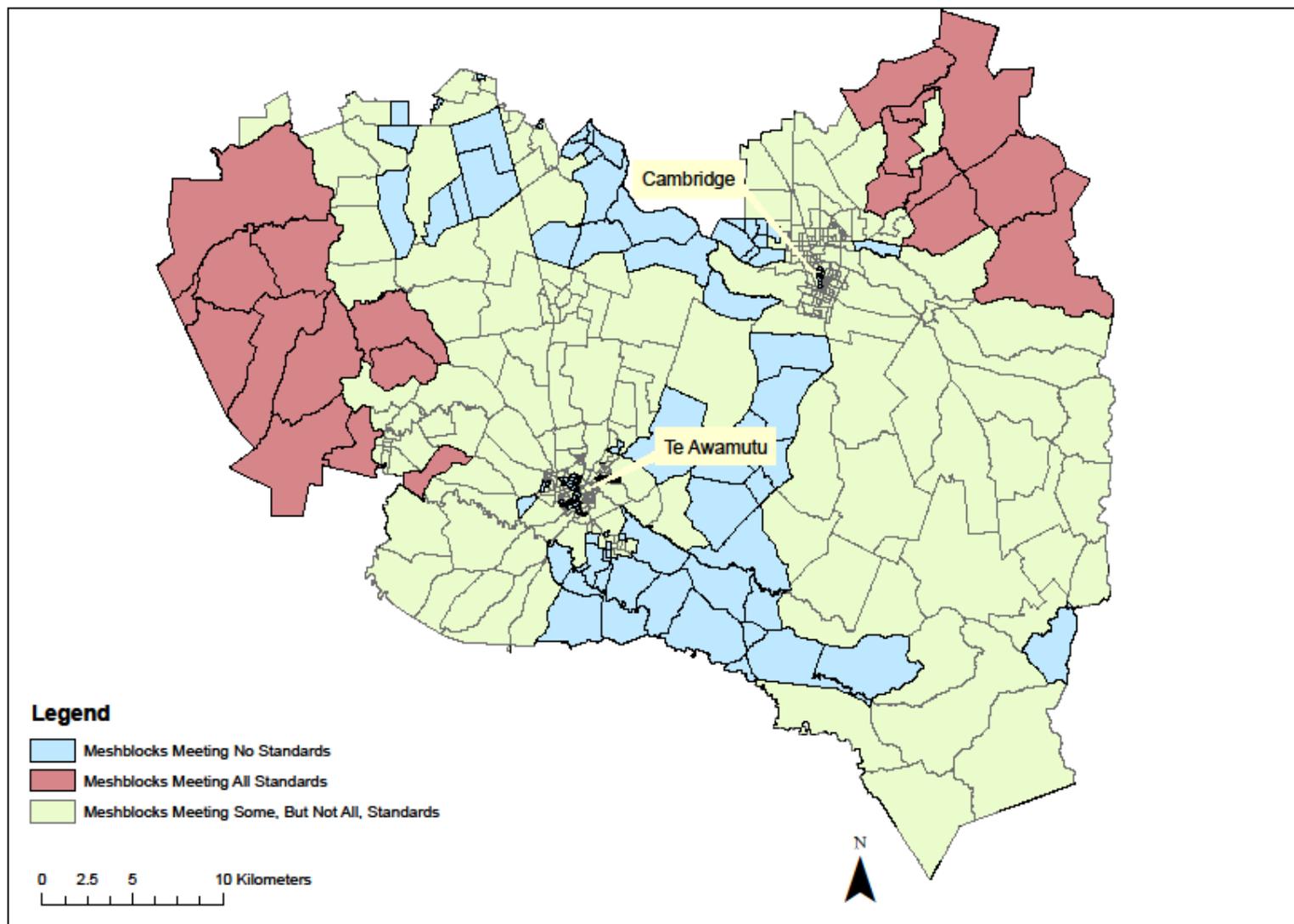


Figure 11 Map Showing Waipa District Meshblocks Meeting All or No ANGSt Standards

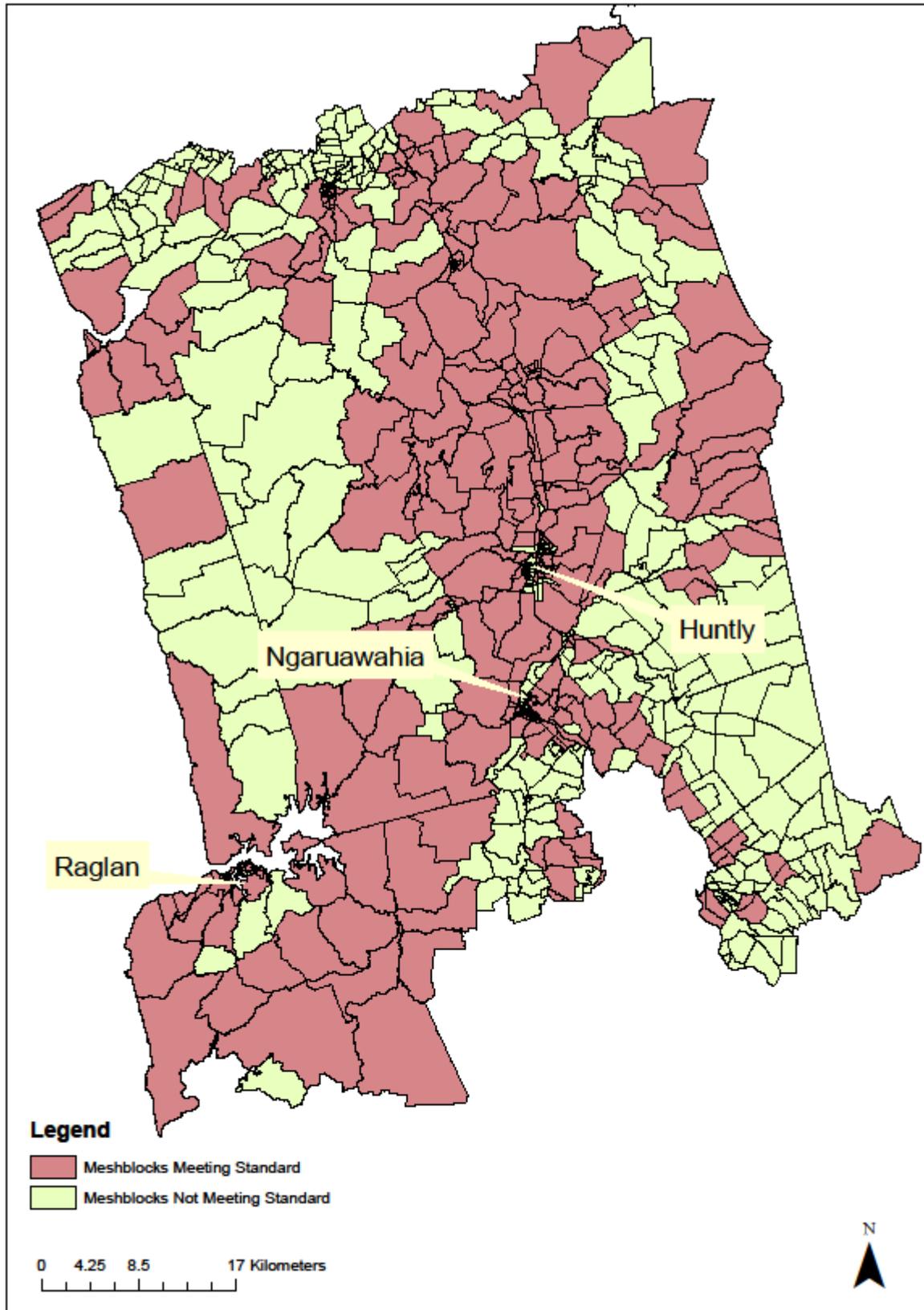


Figure 12: Map Showing Waikato District Meshblocks Meeting Two Hectare Space within 300 metres Standard

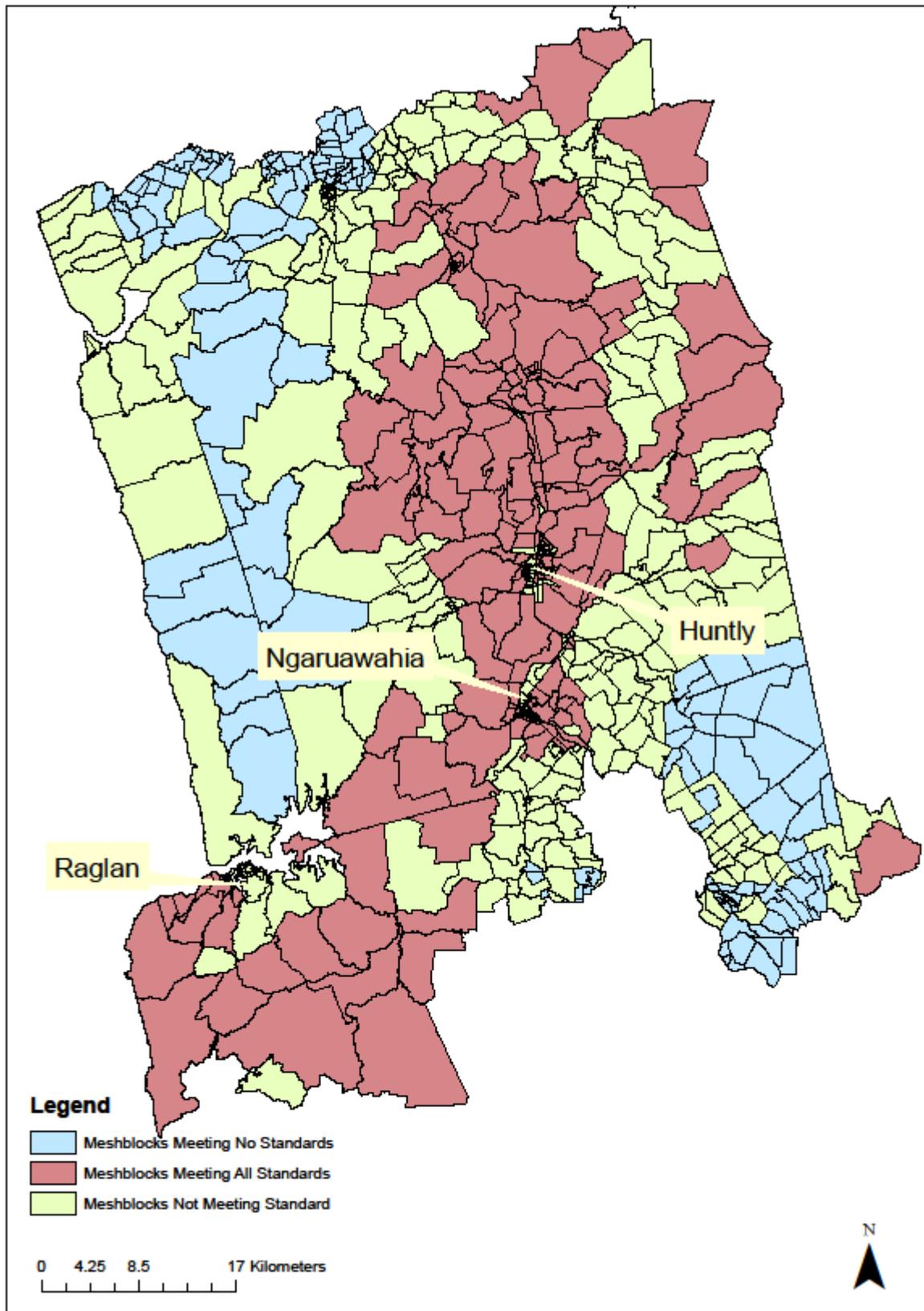


Figure 13 Map Showing Waikato District Meshblocks Meeting All or No ANGST Standards

Examining these maps shows that for the most part the region's largest settlements tend to meet the walking access standard. While the areas that meet no ANGSt standards tend to be primarily rural areas.

In Hamilton, walking access is generally good, with some pockets where meshblocks do not meet this standard. These are mainly in the city centre and on the outskirts of the city. No Hamilton meshblocks meet the standard for a 100 hectare space within 5km, and very few meet the standard for a 500 hectare space within 10km, those that do are all located in the north-western most part of the district.

It can also be seen that most meshblocks in several of the largest towns in the Waikato district such as Ngaruawahia, Huntly and Te Kauwhata meet all four ANGSt standards.

In the Cambridge and Te Awamutu, the regions third and fourth largest settlements, most meshblocks have walking access to green space, however, few meshblocks in the towns meet any other standards.

Public Reserves

Analysing only public reserve areas shows the effect that conservation land has on meeting ANGSt standards.

Table 8: Population meeting ANGSt Criteria from Public Reserve Land Only by Territory

Percentage of Population meeting ANGSt Criteria from Public Reserve Land Only						
	2ha Space Within 300m	20ha Space Within 2km	100ha Space Within 5km	500ha Space Within 10km	All Standards	No Standards
Waikato Region	55.46%	30.29%	7.96%	5.36%	0.76%	31.16%
Hamilton City	77.19%	38.84%	0.00%	0.00%	0.00%	15.52%
Hauraki District	32.32%	19.35%	2.36%	0.00%	0.00%	57.35%
Matamata-Piako District	37.78%	21.44%	5.63%	8.82%	1.03%	47.37%
Otorohanga District	20.39%	9.87%	0.00%	0.39%	0.00%	74.84%
South Waikato District	44.07%	5.51%	0.00%	0.00%	0.00%	54.75%
Taupo District (Partial)	46.90%	59.32%	10.17%	0.16%	0.02%	28.00%
Thames-Coromandel District	50.29%	25.30%	41.13%	12.04%	0.63%	29.98%
Waikato District	37.56%	26.83%	13.32%	21.65%	8.77%	41.93%
Waipa District	63.05%	13.81%	15.11%	3.35%	0.48%	22.77%
Waitomo District (Partial)	35.45%	57.50%	2.28%	4.12%	0.82%	29.87%

Table 8 shows the percentage of each district's population that meets each ANGSt standard using only public reserve land in place of the total green space data. Removing conservation areas from the analysis greatly reduces the percentage of the population that have access to larger spaces and reduces the percentage of the region's residents that meet all of the standards to almost zero in most districts. This is likely due to most public reserves tending to be smaller than 100 hectares in area (the average public reserve has an area of three hectares). Analysing public reserve land access shows that 31% of the region's population do not meet any of the standards indicating that they have no access to a public reserve.

The average NZDep score of meshblocks meeting all ANGSt standards from public reserve land only is 5.9 and the average NZDep score of meshblocks meeting no standards is 5.6, this is reasonably consistent with the NZDep scores for the ANGSt analysis of total green space.

Table 9 shows the percentage of meshblocks with NZDep scores of less than Three (low socioeconomic deprivation and meshblocks with NZDep scores greater than Seven (high socioeconomic deprivation) that meet each ANGSt standard and those that meet all standards or meet no standards.

Table 9: Percentage of High and Low Deprivation Meshblocks that Meet ANGSt Standards

	NZDep Score < 3	NZDep Score > 7
2ha Space Within 300m	64.62%	65.61%
20ha Space Within 2km	50.29%	42.88%
100ha Space Within 5km	22.57%	28.77%
500ha Space Within 10km	20.62%	33.45%
All Standards	7.17%	16.62%
No Standards	15.81%	17.34%

The spatial query of meshblocks with high and low levels of socioeconomic deprivation also failed to produce any clear overall relationship between NZDep score and ANGSt results. People living in meshblocks with low NZDep scores are less likely to meet all of the ANGSt standards, and slightly less likely to meet no ANGSt standards than people living in meshblocks with high NZDep scores. People living in meshblocks with low NZDep scores are less likely to meet the 100 hectare and 500 hectare standards and slightly less likely to meet the 2 hectare standard, but are more likely to meet the 20 hectare standard than people living in meshblocks with high NZDep scores.

Table 10: Comparison of ANGSt Results from Different Studies

Standard	Waikato Region	South East Region	Essex County	Herefordshire County	Norfolk County	Suffolk County
2ha space within 300m	64%	20%	29%	36%	18%	32%
20ha space within 2km	45%	66%	68%	75%	49%	46%
100ha space within 5km	28%	77%	72%	70%	36%	26%
500ha space within 10km	31%	46%	19%	27%	16%	28%
All Standards	15%	N/A	7%	7%	3%	3%
No Standards	17%	10%	14%	6%	30%	33%

In England, the ANGSt analysis has been applied in the South East region as well as the Essex, Herefordshire, Norfolk and Suffolk counties. When the key findings of these studies are compared with the findings of the Waikato study it can be seen that the Waikato region scores higher on the two hectare and 500 hectare standards than all English counties, but lower on the 20 hectare and 100 hectare standards. The Waikato region scores higher for percentage of the population who meet all four standards, and higher than the South East region, Essex and Herefordshire counties for percentage achieving no standards, but lower than Norfolk or Suffolk counties.

Planning and Policy

The semi-structured interviews provided a wealth of qualitative data to supplement the quantitative data collected and analysed. The data collected from these interviews was organised into four categories: limitations of the methods and data, potential explanations for the results, the planning and policy implications of the results and suggested future research to build upon this study.

Limitations of the Methodology and Data

Some of the interview participants raised questions about the validity of the WANZ data, the NZDep data and of the ANGSt model itself.

1. The main issue raised with the WANZ green space data was which types of green spaces are included, and whether any relevant green spaces were missed by this analysis. Some participants felt that some areas had failed ANGSt standards but that access to beaches in these areas should make them meet the standards. Other participants identified some reserves that were included in the ANGSt analysis that do not necessarily meet definitions for naturalness such as a golf course.
2. The participants of one interview believed that comparing NZDep data with the ANGSt results may have failed to produce a correlation due to the nature of the NZDep index. The NZDep index takes into account ten factors that influence socioeconomic deprivation. They felt that the aggregated nature of the index may have diluted the correlations made between NZDep data and ANGSt analysis results.
3. Some participants also questioned the applicability of the ANGSt model for use in New Zealand, and whether the analysis gave an accurate view of green space access. They queried whether the distances in the ANGSt standards were appropriate for New Zealand as they considered green space users may be willing to travel further than 10km to reach a large green space. They also pointed out that in some districts privately owned, but publicly accessible land forms a major part of people's green space access, but that this is not included in the ANGSt analysis. Another limitation of the ANGSt model identified in this interview is that it fails to account for the factors beyond physical distance that can influence the accessibility of green space such as perceptions of accessibility and ability to travel. The participants of another interview considered that the ANGSt model may not be suitable for urban areas, but may be more suitable for rural areas or large cities which can host large green spaces, they stated that it would be difficult for a small city such as Hamilton to meet some of the standards for larger spaces.

Results

1. Some participants considered that the location of DoC land greatly impacts results for both green space quantity and the ANGSt analysis. Thames-Coromandel and Taupo districts have a great deal of DoC land and this contributes to their high percentages of meshblocks achieving each ANGSt standard. At a regional level, other participants identified that areas where intensive farming takes place tend to meet fewer ANGSt standards. The participants of another interview stated that the location of green

spaces is in many cases based on historical factors rather than demand for green space and that relatively few reserves have been created in recent years. The location of reserves is often based on where land was available, sometimes gifted to the crown by private benefactors, and conservation land is often based on the location of significant landscapes and natural features. The participants also noted as an example that the large strip of meshblocks in the Waikato district which meet no access standards is located in rural hill country. They noted that relatively few people live in these areas and they likely have a more access to private green spaces than urban dwellers.

Planning and Policy Implications

1. The participants made the following observations about the projected demographic changes for the region: participants in all interviews agreed that the projected changes for the region are likely to have an impact on green space accessibility and demand. A growing population will lead to more pressure on green spaces as population density increases people will become more reliant on public spaces for activities that once took place in private spaces such as backyards. As urban populations expand in growth areas this will create a need for new green spaces. This growth will also lead to more demand for the stormwater and wastewater functions provided by green spaces. Some participants stated that an ageing population and changes to the ethnic structure of the population are likely to lead to growing demand for different kinds of spaces as these groups may prefer different activities and different spaces. However, more research would be required in order to learn what these changes might be.
2. Other participants noted that an ageing population could lead to changes to the distance people are willing to travel to reach green spaces and demand for different infrastructure to be made available at the spaces. One interviewee felt that younger people may be less interested in visiting natural areas or perhaps be interested in different activities at green spaces, but noted that this was anecdotal and not based on research. Some also noted that trends in recreation will affect green space use. Evidence indicates that participation in many traditional sports is declining while individual recreational activities are increasing (Sport New Zealand, 2016). This is likely to drive demand for different types of spaces and the infrastructure provided at these spaces. Further research is needed to understand the nature of these changing demands so that they can be provided for. With traditional sport declining and activities such as mountain biking and tramping growing, this may drive demand for more natural spaces rather than sports fields. This has the added benefit to biodiversity as more natural areas generally have greater biodiversity.

3. Some participants noted that large sections of Waikato District are becoming urbanised, Auckland is growing southwards while Hamilton grows northwards. They believed this will lead to some level of loss of natural land as land is developed for new urban areas. A growing population and growth in urban areas is likely to lead to more urban parks and less natural reserve. They stated that a lot of the region's reserves are currently unmanaged, largely unused and can be difficult to access, development is more likely to affect these spaces than well used spaces. These spaces might become more managed green spaces to serve the needs of new populations or they may disappear to make way for development.
4. Some participants considered that the ANGSt model would need further testing in order to determine whether it was suitable for New Zealand use. Other participants, particularly those working at a territorial level, considered that the NZRA levels of service worked better for them than the ANGSt model. Despite this, they recognised that the ANGSt results can be used for determining areas of deficient green space access, determining how best to meet the green space needs of future growth areas and, where possible, where new spaces could be created for areas of lower access. Some considered that the ANGSt model may be more suited to use in rural areas where the NZRA levels of service do not apply. They did feel that there may be some value in making comparisons between results of ANGSt analysis and the results of GIS analysis using NZRA level of service.
5. Most participants commented on the difficulties in funding and establishing new green spaces and the historical and contemporary factors that have affected green space distribution. Some participants stated that data for public reserves may be more useful for council planners, as public reserve land can be more easily altered or new reserves created, whereas conservation land is usually based on natural features and generally remains unchanged over time. They noted that conservation areas and nature reserves are often based on significant natural features rather than being specifically placed in order to meet green space access needs, the locations of these spaces are obviously unchangeable which explains why so many conservation areas are located far from urban settlements.
6. Other participants noted that there is not a lot of budget for acquiring new reserves and the primary source of funding for reserves comes from development contributions. One of the major sources of new public reserve land is from esplanade reserves which are created from subdivision along the riparian and coastal margins of waterbodies, however, the creation of these new reserves depends upon subdivision taking place. These areas can provide public access to and along rivers, lakes and coast. Council's ability to provide new green spaces is limited by funding and legal jurisdiction. These

limitations lead to few new reserves being created, as councils often have other functions that take precedence when allocating funding. The major source of the funding for new reserves is from development contributions, which are paid by developers to the council in return for the additional infrastructure required for new developments. One participant noted that it is common in the USA to quantify the benefits of green space as dollar figures and that having this information could help to sell proposals for new green spaces to decision makers and the public. The requirements to assess the costs and benefits of new policies and rules under s 32 of the RMA provides an opportunity to account for the benefits and costs of improving green space access. They stated that green space may not currently be seen as core infrastructure in the same way as wastewater, roads and stormwater in terms of provision and investment.

7. Hamilton City Council has several pieces of policy that relate to improving green space access: The Council is monitoring whether access to the river is improving. The Hamilton Plan states as one of the goals for the future of the city is that Hamilton be an 'urban garden'. This means improvements in access to open space, but also introducing more natural elements such as street trees to improve the city's natural character. The Plan states that part of this goal is to increase the proportion of green spaces in the city. Other related plans and policy include elements of district plans relating to acquisition of land for new reserves, long term plans and reserve management plans.
8. The participants of one interview noted that many green spaces are not accessible using public transport. They believed that improving public transport access to these spaces could be worth exploring. Most of region's population live in urban areas, so these areas are more likely to experience pressure on green spaces. They also noted that rural dwellers have more access to private green space, due to lower population densities and the larger lot sizes in rural areas, therefore providing for access to green space in these spaces may not be as urgent as in urban areas.

Further Research Opportunities

1. Some participants suggested that the results of the ANGSt analysis could be compared with factors such as data from the New Zealand quality of life survey, including perceptions of access to amenities, and feeling of community belonging. Another option for further research discussed was undertaking an in-depth analysis of the results of this study using the National Institute for Demographic and Economic Analysis (NIDEA) population projections for the region, these projections go up until

2063. They also suggested that undertaking the analysis at a Census Area Unit level (a geographic area larger than a meshblock, in urban areas these generally correspond to a suburb). This would allow comparisons to be made between areas within districts. Understanding how demographic changes will affect demand for green spaces will require some form of user analysis be undertaken in order to better understand who uses green spaces and how people use them. Other participants questioned whether changing the distances or sizes in the ANGSt standards could change the results of the NZDep correlations, this would require further study. Understanding the effects that projected population changes will have on the region would require user analysis be undertaken.

Common themes that emerged across the interviews were that limited funding and the cost of acquiring land for reserves are the primary barriers to improving access to green space. Further, that the ANGSt model required more testing before planners would be willing to implement it or to be preferred over other standards such as the NZRA levels of service. That changes such as population growth and population ageing would change demand for green space and the types of spaces demanded.

Conclusion

The results of this study show how green space is distributed across the region and the accessibility of these spaces. The interviews with key informants provided a qualitative element to the data, they explored what the results might mean for planners and what future challenges will mean for green space accessibility.

Green space area per capita varies significantly across the region, with Hamilton having an especially low quantity available per person (60m²) and districts such as Taupo and Waitomo having several hectares of green space per person. The region has a large area of public green space, over 400,000 hectares and has a high green space area per capita compared to most standards. The vast majority of the green space is conservation land and is mostly located in districts where fewer people live, while the region's three most populous districts have the least green space. Quantities of green space vary from district to district, however socioeconomic deprivation does not appear to be able to explain disparities in the area of green space available per capita between districts. The vast majority of the region's green space area is conservation land, while public reserve land only makes up a small proportion. The region has, on average, 1093 hectares of green space per 1000 people, of which 1053 hectares is conservation land and 40 hectares is public reserve land. This puts the regional

average well above the recommendations for green space per capita used by Auckland council (5.5ha of parkland and sports field per 1000 people) or the 26m² of green space per person standard used in a Romanian study (Badiu, et al., 2016).

The findings of the ANGSt analysis show that most Waikato residents have access to some form of green space. Most of the region's residents also have walking access to a green space, especially in urban areas. In rural areas however, less people meet standards for walking access. While access to green space is generally good across the region, there are some areas with significantly lower access. 17% of the region's population meet no ANGSt standards, indicating that they do not have access to any green space. 36% of the region's population do not have a two hectare or greater space within 300m of their home, meaning that they do not have access to a green space within walking distance. ANGSt results vary from district to district, with the most notable difference being between Hamilton and the other districts. The outer extremities of the region tend to have better access to green space, while the centre of the region suffers from a lack of access. As would be expected, the areas with more green space per capita are also the areas that tend to have good access to green space. The Waikato ANGSt analysis returned similar results to previous studies in England, however Waikato residents have far better access to small spaces within walking distance than their English counterparts and are more likely to meet all ANGSt standards.

This study was unable to find evidence of a clear relationship between socioeconomic deprivation and access to green space. Some evidence was found that high deprivation meshblocks are more likely to have access to larger green spaces, but correlations were not strong. Despite this there is a clear pattern to the areas that tend to have worse access to green space, however the cause of this pattern does not appear to be related to socioeconomic deprivation. This does not mean that there is not an equity issue, it is possible that deprived areas have worse access to quality spaces or that other factors beyond physical accessibility may limit accessibility in these areas.

The interviews carried out returned a great deal of qualitative data regarding the planning and policy implications of the GIS results, the limitations of the method, the factors that may have led to some of the GIS results as well as suggestions for further research. As the region undergoes changes including population growth and an ageing population demand for green space will change, however, there is some uncertainty about the extent and nature of these changes. The ANGSt results can be used to identify areas lacking in access to green space, but the cost of acquiring land is a major obstacle to providing for the green space needs of these areas. New developments that take place to meet the needs of a growing population will also require new green spaces to serve these populations. Some participants felt that the

ANGSt method was not well suited to urban areas, due to the difficulties in meeting the standards for spaces over 100 hectares, but potentially had value for use in rural areas. Others questioned the relevance of the sizes and distances used by the standard and felt that longer distances may be more appropriate for the New Zealand context. Some interviewees felt that due to the majority of the region's population residing in urban areas, urban green space access should be prioritised. Some participants felt that the green space data may have failed to include some relevant spaces or included some spaces that did not meet the criteria for naturalness. A number of factors were put forward that may explain the distribution of green space across the region, these include historical factors, population and location of natural features. In general most interviewees felt that user analysis should be undertaken to supplement the findings of the GIS analysis. User analysis could help to understand how demand for green space will change in the future and how councils can respond to these changes.

Discussion

This chapter discusses the results of this study as presented in the previous chapter and examines what they mean for the research questions this study seeks to answer. It also critically evaluates the research methodology in light of the results it produced and explores options for further research.

Research Questions

The three questions posed at the beginning of this thesis were:

- How much green space is available in the Waikato region and how accessible are these spaces?
- What effect does socioeconomic deprivation have on access to green spaces and the benefits of nature in the Waikato region?
- What are the planning and policy implications of this research?

The data gathered by this study can be used to inform discussion of these questions.

Access to Green Space

How much green space is available in the Waikato region and how accessible are these spaces?

In light of the many health, environmental, economic and social benefits access to green space can provide, understanding how easily Waikato residents can access green spaces in order to gain these benefits is essential. The results of the GIS study provide data that can help in answering this question.

Quantifying Green Space

Quantifying green space allows us to see the total green space area, green space area per capita and green space area as a percentage of total area for the region and at a territorial authority level. Public reserve area and conservation land area were also calculated individually.

Overall, the total green space area, green space as a percentage of total area and green space per capita varies greatly from district to district. The most obvious trend is that regions with large areas of DoC land perform well in all three measures.

Hamilton City has, by far, the least green space area of all the districts, it also has the least green space per person and the third smallest percentage of green space as a percentage of its total area (7.8%). This is to be expected as the majority of land in Hamilton is urban area

while most other districts are primarily rural in character. Hamilton also has the highest total population and the highest population density of all of the Waikato's districts. Despite having less green space area than any other district, Hamilton city has 1,152 green spaces, more than most other districts, however, the green spaces in the city are on average far smaller than any other districts. Hamilton city's population is also expected to grow at a faster rate than any other district. This means that the city's green space network faces greater population pressure than any other district, and indicates that efforts to ensure equitable green space access are especially important there.

The Waipa and Waikato districts also have low percentages of green space (3.2% and 6.2% respectively), these areas are both dominated by farming with smaller urban settlements, and they have much smaller areas of conservation land than other primarily rural districts. The Hamilton, Waipa and Waikato districts rank the lowest in terms of green space area per capita, these three districts are the region's most populous and together make up more than 60% of the region's total population. This is significant as it means that these districts are likely to experience the most pressure on their green spaces as a smaller area of green space must serve a larger population.

The Thames-Coromandel, Taupo and Hauraki districts on the other hand, have a much larger area of green space and green space makes up a much larger percentage (30-40%) of the total area of these districts. This is primarily caused by the large conservation areas in these districts, but these areas also have significant areas of public reserve. This indicates that these districts would experience the least population pressure on their green spaces.

The vast majority of the region's green space is made up of conservation land, and a great deal of this conservation land is located far from the most populated areas. This is a potential concern for accessibility, as green space that is inaccessible is not able to confer the benefits of nature as effectively as accessible spaces. The location of conservation land is in many cases dependent on factors outside of providing access, particularly the location of natural features and or what land was available to the crown.

Conservation area makes up the vast majority of the region's green space, and constitutes 16% of the region's total land area. Conservation areas are usually large areas (the average Waikato conservation area is 142 hectares, while the average public reserve is three hectares) however, they are usually located in rural areas and as such may not be as accessible as public reserve land. Public reserve land makes up only four percent of the region's green space and less than one percent of the total land area. Despite this there are nearly twice as many public reserves as there are conservation areas and they make up the majority of the green spaces that urban dwellers have walking access to.

Green space area per capita is relatively high compared to most standards, the regional average of 1.092 hectares per person (1092 hectares per 1000 people) greatly exceeds any of the green space per capita standards discussed in the literature review. Some of these standards specify only parks and/or sports fields rather than green space in general, in order to account for this public reserve land alone can be compared with the standards. With 300m² of public reserve per person the region meets all three standards for green space discussed in the literature review, 26m² per person, 1ha per 1000 people and 5.5ha per person. Although none of the per capita standards directly relate to the data used in this study, the large quantity of green space available per person, even if conservation area is not included in the green space total, indicates that, on a regional level, there is not a serious lack of green space that is open to the public. The quantification of green space does not account for the distribution of green spaces within territories and the distances people must travel to reach the spaces, meaning that it cannot show how accessible all of the green spaces in the region are.

The Waikato region contains 5,334 green spaces smaller than two hectares in area, in total these account for two thirds of the region's green spaces, but only 0.4% of the total green space area. As these spaces are smaller than the two hectare minimum, these spaces are all excluded from of the ANGSt analysis. This means that the benefits of these spaces are not being accounted for by the ANGSt model, and whilst these spaces make up a very small percentage of the region's total green space area, they potentially make up a large part of urban dweller's day to day green space access. The NZRA recommends that people living in urban areas should have access to a neighbourhood reserve of at least 0.5 hectares within walking distance. This indicates that they believe that spaces smaller than two hectares can provide space for recreation at least. While larger green spaces generally provide more benefits than smaller spaces, particularly to biodiversity, the benefits of these spaces are not being accounted for at all. This is a potential limitation of the ANGSt model, particularly as many urban green spaces are smaller than two hectares.

This part of the method showed the overall quantity of green space in the region and gives a basic overview of the population pressure on green space across the region's districts. However, the quantification alone fails to account for the distances people must travel to reach spaces an important aspect of the accessibility of these spaces, and inaccessible green space is unable to provide many of the natural services accessibility can provide.

Access to Green Space Analysis

The ANGSt analysis allows the accessibility of green spaces to be examined in terms of travel distances. ANGSt results vary across the region, and different areas do better in different standards, in general urban areas have better access to small green spaces while rural areas

have better access to large green spaces. 15% of the region's population meet all ANGSt standards while 17% meet no standards.

The ANGSt standard is not designed as a measure of 'performance', it is instead intended to give a strategic overview of green space access. Determining what constitutes an 'adequate' level of access is subjective, and as such ANGSt is more useful as a tool for identifying areas of deficient access to green space and can allow planners and policymakers to take action to better serve the needs of people in those areas.

Overall the results of the Waikato ANGSt analysis are similar to the English ANGSt analyses, with a higher percentage of the Waikato's population meeting all four ANGSt criteria. Drawing conclusions from this comparison alone, however, is unlikely to provide useful or accurate conclusions due to the many differences between the two countries. Besides this, the ANGSt model is not considered a measure of how well an area performs in terms of access to green space, rather it exists to identify areas of deficiency and give an overall view of accessibility. The purpose of this comparison is to provide more information which can be used to evaluate the applicability of the ANGSt model for New Zealand use. Differences in the figures between English and New Zealand results are likely affected by differences between the countries' green space planning, or by the historical, cultural or economic differences between both countries that shape green space planning and conservation efforts.

With 80% of the region's population residing in urban areas, urban access to green space is an extremely important part of access for the region. Urban areas tend to have better walking access than rural areas, but less access to large spaces and higher population densities mean that the green spaces in these areas serve more people than spaces in rural areas. A relatively large percentage of Hamilton City's population meet the ANGSt standards for small spaces, but the city has by far the least green space per person of any district, indicating that it has the most crowded green spaces by far. This is to be expected as Hamilton City has by far the highest population density of any district in the region.

Many of the areas where a lot of the population do not meet ANGSt standards are low population density rural areas, as such the people living in these areas are likely to have access to more private green space on their own property, however these spaces usually do not provide all of the benefits that publicly accessible natural green spaces can provide. Private green spaces can provide people with space for recreation, but often do not have the same conservation values as other spaces, and do not foster social interaction the way that public spaces do.

The low figures in the Otorohanga and South Waikato districts may be explained by the availability of privately owned, but publicly accessible green spaces in these districts. These

spaces have the highest percentage of district population meeting no ANGSt standards, but they also have large areas of privately owned forestry land that in many cases is open to the public for recreational use. This land is not included in the ANGSt analysis and as such, the effects of these areas on people's access to green space are not taken into account.

Analyzing public reserve land separately from total green space is important as altering and establishing reserves is a simpler and much more common process than with conservation land. Reserves can be established by either the Minister for Conservation or by local authorities, while conservation areas are established exclusively by the Minister for Conservation. As reserves are usually much smaller than conservation areas few people meet the standards for 100 hectare and 500 hectare or larger spaces.

Most (64%) of the Waikato's population have access to a green space within walking distance and 83% of the population meet at least one ANGSt standard, this indicates that the majority of the region's residents have some form of green space access. However, areas of low access still exist in the region, many rural areas have poor access to green space, particularly green space within walking distance of their homes. However, people living in rural areas often have more access to private green spaces due to the larger lot sizes in rural areas and in some places privately owned green spaces that are open to the public. These private spaces can provide access for recreation, but often do not have the same benefits for conservation and biodiversity and fail to provide the same opportunities for social interaction as public areas do. The benefits of private green spaces are not as well understood as those of public spaces, further research on access to private green space could help to fill some of these existing research gaps. Areas with deficient access to green space should be a priority when planning future green spaces.

The high level of green space area available per person indicates that there is a great deal of green space in the region, however the majority of this green space is located in districts where fewer people live, this limits the accessibility of these spaces. The Hamilton and Waipa districts have the least green space per capita, and the least green space area in total of all districts in the region. This indicates that the green spaces in these districts are likely to experience the most population pressure.

One of the most significant differences exists between urban and rural areas. Urban areas tend to have better walking access to smaller spaces, but the spaces in urban areas also serve more people than rural spaces do, potentially putting these spaces at risk of becoming overcrowded. Most large green spaces are DoC land which is generally located in rural areas, this leads to few meshblocks urban areas achieving standards for 100 and 500 hectare green spaces. 80% of the region's population live in urban areas, meaning that urban access to

green space is especially important and, due to population densities, improving access in these areas would affect more people than in rural areas. Improving access in urban areas can be more efficient, as it improves access for more people.

It has been suggested that the ANGSt model may suffer as an English standard being transposed to New Zealand, that cultural differences and differences in green space planning between the two countries may affect the ability of ANGSt analysis to accurately assess access to green space. Some interviewees suggested that the distances people are willing to travel to reach green spaces may be further in New Zealand than in England. Extending the travel distances in the model would increase the number of people that have access to green spaces, however research would need to be undertaken to determine what distances New Zealanders would be willing to travel in order to reach green spaces before any such modifications be made to the model. The other limitations of the ANGSt method (such as its inability to account for the quality or perceived accessibility of green spaces) are limitations of scope rather than accuracy, further study would be required to understand these aspects of green space access.

One of the main aims of this study was to examine the provision of green space for the Waikato region. Most Waikato residents have access to a green space of some kind and the majority have walking access to a green space. However, there are still over 65,000 people for whom access does not meet any of the ANGSt criteria, the Otorohanga and South Waikato districts have the highest percentages of population meeting no standards. Some participants felt that public access to private green spaces in these districts may make up for this lack of access, but further analysis would be required in order to better understand what effect private spaces have in these areas. The results of this study highlight the important contribution that conservation land makes to green space access in the region. Conservation land makes up 96% of the regions greenspace and is especially important for rural green space access. Conservation areas make up the majority of accessible green spaces over 100 hectares in area.

The figures given in the previous chapter cannot show whether the region has sufficient or insufficient green space access. The ANGSt model does not state any threshold for what constitutes an acceptable level of green space access, rather the model is used to provide a strategic overview of access to green space (McKernan & Grose, 2007). This overview can be used as part of the evidence base for green space related planning and policy initiatives. Determining what constitutes an acceptable level of access is a value judgment and would likely require that the costs and benefits of improving access be considered. While the quantification of green space showed that there is a large amount of green space, a lot of this

is not very accessible to the public. Much of the largest green spaces are located far from the region's main urban areas. The areas where high percentages of the population meet the standards for access to large green spaces have large areas of DoC land. Urban areas tend to have more small spaces within walking distance while rural areas have better access to large spaces. Understanding these disparities in access to green spaces is important for understanding how to improve provision of green space.

The research undertaken here gives only a part of the picture of green space accessibility for the region. There has still been very little research on the quality of green spaces in the region, how people use green spaces and how use might change in the future.

Socioeconomic Deprivation

What effect does socioeconomic deprivation have on access to green spaces and the benefits of nature in the Waikato region?

Determining whether a relationship exists between socioeconomic deprivation and access to green space and what the nature of this relationship is would be a valuable starting point for addressing the environmental justice issue such a relationship would create. Environmental justice requires that all people have an equal access to the benefits of nature and that all people share the costs of environmental degradation.

The research was unable to find a strong correlation between NZDep scores and ability to meet ANGSt standards. The effect of socioeconomic deprivation on access to green space remains unclear, very little correlation was found between a meshblock's NZDep score and whether it met ANGSt standards. Comparing the ANGSt results of low and high deprivation meshblocks showed that high deprivation meshblocks were less likely to meet all four standards, but also slightly less likely to meet no standards. Meanwhile low deprivation meshblocks were less likely to meet the 100 and 500 hectare standards, and slightly less likely to meet the two hectare standard, but are more likely to meet the 20 hectare standard than high deprivation meshblocks. These results do not show any clear relationship between socioeconomic deprivation and access to green space, and seem to indicate that some other factor or factors has greater influence green space access. The inconsistency of these results and the weak correlations between NZDep score and ANGSt results indicate that other factors are likely influencing access to green space. Interviewees believed that the nature of the NZDep data may prevent correlation, and that other variables could provide a better comparison with ANGSt data.

There is little correlation between green space per capita at a district level and the average NZDep score for the district. Although the small sample size of this sample probably limits the accuracy of this analysis. It is possible that if this analysis were undertaken on census area units or meshblocks that a greater correlation would be found as NZDep scores show little variance between territorial authorities.

Overall a decisive answer could not be found to this question, further study is needed in order to better understand the causes of disparities in green space access. The results of this study were inconclusive, high deprivation meshblocks were more likely to meet some ANGSt standards, but less likely to meet others and no clear relationship could be identified. It is likely that other factors influence green space access, further research is required to determine what these factors might be and what effect they have on access. While this study was unable to show a consistent relationship between deprivation and distance to green space some studies have found that perceived accessibility of green space and access to quality green spaces is related to socioeconomic deprivation. Further research could explore the nature of these relationships.

Comparing NZDep scores against ANGSt results failed to produce any clear relationship between socioeconomic deprivation and access to green space. If a relationship does exist between socioeconomic deprivation and access to green space this study was unable to find evidence of its existence. If this relationship exists, more research is needed to establish its existence and nature. There is some evidence that meshblocks with low NZDep scores have less access to large green spaces (areas over 100ha in area). Overall, however, no clear relationship was found between the two variables. It is possible that there is some relationship between socioeconomic deprivation and access to green space, however the nature of this relationship remains unknown. Some interview participants suggested that finding correlations with an aggregated index such as the NZDep index can be difficult. Some studies have suggested that deprivation may affect different aspects of green space access such as access to high quality spaces or perceived access to green space, further study could help shed more light on the nature of these relationships. Other studies have found that people living in socioeconomically deprived areas are less likely to visit green spaces, this indicates that there is some relationship between green space accessibility and deprivation, although it may not be related to the physical distance to green spaces. The aggregated nature of the NZDep index may have diluted the correlation between deprivation and access to green space. Further research could look at more refined measures of deprivation, they could, for example use income alone as a measure for deprivation. This may produce different results than those found by this study and may shed more light on the relationship between the two factors.

Planning and Policy

What are the planning and policy implications of this research?

The Waikato region faces many challenges as it undergoes population growth and changes to its population structure. Planners and policymakers will have to respond to these challenges in order to ensure that the needs of the population are met. These changes will have impacts on the demand for, and accessibility to, the region's green spaces. The results of the GIS analysis show that the region has a great deal of green space, but also has areas where green space is largely inaccessible or where certain types of spaces are less accessible than others.

In 2013, NIDEA produced a report on the demographic trends and projections from 1986-2031. The Waikato's population increased from 325,220 in 1986 to 416,200 in 2012, and it is expected to grow to 469,910 by 2031 (up 13.8% from 2011), 83% of this growth is expected to be in the 65+ age bracket (Jackson 2013). The Waikato region's population is slightly older than the national average and is ageing slightly faster than average. In terms of growth by ethnicity, Māori, Pacific Island and Asian populations are projected to grow at a faster rate than the region's European/Other population. The majority of the region's population growth is expected to take place in the Hamilton, Waikato and Waipa districts. Conversely, the Hauraki, Otorohanga, South Waikato and Waitomo districts are projected to experience an overall decline in population between 2011 and 2031. The 65+ age group is the only group projected to grow in all districts and is expected to make up a significantly larger percentage of the region's total population.

These projected changes have significant implications for planning and policy. A growing population will lead to a growth in demand for green space, this will put strain on all of the region's infrastructure including green spaces unless more green spaces can be made accessible to the public. A growing population will also lead to further development of green fields land as urban populations expand outwards, this will lead to less green space, and is likely to lead to a loss of unmanaged wilderness areas while urban parks become a larger part of people's access to green space. A more diverse population will likely lead to demand for a larger range of green space sizes, green space types and different infrastructure provided at these spaces. Older people will want different kinds of green spaces than younger people, and it is possible that different ethnic groups may have different green space preferences, though more research would be needed to establish the exact nature of these preferences. Older people may be unwilling to travel as far to reach green spaces. This may require that these populations have access to green spaces closer to where they live. The majority of population growth is taking place in the Hamilton city, Waikato, Waipa districts, this means that demand for green spaces increase the most in these districts. This is significant as

Hamilton and Waipa already have the least green space area per capita in the region and this will increase pressure on the limited spaces available in these districts. A declining population would lead to a decrease in demand for green spaces in those districts, however, the districts where population is expected to decline already have the most green space area per capita, so the effect of this decrease in demand may not be significant.

As population grows and population structure changes, the region's green space network will face increasing pressure in order to meet the needs of the population. This may mean that councils increasingly look at multifunctional green spaces and green infrastructure in order to most efficiently use the land and resources that they have.

Growth areas will require new green spaces be established in order to meet the needs of these communities. The results of this study can help to determine what spaces exist that might be useful for these areas, and if new reserves need to be established, what the best options are for meeting access needs. The results of the ANGSt analysis can also be used to help determine if providing new spaces in existing areas is feasible. The new development that will result from growing populations will most likely have impacts on existing green space as this land is developed to meet the needs of new populations. Underused, inaccessible and unmanaged natural spaces are more likely to be developed than popular, more managed green spaces. This is likely to impact conservation efforts, as more natural areas tend to be better for biodiversity than urban parks and other managed spaces. This expansion of urban areas into natural environments will present challenges for organizations concerned with conservation.

Policy Framework

The RMA gives councils authority to designate land for parks and open spaces to signal their intention to purchase the land as a public work. The RMA also allows councils to take land for esplanade reserves when subdivision occurs along the riparian or coastal margins of a water body. The RMA enables territorial authorities to collect financial contributions from developers in return for the infrastructure provided as part of new developments. These powers are in addition to a development contributions policy enabled through s 102(2)(d) of the Local Government Act 2002 (LGA). The LGA also allows territorial authorities to collect targeted rates to fund these activities. Methods for acquiring land for reserves used by councils include purchase from a willing seller, compulsory acquisition under the Public Works Act 1981, accepting land as a gift from a landowner and land being vested in council ownership due to planning rules (such as esplanade reserves). The Reserves Act 1977 allows territorial authorities to declare parks and open spaces as reserves.

Reserves are established under Part Two of the Reserves Act 1977, this act allows the Minister of Conservation, or local authorities to establish reserves. Section 7 of the Conservation Act 1987 allows the Minister of Conservation to acquire and hold land for conservation purposes, s17A makes the DoC responsible for administering and managing these areas. Under s 41 of the Reserves Act 1977, the administering body of a reserve must produce a reserve management plan within five years of taking over the administration of the reserve. Reserve management plans are required to provide for the “enjoyment, maintenance, protection, and preservation, as the case may require, and, to the extent that the administering body's resources permit, the development, as appropriate, of the reserve for the purposes for which it is classified” (s41 (3)).

Acquiring, developing and maintaining reserves by local authorities requires funding. Long term plans are developed under s 93 of the LGA, and generally cover a period of 10 years. Long term plans provide a long term focus for local authorities and cover all of their functions including financial planning. The long term plan outlines long term goals for management and improvement of council resources including green spaces. A council's long term financial planning for green space projects is contained in its long term plan. Annual plans are developed under s 95 of the LGA, they contain local authorities' proposed annual budgets and support long term plans in providing strategic direction for councils. Through this mechanism local authorities can strategically plan for green space development in conjunction with the LGA development contributions policy discussed earlier. Understanding current access to green space and projected population change in the region assists in developing strategic reserve development and funding policy.

However, in practice establishing new green spaces is an expensive process due to the costs of land, infrastructure and maintenance. This limits councils' abilities to create new reserves. While it is relatively easy to identify where areas of deficient green space access are, resource limitations can make it difficult to create green spaces to meet the needs of these areas and other council functions often take priority. However, new research showing the benefits of green spaces and the increasing use of green infrastructure in planning could make green spaces more appealing to decision makers. In most cases the primary source of capital for acquiring new spaces for reserves comes from development contributions paid to councils when new developments take place. For this reason, providing reserves for new developments is often given priority over retrofitting spaces for existing areas, which may be deficient in green space access. Councils also tend to prioritize high population areas, as green spaces in these areas can serve the needs of many people, this can lead to poor walking access to green space in rural areas. However, these areas usually have higher access to private green space than urban areas, which can mitigate the impact of deficient access to green space.

Due to the cost of acquiring land improving access to large spaces would be much more difficult than improving walking access to small spaces, particularly in urban areas. Large areas of green space are usually established and managed by the DoC as conservation areas, as such it is more likely that the DoC will be better placed to improve access to large green spaces.

Local Level Policy

The Waikato Plan is an ongoing project by the Waikato Mayoral Forum to develop a joint spatial plan for the region. The infrastructure inventory undertaken as part of the Waikato Plan project states that consideration may be given to jointly funding regional parks. The inventory states however that there is likely to be little benefit in regional collaboration in the management of local parks due to differences in local needs (Waikato Mayoral Forum Technical Working Group 2013). If regional parks were established, this could potentially lead to improvements in the accessibility of large spaces. Regional parks tend to attract people from further distances than many other green spaces, so it is possible that regional parks could serve the recreational needs of people across the region (and from other regions).

The Future Proof growth strategy explores scenarios for the future proof sub-region (Hamilton City, Waikato District and Waipa District) based on projections up to 2061. The growth strategy was developed in 2009 to manage collaborative and sustainable growth in the sub-region. The Future Proof implementation plan includes a section on open space, recreation and leisure. This section outlines the growth issues and key approaches and actions relevant to open space planning. The implementation plan acknowledges the contribution of open spaces to quality of life, and notes how community expectations for open space are changing. Key approaches identified include supporting existing spaces rather than establishing new competing spaces, fostering connectivity by providing green corridors and ensuring all people have equitable access to the open space network. Actions listed in the plan include providing spaces for future growth areas, creating a range of high quality spaces and developing a coordinated approach to planning regional open space network. The strategy also identifies improving access to the Waikato River as an action for achieving the objective of restoring and protecting the river. The strategy also recognizes that sometimes conflicts can arise between providing access and protecting ecological values. It is notable that the future proof sub-region is made up of the three districts that have the highest populations and smallest quantities of green space.

At a local level, there is a great deal of high level strategy for managing green spaces, but more specific standards and regulatory measures are rare. Some interview participants felt that while the policies were in place, actually implementing these policies can be difficult due

to resource limitations and other council functions often taking precedence. Hamilton City, having the least green space available per capita and being the largest urban area in the region has more green space related policy than other territorial authorities. This is likely due to the higher pressure the district's green spaces face, as urban dwellers rely on public green space much more than rural dwellers. Differences in council funding probably also partially account for differences in the amount of policy between territorial authorities.

The Hamilton Plan identifies ten priorities for the city over the next ten years, one of these priorities is that Hamilton becomes an 'urban garden', which is characterized by a connection with nature achieved through the proliferation of both green spaces and smaller fixtures such as street trees and plantings. As part of achieving this goal the council aims to increase the proportion of green space in the city. The long term plan budgets \$76 million for various parks and green spaces related projects over the next 30 years, including purchasing new reserves, upgrading existing reserves and specific large projects including the Rototuna Sports Park. The plan outlines issues and options relating to green spaces and parks, one significant issue identified in the plan is ensuring that new areas of the city have access to large open spaces. The plan recognizes that land will have to be identified, purchased and developed in order to meet these needs. The Hamilton Open Space Plan sets out a strategic vision for the city's open spaces for the next 50 years. This vision includes guiding principles including making the best of existing spaces, no net loss of open space and maintaining biodiversity and outlines actions for realizing these principles. Other relevant plans and policies include the Partly Operative District Plan and the individual reserve management plans prepared under the Reserves Act 1977. Hamilton has a significant proportion of the region's population and its green space network faces greater population pressure than anywhere else in the region. Therefore improving access to green space in the city and ensuring that future needs will be met is especially important. The increased planning focus on understanding and improving green space access shows that this is now starting to be recognized. However there is still more work to be done to provide equitable access for all.

Other territorial authorities have less specific green space plans and policy, but green space accessibility is often covered by other plans and policies. Most district plans have zoning for reserves or open spaces with relevant objectives, policies and rules for these zones. These govern the types of activities that can take place in each district's green spaces. Territorial authorities commonly use local purpose reserves (and other reserve types) created under the Reserves Act 1977 for providing access to green space to local communities.

As access to green space can provide a wide range of benefits, the results of this study have additional implications for planning and policy. Recent plans and policies created by councils

show that the importance of green space is being increasingly recognized at a local government level. Some city councils in New Zealand have begun to map access to open space using similar methods to those used in this study. Hamilton City Council has mapped access to neighbourhood reserves, using a standard of 0.5 hectare reserve within 500m actual walking distance. This study found that 82% of all residentially zoned lots in the city have access to a neighbourhood reserve. The council plans to continue to monitor this measure of access, to see how it changes over the next 10 years. The council plans to build on this potentially with some form of user analysis, it considers that this will help better understand green space use and how it might change in the future. In addition to providing for the needs of future growth areas, the council plans on using the results of this analysis to identify areas where they can improve access, but funding limitations may limit ability to do so.

Some interview participants pointed to the recent work Auckland Council has done as a good example of planning for green space accessibility. Auckland Council policy concerning green space includes provisions of the Unitary Plan, the Parks and Open Space Acquisition Policy and ongoing work at developing tools for assessing open space accessibility and demand. Objective B2.7.1 (1) of the Auckland Unitary Plan Operative in Part states that “Recreational needs of people and communities are met through the provision of a range of quality open spaces and recreation facilities” with the indicator for this objective calling for “The levels of accessibility, total area and quality of parks and recreational facilities increase over time.” Auckland Council have also developed the Auckland Parks and Open Space Acquisition Policy, which sets out procedures for identifying and acquiring land for creating new parks and reserves or for improving existing spaces. This policy, prioritises acquisitions that will service new developments as well as parts of the city undergoing rapid growth. This is consistent with the priorities of councils identified in the interviews of this study. The four criteria for new acquisitions are meeting the open space needs of the population (both present and future), improving the connectivity of the city’s green space network, protecting and restoring significant natural features and improving existing spaces. Auckland Council has also recently undertaken GIS work similar to that of Hamilton City Council and have been developing tools for assessing open space provision, including open space provision guidelines. These tools will not only assess the accessibility of open space, but also their capacity (Auckland Parks and Open Space Acquisition Policy 2013). A policy like this could help councils to acquire green spaces to meet the demands of new areas or to provide access to areas where it is lacking.

There are likely to be many more implications for planning and policy, however, it is clear that further research is needed in order to fully understand them. Better understanding the way green spaces are used and how this use will change over time would allow planners to better

provide for the needs of green space users and increase people's use of green spaces. Increased use of green spaces has been shown to have many health benefits.

Methodology and Limitations

Overall the methodology was successful in providing data that allowed regional green space accessibility to be examined in a way that had not been undertaken before. While the causes of disparities in access to green space remain unknown, the work to determine the relationship between socioeconomic deprivation and access does contribute to the body of research on the topic.

Some concerns were raised by interview participants about the limitations of the ANGSt method and the data used. These concerns generally related to the applicability of the standards for New Zealand use and the usefulness of the standards for urban areas. While the ANGSt standards need further testing before their effectiveness in a New Zealand context is fully understood, the results of this analysis still provide a useful strategic overview of green space access. Some felt that New Zealanders may be willing to travel further than 10 kilometers to reach a large green space. If the distances on the criteria were altered it could drastically alter the results of the analysis. Determining whether the distance and size criteria are appropriate for New Zealand would require some form of willingness to travel research be undertaken and research into the benefits that different sized spaces can provide.

Further Research

This research represents a part of the picture of green space access, and access to amenities in general, however, in order to achieve a better understanding of accessibility more research is required. Further research is needed in order to better understand green space access, its relationship with socioeconomic deprivation, the causes of disparities in access to green space and the planning and policy implications of this.

In New Zealand there has been very little research into access to green space, as such there are major gaps in the data available around the topic. Further research would give an opportunity to fill in some of these gaps and hopefully shed light on some of the aspects of green space accessibility we don't yet understand. The research could be supplemented by

work that looks at the aspects of green space access that the ANGSt analysis fails to account for, such as green space quality and the perceived accessibility of green spaces. Carrying out some form of user analysis for green spaces would also provide useful data for understanding how people use green space.

An assessment of green space quality would add another element to the analysis for access to green space. A quality assessment of green spaces could involve some form of contrast of higher quality with lower quality green spaces or an assessment of the types of spaces people have access to in different areas. Assessing the quality of green spaces would not only show the quality level of the region's green spaces, but this data could also be mapped using GIS to show how quality green spaces are distributed spatially. Assessing green space quality would likely involve undertaking either site visits to spaces or some form of remote assessment with satellite imagery. The POST assessment, an Australian tool, is an example of this type of assessment, however this assessment is intended primarily for urban parks, and data collection can be time consuming. Some form of quality assessment may be possible by reviewing reserve management plans and other existing information held by territorial authorities. This would most likely be less costly than undertaking site visits, but the information contained in these plans would be more limited than the data that could be collected during site visits. Developing a tool or set of tools that could assess all types of green space in terms of quality and conducting assessments of all of the region's green space would likely be very time consuming. Determining what constitutes high quality or low quality green space would potentially require collecting data on the types of spaces that people prefer. This data could be used in conjunction with the ANGSt results to determine where people had access to high quality spaces or the types of spaces that people in different areas have access to. This could be compared against deprivation data to determine if deprivation had some effect on the quality of green spaces available and if high quality green spaces are equitably distributed. As discussed earlier more refined measures such as income could be used to avoid the issues that may have affected this study.

Determining what role private green spaces play in providing people with access to green space, and what benefits this access provides could help to fill in a major gap in the research, especially as access to private green space is more common in many areas with less access to public spaces.

User analysis could be undertaken to examine how people use green spaces, which green spaces are most used and who is using them. It would likely involve demographic analysis of the users of green space and some form of count of users for green spaces. Having this data would be useful for estimating how demand for green space might change as population and

demographics change. It would also allow planners to determine which green spaces experience the highest demand and focus their green space planning efforts on these spaces. Some form of user analysis could also be carried out to examine perceptions of accessibility of green spaces. Some studies suggest that the perceived accessibility of green spaces may be more important than their physical accessibility in terms of encouraging use. This would likely involve some form of survey to gather data about how accessible people feel green spaces are in their neighbourhood and how often they use these spaces. The New Zealand quality of life survey collected data about people's perceived access to amenities, this dataset could prove useful for further study. This perceived accessibility data could be compared with the physical accessibility data from this study and deprivation data to determine if there is a link between deprivation and perceived access as some international studies have found. The causes of disparities between perceived access and physical access are not well understood, nor are the causes of differences in perceived access between different groups of people, more research is needed to establish the causes of these trends. Analysis of trends in green space use could help planners in providing for the future green space needs of the region.

The ANGSt analysis could be undertaken in other regions or for the whole country. This would allow comparisons to be made between regions and would also give a larger dataset to examine patterns in the data. ANGSt analysis could also be used to determine if future developments will have adequate greenspace provision, and work could be carried out to determine how urban growth and changes in population structure will impact access to green space. The model may require further testing first to determine whether it is suitable for New Zealand use.

More research is also needed into perceptions of green space accessibility, perceived accessibility often differs from measured accessibility and the reasons behind this are not well understood. The New Zealand quality of life survey collected data relating to perceived accessibility of amenities, but a more focused study of green space accessibility may be more useful for this work.

Further research is needed on the causes of inadequate access to green space. Given that comparing the ANGSt analysis results against NZDep data failed to produce any strong correlation, it may be rewarding to compare the results against other variables to see what relationship they have. The ANGSt results could be compared with factors such as soil quality, land values or some form of terrain dataset. Many of these datasets already exist, which would make undertaking these analyses simpler. Comparing the results of the ANGSt analysis against other datasets may produce stronger correlations. Although it is unlikely that any single factor will have an especially powerful explanatory effect on access green space, it is more

likely that access to green space is determined by a range of factors. Alternatively, the results of ANGSt analysis could be used to determine what effects access to green space has, Potential relationships follow-up research could explore include self-reported quality of life, perceived access to amenities and health and wellbeing data.

Carrying out this research would provide a more complete view of green space access and its relationship with socioeconomic deprivation, which would allow the planning and policy implications to be better examined. More generally further research is needed into the economic benefits of green space access, access to green space in developing countries and more research into green space in New Zealand.

Conclusion

The Waikato region is home to over 400,000 hectares of public green space, however, the ANGSt analysis shows that some people do not have access to any of these spaces. Most of the region's population have access to some type of green space, but some areas are still lacking in access. Urban areas tend to have better walking access to green spaces, while rural areas have better access to large spaces.

Overall, a clear overall relationship between socioeconomic deprivation and access to green space could not be found. There is some evidence that deprived areas have better access to larger green spaces, but no clear direct relationship. While it is possible that the socioeconomic deprivation data used in this study affected the accuracy of the results, it is more likely that other factors influence access to green space. The distribution of green space in New Zealand is dependent upon many factors, including historical, economic, cultural and environmental factors. Socioeconomic deprivation may or may not affect the distribution of green space, however this study was unable to find a clear relationship between the two variables. Previous studies have found that people living in socioeconomically deprived areas are less likely to use green spaces and more likely to perceive green spaces to be less accessible than people who live in less deprived areas. Further study is needed to determine the exact nature of the relationship between socioeconomic deprivation and green space accessibility. If green spaces are less accessible for people living in socioeconomically deprived areas, whether they are less physically accessible or only perceived to be less accessible, it would present a challenge for planners and policymakers to find a way to provide equitable access for these people.

As the region undergoes several population and demographic changes the demand for green space will change, both in terms of the quality and the quantity of the spaces required. Understanding exactly how these societal changes will affect demand for green space, would

likely require some form of user analysis be undertaken. Areas of poor access identified by the ANGSt analysis can be used by planners to decide where to locate new green spaces in order to best serve the region's green space needs. Along with providing green space access for new growth areas, these areas where access to green space is lacking should be the priority for improving access. However, resource limitations can impede council's ability to improve green space accessibility. Overall more data is needed in order to better understand the planning and policy implications of the region's green space accessibility.

Although this research provides an important first step towards understanding regional green space accessibility, much more research is needed in order to understand the causes of inequalities in access to green space and the other aspects of accessibility that were beyond the scope of this study. It is recommended that research be undertaken to assess the quality of green spaces in the region and to understand demand for green spaces and how this demand might change in the future.

17% of the region's population do not meet any ANGSt standard, indicating that they have little or no access to green space. This is probably the most concerning finding of this study, The Otorohanga and South Waikato districts have the largest proportion of their population not meeting any standards, some question has been raised about whether the access to privately owned but publicly accessible land such as forestry blocks (which make up a large part of people's access to green spaces in these districts) should be taken account of. Devising a method for including privately owned, publicly accessible green spaces and determining if they are capable of filling the same role as public green spaces is beyond the scope of this study.

The ANGSt model has never before been used in New Zealand, and likely requires further testing in order to determine whether any significant issues arise from transposing an English standard to New Zealand, despite this the model does provide a good overview of accessibility for the region, one that could be built on with further research. Further testing is needed to determine if ANGSt is appropriate for New Zealand use, while the basic principles of access to green space would remain the same between the two countries, historical, cultural, economic and environmental differences between the countries may have some effect on the accuracy of the analysis. This research is only a part of the greater picture for access to green space, the results presented should be viewed in the context of the wider body of research, much more of which is needed.

Access to green space provides people with access to the benefits of nature, as such it is important to ensure that all people have equitable access to green spaces. The GIS analysis undertaken as part of this study showed that most people have access to a green space,

however, there is still a significant percentage of the population who do not have access to public green space. No relationship was found between socioeconomic deprivation and access to green space, it is more likely that inability to access green space is caused by historical, environmental and cultural factors. Reserves are often planned based on servicing population centers and conservation areas are usually located where there are significant landscapes and conservation values. The results of the GIS analysis have a variety of implications for planning and policy, they indicate that there are areas of deficient green space access throughout the region. Meeting the green space needs of these areas could prove expensive and resource limitations may limit the ability to meet green space needs in all areas. While this study provides a valuable first step for understanding green space access for the region, more research is needed in order to better understand accessibility and what it means for planning.

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Appendix

Semi-Structured Interview Schedule:

This schedule outlines the topics that I would like to discuss in this interview. You do not have to answer every question and you are welcome to bring up other topics that are not covered in this schedule. I would like to know about green space access and its link with socioeconomic deprivation.

1. Do you think that the distribution of green space and the accessibility of green space across the Waikato region is affected by planning and policy?
 - *What planning and policy (at a local, regional or national level) might have led to this outcome?*
2. Do you think that the ANGSt standards are a realistic benchmark for green space access in the Waikato region and/or New Zealand as a whole?
 - *Why/why not?*
3. What do you think the results of this research mean for planning and policy?
4. Do you think that territorial authorities can do more to improve people's access to green spaces?
5. Do you think that the benefits of green space access are given adequate consideration in the planning and policy process?
6. Do you foresee any potential barriers (legal, financial or otherwise) to implementing policies that could improve green space accessibility for the region?
7. How do you think demographic changes (growing population, increasingly urbanised population, and aging population etc.) will affect the demand for green space in the Waikato?
8. What effect might these changes have on future green space planning?